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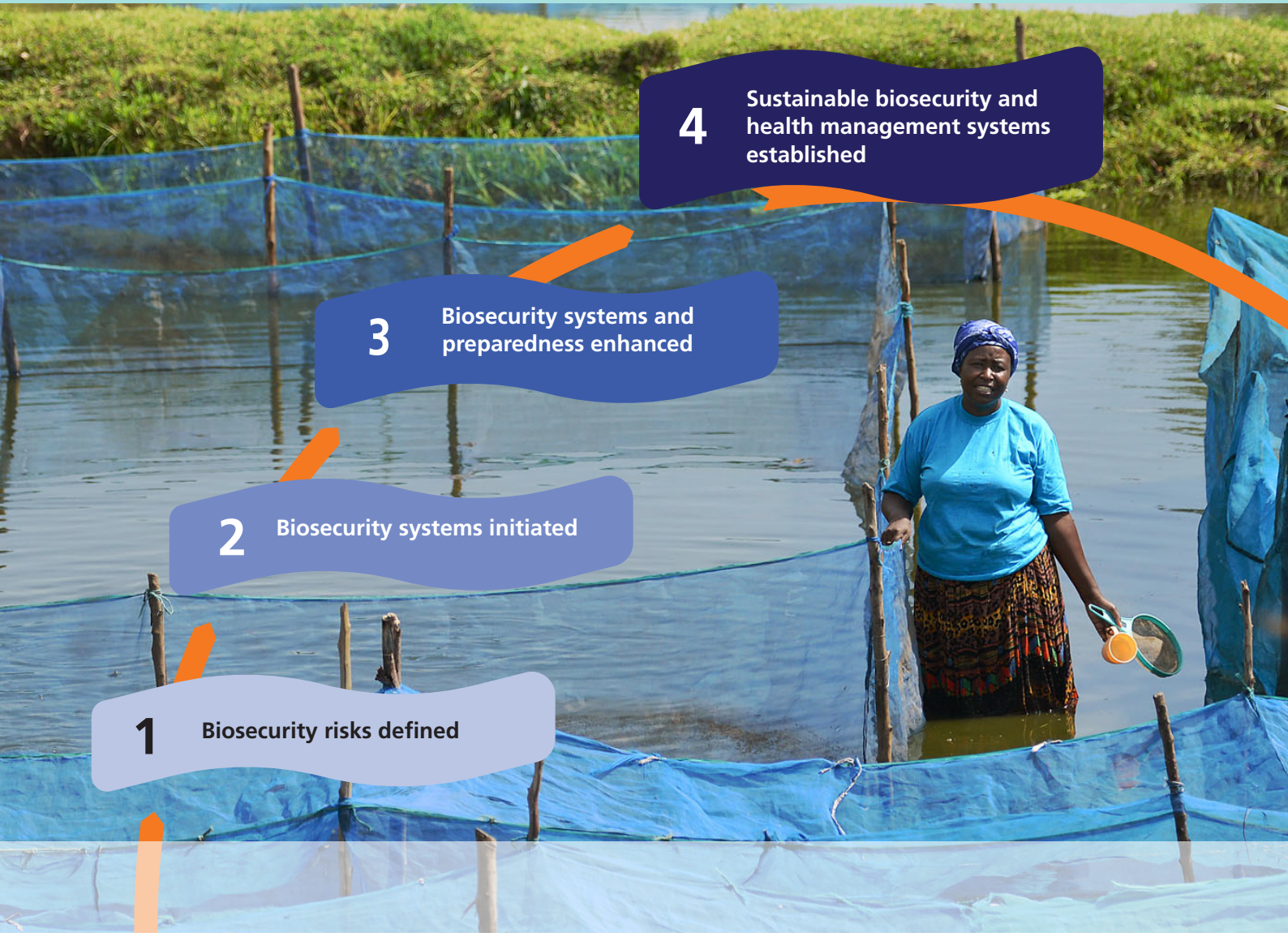
The Progressive Management Pathway for Aquaculture Biosecurity

Guidelines for application



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Preparation of this document

The Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB) is an extension of the "Progressive Control Pathways" (PCP) used for controlling major livestock and zoonotic diseases. The PMP/AB is an ongoing initiative that the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (WOAH), the Network of Aquaculture Centres in Asia-Pacific (NACA) and industry and academic/research partners are promoting after a consensus was reached during several multi-stakeholder and technical meetings attended by delegates and experts representing the governance authorities, industry, academe and other aquaculture stakeholders, held between 2018 and 2021.

The first draft, prepared and presented by Brett MacKinnon and Melissa McLaws, during the second multi-stakeholder consultation (January, 2019), was further developed by members of the PMP/AB Technical Working Group (TWG), chaired by Victoria Alday. Members of the TWG (2019–2021) are (in alphabetical order): Richard Arthur, Edgar Brun, Supranee Chinabut, Elizabeth Cottier-Cook, Andrea Dall'Occo, Alicia Gallardo-Lagno, Bin Hao, Motseki Hlatshwayo, Jie Huang, Stian Johnsen, Mark Lawrence, Yan Liang, Brett MacKinnon, Sharon McGladdery, Melba Reantaso, Itamar Rocha, Rohana Subasinghe, Saraya Tavornpanich and Birgit Van Tongelen, and new members of the TWG (2022) are: Alain Lebreton, Marc Le Groumellec, Bernard Mudenda and Qingli Zhang.

This work supports FAO's new strategic framework (2022–2025) on better production to ensure sustainable consumption and production patterns, through inclusive food and agriculture supply chains at the local, regional and global levels, ensuring resilient and sustainable agri-food systems in a changing climate and environment. The relevant Programme Priority Areas (PPAs) are Blue Transformation, a vision and process of using existing and emerging knowledge, tools and practices to secure and maximize the contribution of aquatic (both marine and inland) food systems to food security, nutrition and affordable health diets for all; and One Health, which addresses the increasing losses to production and adverse health effects caused by the spread of biological threats, including zoonotic infections of pandemic potential and antimicrobial resistance (AMR) in the crop, animal and aquaculture sectors. The relevant Sustainable Development Goal targets include: (1) 1.5 Build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters; (2) 3.d Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks; and (3) 15.8 Introduce measures to prevent the introduction and reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.

The finalization of the document was under the technical oversight of Melba Reantaso, Leader of Food Safety, Nutrition and Health Team (NFIMF) of the Fisheries and Aquaculture Division (NFI) of FAO, with assistance from Infofish (Director Shirlene Maria Anthonysamy and her staff), NFIMF and NFI colleagues, namely: Marianne Guyonnet, Paulo Padre, Sebastian Sims and Florence Faivre.

Project support was provided by the Norwegian Agency for Development Cooperation (Norad) through two Trust Fund projects, namely: GCP/GLO/979/NOR and GCP/GLO/352/NOR, and through FAO's Regular Programme funds.

Abstract

The Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB) builds on existing frameworks, capacity and appropriate tools, using risk-based approaches and public–private sector partnerships. It is expected to result in the sustainable (i) reduction of burden of diseases; (ii) improvement of aquatic health and welfare at farm, national and regional levels; (iii) minimization of global spread of diseases; (iv) optimization of socioeconomic benefits from aquaculture; (v) attraction of investment opportunities into aquaculture; and (vi) achievement of One Health goals.

In the context of the PMP/AB, biosecurity refers to the cost-effective management of risks posed by pathogens to aquaculture through a strategic approach at the enterprise, local-sector, national and international levels with shared public–private responsibilities.

This guidance document for PMP/AB application contains the rationale, vision, mission, scope, goals and benefits of the PMP/AB. The four stages of the PMP/AB are described in detail, including the overall objectives and key outcomes to complete each stage. It also presents a general stepwise process and recommended activities for completing the different stages. The PMP/AB checklist is divided into four broad categories, namely: Sectors and Stakeholders; Aquatic Health Services; Surveillance, Monitoring and Diagnostics; and Management and Evaluation.

The PMP/AB has four scenarios that provide opportunity and flexibility to any country, at whatever stage of aquaculture development, to initiate the PMP/AB by using these scenarios as entry-points: (i) countries with no national aquaculture biosecurity strategy in place, but an aquaculture sector exists or is in the early stages of development; (ii) countries with a national aquaculture biosecurity strategy in place with some level of implementation; (iii) countries with an advanced national aquaculture biosecurity strategy in place with full implementation; and (iv) countries whose aquaculture biosecurity is dependent on the biosecurity situation in neighbouring countries due to shared waterbodies, watersheds or coastlines and where a regional or sub-regional aquaculture biosecurity strategy is needed. Available tools that can assist in pilot testing and eventual implementation are also presented.

The PMP/AB offers a great opportunity for longevity, is sufficiently responsive to environmental and anthropological challenges, and enablespolicy environments, and the adoption of sound aquaculture production and good biosecurity practices.

Concerned stakeholders and entities are encouraged to join efforts in attaining the goals of the PMP/AB.

a
b
c
d

PLATE 1

Important aquaculture commodities
a Shrimp broodstock raised in a biofloc system in Saudi Arabia. @ SHUAIB T MUHAMMED
b Abalone farm in Lucap, Pangasinan, Philippines @ MELBA REANTASO
c Seaweed farm in Calatagan, Batangas, Philippines @ MELBA REANTASO
d Catfish from Chokanan Farm in Chiang Rai, Thailand @ PAULO PADRE

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Acknowledgements

The Food and Agriculture Organization of the United Nations (FAO) thanks the delegates and experts representing aquaculture stakeholders from governance authorities, the industry, the academe, intergovernmental organizations, donors and aid agencies; the hosts of the various events, i.e. the World Bank, the World Organisation for Animal Health (WOAH) and the FAO Liaison Office for North America; and the members of the PMP/AB Technical Working Group (TWG) for their active support and engagement during the consultations held in 2018 and 2019 that contributed significantly to formulating the concepts, principles and application of the Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB) that served as the main reference for the development of this guidelines for application document. Dr Keith Sumption, FAO's Chief Veterinary Officer, is especially thanked for his insightful advice and guidance in the thinking behind the PMP, which led to the exploration of the concept as applied to aquatics, and Dr Vimlendra Sharan, formerly Director of FAO Liaison Office for North America (Washington DC) and currently FAO Representative to Sri Lanka, for his generous support to the initiation of the stakeholder meetings held in 2018 and 2019.

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Abbreviations and acronyms

AAHS	aquatic animal health services
ALOR	acceptable level of risk
AMR	antimicrobial resistance
CA	Competent Authority
COFI/SCA	Committee on Fisheries Sub-Committee on Aquaculture (of FAO)
EPR	emergency preparedness and response
FAO	Food and Agriculture Organization of the United Nations
GMO	Genetically modified organism
HACCP	Hazard Analysis and Critical Control Points
IAS	invasive alien species
Infofish	Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region
IPPC	International Plant Protection Convention
LMO	living modified organism
M&E	monitoring and evaluation
MME	mass mortality event
NACA	Network of Aquaculture Centres in Asia-Pacific
NADL	National Aquatic Disease List
NAOHS	National Aquatic Organism Health Strategy
NAPL	National Aquatic Pathogen List
Norad	Norwegian Agency for Development Cooperation
NSAAH	National Strategies for Aquatic Animal Health
NTWG	National Technical Working Group
OIE	World Organisation for Animal Health (see WOAH)
PCP	Progressive Control Pathways
PMP/AB	Progressive Management Pathway for Aquaculture Biosecurity
PPA	programme priority area (of the FAO)
PPP	public–private partnership
PVS	performance of veterinary services
RAOHS	Regional Aquatic Organism Health Strategy
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
SWOT	Strengths, Weaknesses, Opportunities and Threats
TWG	Technical Working Group of the PMP/AB
WOAH	World Organisation for Animal Health (formerly OIE)
WTO	World Trade Organization

PLATE 2
Red tilapia cages on the river at
Nam Sai Farms in Prachin Buri Thailand

@ NAM SAI FARMS/WARREN ANDREW TURNER

1. Introduction

As defined by the Food and Agriculture Organization of the United Nations (FAO), biosecurity is a strategic and integrated approach that encompasses both policy and regulatory frameworks, aimed at analysing and managing risks relevant to human, animal and plant life and health, including associated environmental risks (FAO, 2007a). It covers food safety, zoonoses, the introduction of animal and plant diseases and pests, the introduction and release of living modified organisms (LMOs) and their products (e.g. genetically modified organisms, GMOs), and the introduction of invasive alien species (IAS). A core concept of biosecurity is to prevent and control the occurrence and spread of infectious diseases, and needs to be incorporated into governmental regulations as well as farm operational plans. If disease challenges are not properly handled, an aquaculture industry will not be sustainable. The sustainability of the aquaculture sector will be determined by effective biosecurity governance that can be put in place at all levels (e.g. policy and farm levels).

Prior to the initiation and development of the Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB), factors, drivers and pathways pathways, factors and/or drivers for disease emergence (**Figure 3**) in aquatic populations and aquaculture were analysed. They were as follows:

- **Health management and disease control:** Factors that limit the effectiveness of biosecurity measures include multiple institutions involved in aquaculture production and aquatic health management (i.e. fisheries and aquaculture authorities, veterinary services, food safety agencies); a lack of or before inadequate or poorly implemented biosecurity strategies at the farm, sector and national levels; low capacity for response to emergencies; weak implementation of international standards; and a weak regulatory framework and enforcement.

- **Trade:** Aquatic animals and plants are highly traded commodities, especially internationally, and many forms of live aquatic animals and plants (e.g. larvae, seedlings, fry, adults) and their products (live, fresh, frozen) are traded; their pathogens, as well as invasive plants and animals ("fellow travelers") can be transferred at the same time.

- **Knowledge of pathogens and their hosts:** Due to the unique aquatic medium, the health of a cultured population is not readily apparent. The large number of species kept in a variety of culture systems implies that knowledge on new diseases and host susceptibility will always be lagging behind aquaculture development. There is slow collective awareness of new threats, a lack of basic pathogen data (e.g. transmission routes), and a lack of basic host data (e.g. immunity, genetics). Diagnostics are usually focused on known and listed pathogens and diseases. Breeding strategies with health management elements are not in place for many species.

- **Ecosystem changes:** Aquatic ecosystems change through direct human activity (dams, community expansion, etc.) and indirect impacts (climate change, global pollution, etc.). Farming in these situations is complicated by the physiology of the animals and plants being cultured and in adjacent environments (e.g. poikilothermic constraints to adaptation), emergence of pathogens, and changing geographic ranges of wild stocks, microbes and parasites as environmental factors change near the tolerance levels for hosts and pathogens.

Aquaculture is a highly complex sector with many farmed species under many production systems and practices, and in different aquatic environments. People engaged in aquaculture are diverse, ranging from small-scale backyard producers to sophisticated large-scale industrial aquaculturists. The high volume of international trade in live aquatic organisms for aquaculture development further drives emerging diseases into regional or global outbreaks.

Biosecurity measures have been applied at the farm level in many countries, and various levels of success in improving biosecurity and reducing disease-related losses have been seen in some places. However, there have also been failures and breaches of biosecurity at both the farm and national levels. As long as cultured aquatic organisms are directly or indirectly in contact with wild organisms, new diseases will continue to emerge, and previously known diseases will reappear.

Pathogen introduction leading to disease outbreaks as a consequence of the movement of their hosts has become even more prominent in some regions, causing serious production and economic losses, even after two decades of continuous biosecurity applications.

The lack of effective national plans and strategies, and lack of awareness of the important role of biosecurity, weak adoption of appropriate biosecurity at governance and sector levels and poor public–private sector partnership (PPP) are all recognized as hampering the ability to reduce the incidence and impact of disease incursions. Thus, there exists an urgent need for a paradigm shift in the way disease challenges are being handled. When put in place proactively and preventatively, biosecurity measures are less expensive than solution-based, reactionary responses to outbreaks. Biosecurity should be established in parallel with any aquaculture development by all producing countries. Prevention and reducing the response time following an outbreak are essential basic steps for efficient biosecurity.

In view of the above, the development of the PMP/AB came to light. The PMP/AB is a new initiative that the FAO, the World Organisation for Animal Health (WOAH), the Network of Aquaculture Centres in Asia-Pacific (NACA), industry and academic/research partners are promoting after a consensus was reached during two multi-stakeholder consultations and two technical working groups throughout 2018 to 2019 as shown in **Figure 1**. The PMP/AB concept and principles were presented as Agenda 6 during the Tenth session of FAO's Committee on Fisheries Sub-Committee on Aquaculture (COFI/SCA 10, Trondheim, Norway, August 2019) with outstanding outcomes. The COFI/SCA 10 welcomed and endorsed the PMP/AB, and recommended the following: (1) to establish a TWG to further develop this initiative and provide guidance in application; (2) to pilot test the PMP/AB; and (3) to improve the communication stream (FAO COFI/SCA, 2019).

The Eleventh session of COFI/SCA (Rome, Italy, May 2022, virtual event) encouraged the continued development of the PMP/AB (FAO, 2022) while the Twelfth session of COFI/SCA (Hermosillos, Mexico, May 2023) expressed appreciation of FAO's work on biosecurity and aquatic animal health including the PMP/AB and the activities of the PMP/AB TWG and encouraged its continued implementation, including through regionally relevant initiatives.

The PMP/AB provides a solid platform as the PMP/AB's strategic and implementation plans should be jointly developed by industry stakeholders and governance authorities. This ensures buy-in and best-fit for each country, while providing a template that delivers a degree of consistency between participating countries.

FIGURE 1
Timeline

2. Rationale

The great potential of aquaculture to contribute to food security and poverty alleviation is being significantly hampered by aquatic disease challenges resulting from inadequate biosecurity measures applied in the aquaculture value-chain. National capacities in terms of infrastructure, enabling environment and expertise required to address the disease issues faced by the aquaculture industry, have not developed as quickly as required to support the rapid growth of the sector.

The PMP/AB was developed as an extension of the FAO's "Progressive Control Pathways" (PCP) approach (EuFMD, 2009), which has been internationally adopted to assist countries to develop systematic frameworks for planning and monitoring as well as strategies for the reduction, elimination and eradication of major livestock and zoonotic diseases. The PMP/AB builds on years of experience of the FAO, WOAH, NACA and their partners, regional and international organizations, national governments, academics and producers on managing the risks to the health of aquatic organisms.

3. Vision

The vision of the PMP/AB is to reduce the burden of diseases by improving aquaculture biosecurity practices worldwide in order to support food security and nutrition, social and economic development and resilience, rural livelihoods, food safety and public health, and the environmental sustainability of the aquaculture sector.

4. Mission

The mission of the PMP/AB is to guide countries towards achieving sustainable aquatic organsim health management and aquaculture biosecurity systems through the implementation of risk-based, progressive, and collaborative processes at the regional, national, and local-sector and enterprise levels; promotion of strong stakeholder engagement; improvement in aquatic health and production; and the prevention or reduction in the spread and impact of serious diseases of aquatic organisms in an effective and sustainable manner.

5. Scope

The PMP/AB is aimed at enhancing aquaculture biosecurity capacity at the regional, national, local-sector and enterprise levels by building on existing frameworks, capacity and appropriate tools using risk-based approaches and PPP. Whereas most PCPs focus on the control of a single disease or disease complex, the PMP/AB focuses on building resilience to aquaculture biosecurity vulnerabilities, e.g. threats to sustainable aquaculture due to pathogens and their associated diseases that result from poor management practices, legal and uncontrolled trade, and lack of capacity in public and private institutions.

The PMP/AB is intended to be flexible and inclusive to account for the diverse and complex nature of the aquaculture sector as a whole. The approach can be applied by a country to manage risks in any aquaculture sector, no matter what species, environment, production system, management strategy or size of operation are in place. It also can be applied by an individual farm to achieve a certain aquaculture biosecurity status for a specific species.

The PMP/AB focuses on building management capacity through combined bottom-up/top-down approaches. It promotes the application of risk management at all levels, as part of a coordinated national approach, and the development of an effective National or Regional Aquatic Organism Health Strategy (NAOHS or RAOHS) by focusing on mid- to long-term aquaculture biosecurity strategy development processes and by promoting a co-management approach to actively engage stakeholders.

Although initially conceived for the improvement of biosecurity measures for cultured aquatic animals, the PMP/AB has been expanded to include all cultured aquatic organisms (both aquatic animals and plants). This change recognizes the important contributions of seaweeds to global aquaculture production, national economies and the well-being of many local communities.

6. Terminology

The broader scope of the PMP/AB was derived from the terminology used by the WOAH in its *Aquatic Animal Health Code and Manual of Diagnostic Tests for Aquatic Animals* (WOAH, 2021a, 2021b), by the International Plant Protection Convention (IPPC) (ISPM, 2007), and in the many FAO documents dealing with various aspects related to aquatic biosecurity. The PMP/AB TWG has attempted to standardize and update the terminology applicable to the PMP/AB (*see* **Glossary**). Users of this document should note that the focus the PMP/AB is on pathogens of aquatic organisms (i.e. viruses, bacteria, fungi and parasites) and the diseases that they cause, while the focus of the IPPC is broader, being on plant "pests", a term that includes not only pathogens, but also invasive species and other free-living organisms that are harmful to plants.[1] Similarly, in the initial documents outlining the PMP/AB (FAO, 2020a, 2020b), the term "infectious agent" was used, where this current guidance document uses the term "pathogen". The acronym PMP/AB has also been shortened to mean Progressive Management Pathway for Aquaculture Biosecurity.

7. Goals

The PMP/AB is expected to result in the sustainable:

- reduction of burden of diseases;
- improvement of aquatic health and welfare at farm, national and regional levels;
- minimization of global spread of diseases;
- optimization of socioeconomic benefits from aquaculture;
- attraction of investment opportunities into aquaculture; and
- achievement of One Health goals.

[1] The IPPC (ISPM, 2007) defines "pest" as "any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products."

8. Benefits of PMP/AB

The PMP/AB offers countries the opportunity to harness aquaculture production in a sustainable manner that is responsive to environmental and anthropological challenges and requires the establishment of enabling policy environments. It promotes the awareness and adoption of appropriate biosecurity governance at the national, local-sector and enterprise levels, which can lead to reduction in the incidence and impact of targeted priority diseases and a reduced reliance on veterinary medicines, whose misuse can lead to the development of antimicrobial resistance (AMR) in aquatic populations.

The PMP/AB also provides a solid platform for PPP, through the formulation of strategic and implementation plans that are jointly developed by industry stakeholders, governance authorities and the academic and research sectors. This ensures buy-in and best-fit for each country, while providing a template that delivers a degree of consistency between participating countries and regions.

The PMP/AB can be applied to improve biosecurity for all forms of aquaculture production. Each stage provides a tangible benefit to stakeholders, and should demonstrate, communicate and advocate for activities that solve the challenges inherent in retaining this commitment. Co-management principles at each stage should ensure that problems are well recognized, and management solutions are identified. The PMP/AB also looks at establishing risk ownership and promotes active engagement and long-term commitment to risk management.

9. Advancement along the PMP/AB

The PMP/AB is not intended to be prescriptive, particularly at Stages 1 and 2 of the four-stage pathway (**Figure 2** and **Table 1**), as it is usually possible to realize the key outcomes through different activities or combinations of activities (see **Annex 1**). It is essential to address all the key outcomes for one stage in order to progress to the next stage.

It follows the principles of being risk-based, collaborative and progressive and a good understanding of the epidemiological triad showing the relationship between pathogen and susceptible aquatic population in a suitable environment that allows transmission of the pathogen and development of disease in the population. The Snieszko Circle (see **Figure 4**) shows the epidemiological triad of factors that contribute to the emergence and spread of diseases. Understanding the relationship between host, pathogen and environment further affected by human actions (see **Figure 3**) is key to the implementation of the PMP/AB.

FIGURE 2
The four stages of the PMP/AB

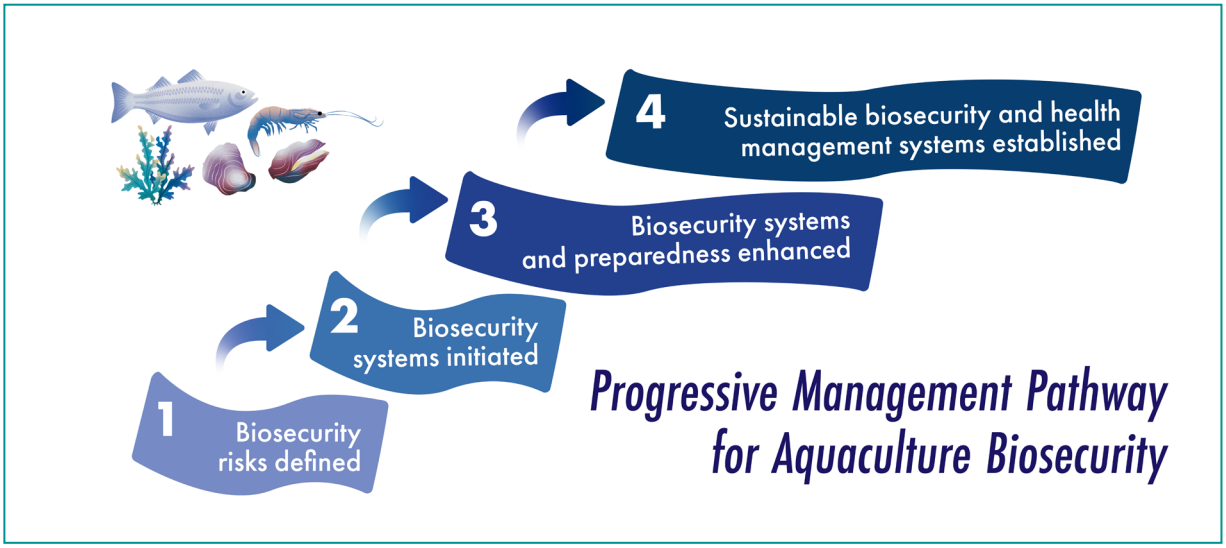


FIGURE 3
Factors, drivers and pathways to aquatic disease emergence

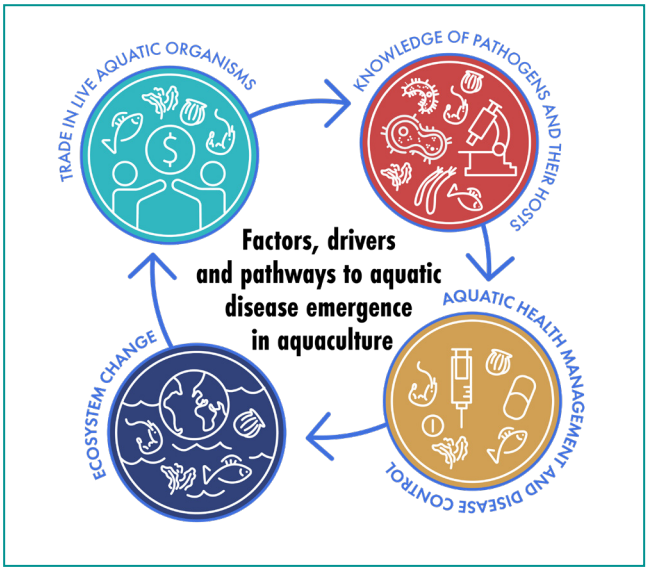
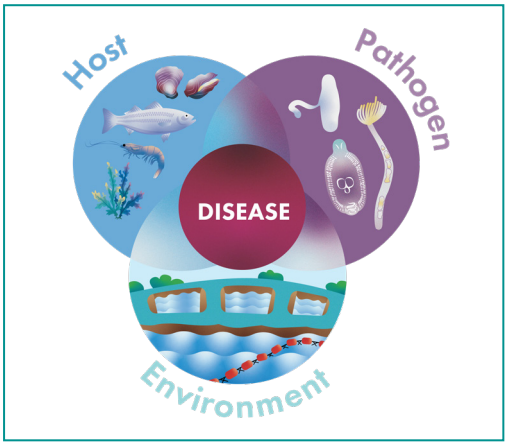


FIGURE 4
The Snieszko Circle

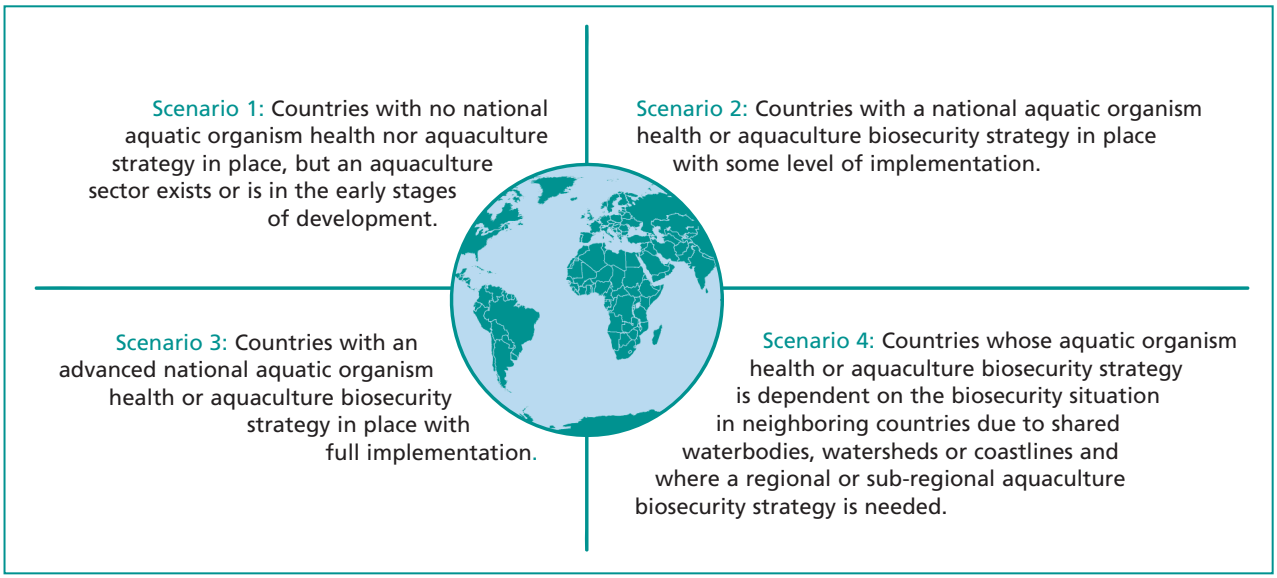


Source: Modified from **Snieszko, S.F.** 1974. The effects of environmental stress on outbreaks of infectious diseases of fishes. *Journal of Fish Biology*, 6(2): 197 – 208. https://doi.org/10.1111/j.1095-8649.1974.tb04537.x

The PMP/AB may be applied by any country, no matter what the current status of its national aquaculture biosecurity is. Possible scenarios for countries adopting the pathway include the following (see **Figure 5**):

- **Scenario 1:** Countries with no national aquatic organism health nor aquaculture biosecurity strategy in place, but an aquaculture sector exists or is in the early stages of development.
- **Scenario 2:** Countries with a national aquatic organism health or aquaculture biosecurity strategy in place with some level of implementation.
- **Scenario 3:** Countries with an advanced national aquatic organism health or aquaculture biosecurity strategy in place with full implementation.
- **Scenario 4:** Countries whose aquatic organism health or aquaculture biosecurity strategy is dependent on the biosecurity situation in neighboring countries due to shared waterbodies, watersheds or coastlines and where a regional or sub-regional aquaculture biosecurity strategy is needed.

FIGURE 5
Country scenarios as entry points to the PMP/AB



Countries decide for themselves how far, and how fast, it is appropriate for them to progress along the PMP/AB. Commitment to the pathway is meant to be flexible, and a country may not always need to progress to the next stage. Countries may initiate actions in different stages at the same time. However, to complete a stage and move to the next, a country must be able to demonstrate that it has achieved all the outcomes in that stage. These achievements are usually described in a nationally endorsed strategic document called a Gateway Pass which provides the foundation for the country to progress to the next stage. Countries can determine their current position on the pathway through a self-assessment questionnaire (the "PMP/AB checklist"), which lists specific minimum requirements (i.e. quality indicators) based on the key outcomes described in the PMP/AB stage descriptions. The PMP/AB checklist is presented in **Annex 3** and is described in more detail below.

Considering the wide variation of aquaculture sectors that may be present within a country, it is recommended to focus on a single prioritized aquaculture sector (or multiple prioritized sectors) while progressing along the PMP/AB. Priorities should be assessed and decided upon via consultations with public and private stakeholders. Therefore, aquaculture sectors within a country may advance along the pathway at different speeds.

10. PMP/AB stage descriptions

The four stages of the PMP/AB are summarized below and illustrated in **Figure 2.**

Stage 1: Biosecurity risks defined — key stakeholders in all aquaculture sectors are identified and the different aquaculture production systems in the country are described. Key vulnerabilities are identified, which may include threats to aquaculture biosecurity and production, wild populations, ecosystems, or human health in the vicinity. The enabling environment is developed through cooperation between key stakeholders and the establishment of capacity in risk mitigation. A list of nationally significant pathogens and diseases of aquatic organisms is defined

using internationally accepted criteria. The country conducts preliminary risk assessments to prioritize control efforts at high concentrations of risk in the value-chain (where biosecurity is most vulnerable). The end-goal, and "Gateway Pass", of this stage is the development of an aquatic organism health or aquaculture biosecurity strategies at the enterprise, local-sector and national levels that aim at reducing the impact of listed pathogens and diseases, with priority for those diseases that are endemic in the country; this includes the development of a practical emergency response plan to respond to outbreaks of these diseases.

Stage 2: Biosecurity systems initiated — the focus is on the initiation of the risk-based strategies developed in Stage 1, including monitoring the level of their implementation and success. Surveillance will be conducted for mapping the presence/absence of pathogens and diseases of aquatic organisms that are risk-assessed and listed as being of national concern (i.e. those pathogens and diseases of aquatic organisms that pose significant threats to national socioeconomic stability or environmental health). The country will have evidence of improvement in aquatic health expertise and implementation of aquaculture production and biosecurity practices. The enabling environment is further developed through strengthened partnerships and enhancement of the capacity to manage risks at the national level. Based on evaluation of the monitoring results of the strategies developed in Stage 1, the country will further revise and strengthen them (Gateway Pass).

Stage 3: Biosecurity systems and preparedness enhanced — the revised aquatic organism health or aquaculture biosecurity strategies are implemented. In Stage 3, sufficient capacity is developed to support sustainable aquaculture and safeguard the country against nationally-listed pathogens and their associated diseases, including those that are exotic to the country or those that are emerging or re-emerging in a population. Through surveillance and monitoring systems, there is evidence that diseases that pose the greatest threats to the aquaculture sector are prevented or controlled, and pathogen freedom for disease control/certification purposes is ensured and documented. The enabling environment is strengthened and capacity to engage in safe trade is enhanced through a legislative framework. Preparedness to detect and respond rapidly to emergencies is ensured through development of field, laboratory and research capacity. Public, private and international stakeholders demonstrate their commitment to sustaining aquaculture biosecurity, including investment (Gateway Pass).

Stage 4: Sustainable biosecurity and health management systems established — the aquatic organism health or aquaculture biosecurity strategies are fully and sustainably implemented. Stakeholders clearly demonstrate ongoing commitment to support the health of aquatic organisms, humans and the ecosystem. There is evidence of a sustainable and evolving biosecurity system as management practices improve and partnerships mature.The risk communication mechanism has been fully established to ensure a transparent and auditable biosecurity implementation for all stakeholders in the aquaculture sector. The end-goal of Stage 4 is to have confidence from national and international stakeholders in national aquaculture to enable sustainable production and safe trade while maintaining ecosystem health.

The four stages of the PMP/AB, including the overall objectives and key outcomes to complete each stage, are presented in more detail in **Table 1**. The title of each stage of the PMP/AB represents the overall objective or aim of the stage. The numbered points outline the "key outcomes" (or results) necessary to achieve that aim. Because certain activities may have considerable overlap, the key outcomes in each stage are not meant to be completed in chronological order. However, it is important that all key outcomes are addressed fully to complete the stage and progress to the subsequent stage, as appropriate. A more detailed narrative for each of the key outcomes, including suggested typical activities to complete them, is provided in **Annex 1**. A flowchart highlighting the general stepwise process and activities for completing Stages 1 to 3 of the PMP/AB is then presented in **Annex 2**.

TABLE 1.
The four stages of the PMP/AB, including overall objectives and key outcomes to complete each stage

KEY OUTCOMES	**Stage 1: Biosecurity risks defined** **Objective:** Define biosecurity strategies to support aquatic health and production	
	1	Key stakeholders are identified and production systems, marketing network and associated socioeconomic drivers are well described and understood for aquaculture sectors (value-chain analysis)
	2	Key threats to aquaculture and biosecurity vulnerabilities are identified and described
	3	Risk hotspots, critical control points and risk mitigation measures are identified through risk analysis
	4	The enabling environment for aquaculture biosecurity is reviewed and developed
	5	Aquatic organism health or aquaculture biosecurity strategies that aim at reducing the impact of listed endemic diseases are developed and endorsed at enterprise, local-sector and national levels (Gateway Pass)
KEY OUTCOMES	**Stage 2: Biosecurity systems initiated** **Objective:** Take action to improve biosecurity in aquaculture sectors	
	1	Aquatic organism health or aquaculture biosecurity strategies developed in Stage 1 are implemented by public and private stakeholders
	2	The management of biosecurity vulnerabilities and occurrence of listed endemic diseases are monitored
	3	There is evidence that the biosecurity system strengthens aquatic health resilience and reduces the impact of diseases within the aquaculture sector
	4	The enabling environment is further developed, with the necessary standards and plans, and enhanced by co-operation between public and private sectors
	5	Aquatic organism health or aquaculture biosecurity strategies are enhanced and revised, based on evidence gained from programme implementation (Gateway Pass)
KEY OUTCOMES	**Stage 3: Biosecurity systems and preparedness enhanced** **Objective:** Enhance biosecurity and preparedness in aquaculture sectors	
	1	Revised aquatic organism health or aquaculture biosecurity strategies are implemented
	2	Continuous surveillance is conducted for detection and monitoring of emerging and listed diseases
	3	Disease incidences and impacts are reduced
	4	Enabling environment is strengthened and relevant legislation, standards and plans are established or revised to support aquatic organism health or aquaculture biosecurity strategies
	5	Commitment is demonstrated, including investment, from public and private stakeholders to safeguard progress (Gateway Pass)
KEY OUTCOMES	**STAGE 4: Sustainable biosecurity and health management systems established** **Objective:** Sustainable health management to support the national aquaculture system	
	1	Risk management activities are sustained and improved based on evidence
	2	Systems for preparedness and response to emergencies, and associated capabilities, are fully developed
	3	The enabling environment is maintained and continuously improved as necessary
	4	Reduction of disease burden is achieved for all (including small-scale producers) and food security for consumers
	5	National and international stakeholders have confidence in national aquatic health services and ecosystem health

11. PMP/AB checklist

The PMP/AB checklist (**Annex 3**) allows a country to assess its progression along the PMP/AB.

The checklist highlights the indicators (minimum requirements) for a country to complete Stages 1–3 of the PMP/AB based on the key outcomes. Stage 4 is reached once all requirements for the first three stages are met. It is expected that the requirements to fulfil a previous stage are still in place when a country progresses to the next stage. It is recommended that a country continues to self-assess its position on the pathway with the PMP/AB Checklist at least once every two years to ensure it continues to meet the requirements.

The PMP/AB is meant to be flexible to accommodate each country's situation and, therefore, aquaculture sectors can progress independently, or at different paces along the pathway. A country can conduct the self-assessment separately for each aquaculture sector, as appropriate, according to its national priorities.

The PMP/AB checklist for each stage of the PMP/AB is divided into the following four general categories:

- Sectors and Stakeholders;
- Aquatic Health Services;
- Surveillance, Monitoring and Diagnostics;
- Management and Evaluation.

Each category contains a list of statements that have "Yes" or "No" answers. The checklist should be completed by the highest official of the Competent Authority(ies) (CAs) for each indicator statement. The answer "Yes" means the indicator correctly reflects the current situation in the country. "No" means the indicator does not correctly reflect the country's current situation. Comments may be provided for each indicator in the checklist – these comments may be useful to provide evidence or reasoning to support the chosen answer. Completion of all indicators is required to assess a country's current position on the pathway.

In addition to assessing PMP/AB stage progression, a country can assess the overall completion of each of the four categories to assist in identifying biosecurity strengths and weaknesses. This may be useful for prioritization and identification of where external support could best be targeted.

12 PMP/AB toolkit

In addition to the PMP/AB Checklist, several other tools based on multidisciplinary expertise are available or are being developed to assist with a country's initiation and implementation of the PMP/AB. The PMP/AB toolkit consists of self-assessment questionnaires, guidance documents, manuals, e-learning courses, in-person training courses and other supporting information. These will need to be reviewed, revised and updated as appropriate in order to fit within the PMP/AB context. Thus, the PMP/AB toolkit is under continuous development as new tools are being created. Tools that are currently available are listed in the next section. The applicable stage(s) of the PMP/AB supported by the tools are given in parentheses. A short stepwise guidance document to assist CAs with implementing pilot testing of the PMP/AB is currently being prepared by the PMP/AB TWG and other specialist sub-groups. Tools to support the development of PPP, the development of biosecurity action plans and framework for analysing the costs and benefits of aquatic biosecurity are also in preparation.

12.1 GUIDANCE ON CONDUCTING SWOT AND GAP ANALYSIS (STAGE 1)

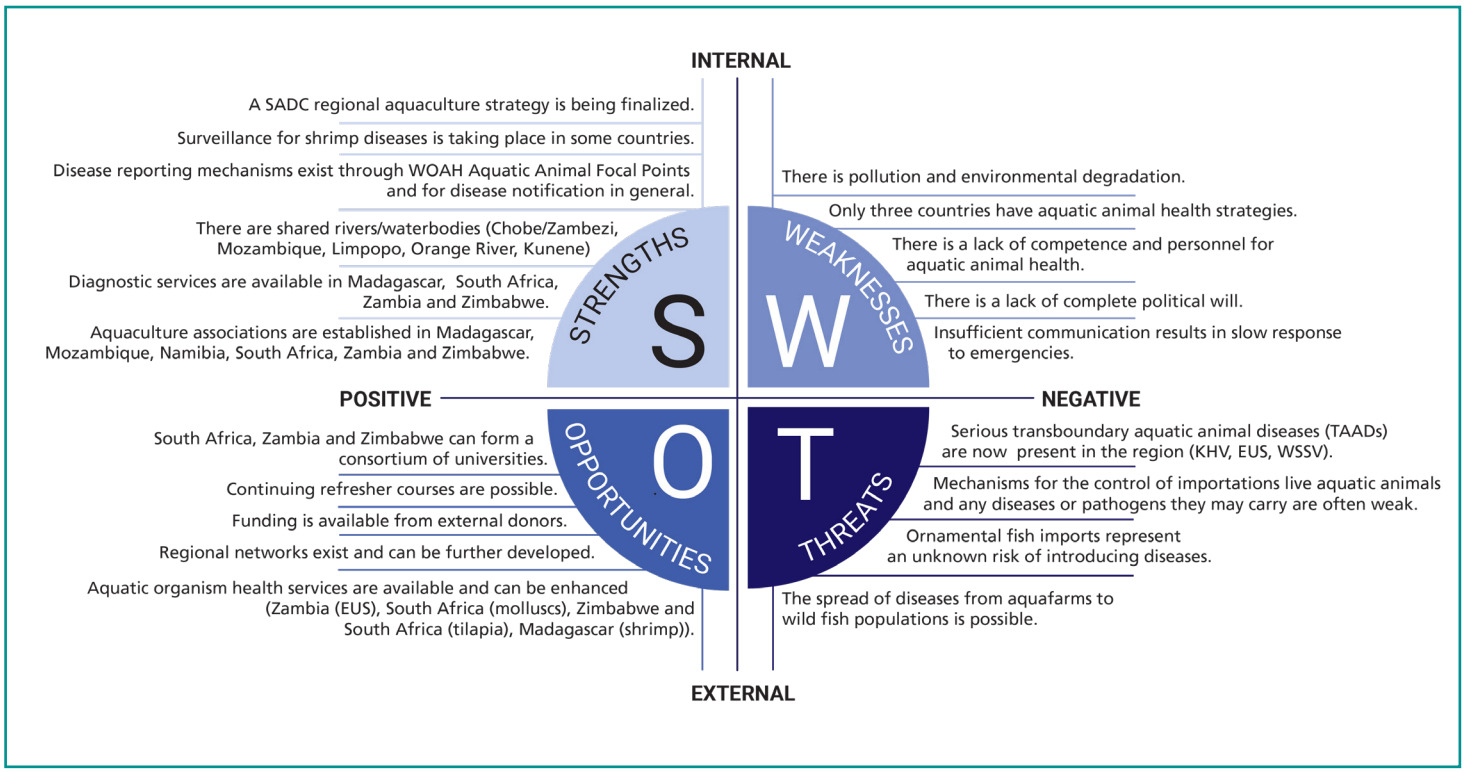
A *Strengths, Weakness, Opportunities, Threats (SWOT)* analysis is a useful exercise to help the implementing agency identify strengths, weaknesses, opportunities, and threats related to project planning. SWOT analysis can be used during the preliminary stages of a decision-making process to help evaluate the strategic position of a country with regard to its aquatic biosecurity, and identify the internal and external factors that are favourable and unfavourable to achieving its objectives under the PMP/AB. An example of a completed SWOT analysis for assessing a country's national aquatic biosecurity is given in **Figure 6**. SWOT analysis has often been applied in FAO projects related to aquatic biosecurity and strategic planning (see, for example, Van Anrooy, 2009; FAO/Regional Commission for Fisheries, 2009).

A gap analysis is a process that can be used to compare the current capability and performance of country's aquatic biosecurity sectors with what is needed to achieve its desired stage within the PMP/AB. The method provides a way to identify suboptimal or missing strategies, capacities, capabilities, processes, practices, technologies and skills, and then recommend steps that will help meet PMP/AB goals and the development of biosecurity strategies. The four steps of a gap analysis are:

- Decide on the stage of the PMP/AB to be achieved and its associated requirements (set the goals).
- Identify the current situation with regard to the requirements of the desired PMP/AB stage.
- Analyse the gaps between the current situation and the requirements of the desired stage.
- Establish a plan to close existing gaps.

While gap analysis has not yet been widely applied in aquatic biosecurity, some examples can be found in the fisheries and aquaculture sector and in terrestrial biosecurity (see, for example Davies *et al.*, 2014; Key, 2017; Casstriciones and Vijayan, 2020). Countries also have their own internal procedures for evaluating gaps as part of government planning processes.

FIGURE 6
Example of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis



Source: **FAO.** 2018. *Development of a Regional Aquatic Biosecurity Strategy for the Southern African Development Community (SADC).* FAO Fisheries and Aquaculture Circular No. C1149. Rome, FAO 344 pp.

Guidance for assessing current national capacity related to the PMP/AB is given in the "FAO Aquatic Organism Health Capacity and Performance Self-Assessment Survey Questionnaire", presented in **Annex 4**.

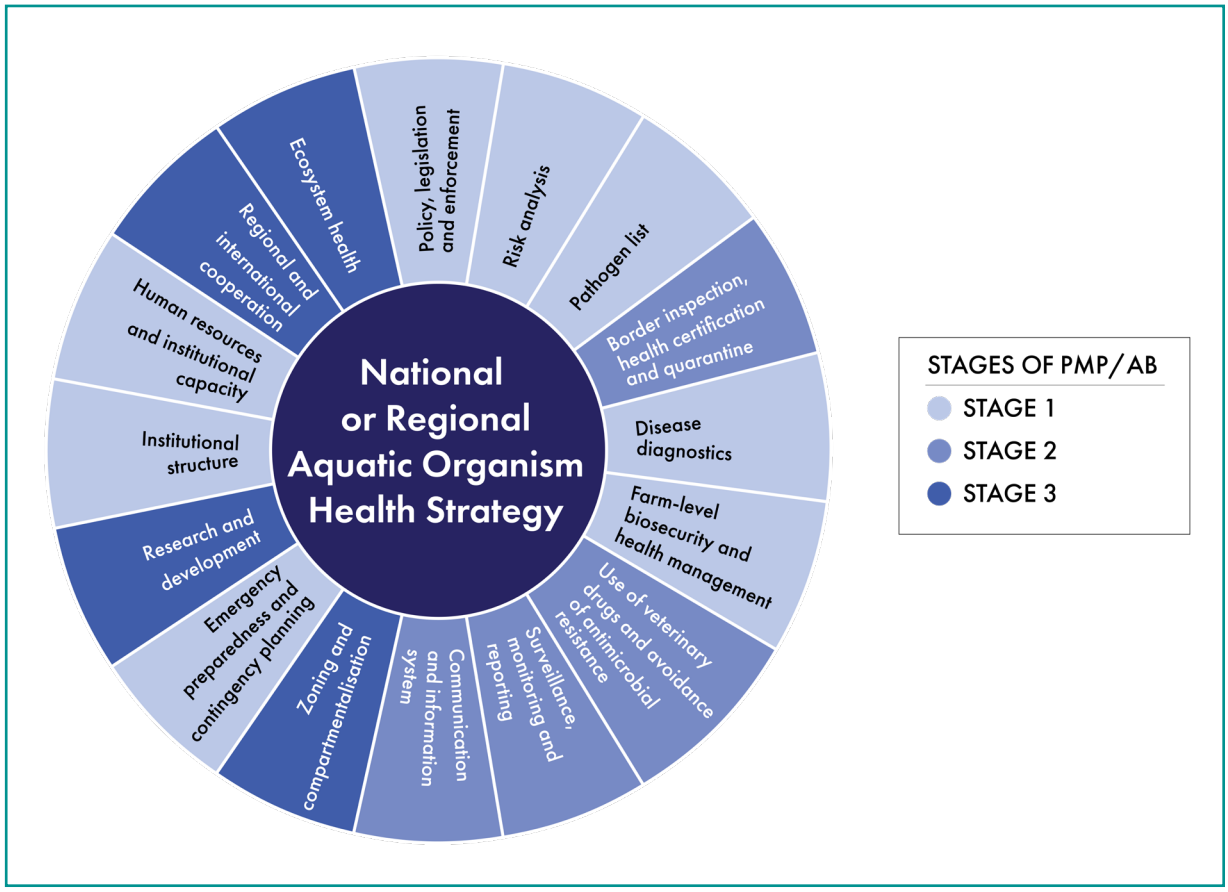
Another useful assessment methodology available to members of WOAH, is the WOAH Performance of Veterinary Services (PVS) Pathway (see WOAH, 2O21c). The PVS Pathway aims to support sustainable improvement of national aquatic animal health services (AAHS) by providing WOAH Member Nations with a comprehensive understanding of their strengths and weaknesses using a globally consistent methodology based on international standards. As part of the pathway, a PVS evaluation using the WOAH PVS Tool: Aquatic is undertaken at the request of a Member Country to evaluate the performance of its national AAHS. This evaluation is conducted by WOAH certified experts and provides an external expert perspective to reveal gaps, inefficiencies and opportunities for innovation. The PVS Tool: Aquatic has four Fundamental Components and 47 Critical Competencies. The Critical Competencies, which are identified within each of the four Fundamental Components, have five possible levels of advancement (i.e. 1 to 5); higher levels of advancement assume that the AAHS complies with the preceding levels. Once a PVS evaluation has been completed, a WOAH PVS Gap Analysis, based on strengths, weaknesses and national priorities identified, can be undertaken and may be followed by Strategic Planning support. The PVS Tool–Aquatic (second edition, 2021) is also available to use for self-evaluation purposes (https://www.woah.org/app/uploads/2021/12/v4-pvstoolacua-fnl.pdf).

The WOAH PVS Pathway is complementary to the overall mission of the PMP/AB. Therefore, if a country has undergone a PVS evaluation or self-evaluation using the PVS Tool–Aquatic, results from the assessment may be integrated with the PMP/AB's gap analysis and may satisfy the requirements for completing certain indicators in the PMP/AB checklist.

12.2 GUIDANCE ON DEVELOPING A NATIONAL OR REGIONAL AQUATIC ORGANISM HEALTH STRATEGY (STAGE 1)

The development of a National or Regional Aquatic Organism Health Strategy (NAOHS or RAOHS) is a critical component of the PMP/AB for any country (**Figure 7**). For countries with an existing national (or regional) aquatic biosecurity strategy, this strategic document may be known as a "National Strategy on Aquatic Animal Health", "National Strategy on Aquaculture Biosecurity", or "Regional Aquatic Biosecurity Strategy", etc. However, reflecting the broadened scope of the PMP/AB, which now includes both aquatic plants and aquatic animals, the term NAOHS or RAOHS is recommended. A NAOHS or RAOHS is a broad, yet comprehensive strategic plan that will serve to build and enhance capacity for effective management of national aquaculture biosecurity and aquatic health, based on risks assessed at the sector and national levels. Detailed guidance for the development of a NAOHS or RAOHS is given in **Annex 5**. The elements (or components) of a NAOHS or RAOHS have been expanded to now include 16 elements from the time it was first established (FAO, 2007). The draft NACA RAOHS added a 17th element on Aquatic Organism Welfare.

FIGURE 7
Elements of a national or Regional Aquatic Organism Health Strategy



Source: **FAO.** 2007. *Aquaculture development. 2. Health management for responsible movement of live aquatic animals.* FAO Technical Guidelines for Responsible Fisheries. No. 5, Suppl. 2. Rome, FAO. 2007. 31p.

12.3 GUIDANCE ON DEVELOPING A NATIONAL AQUATIC PATHOGEN LIST (STAGE 1)

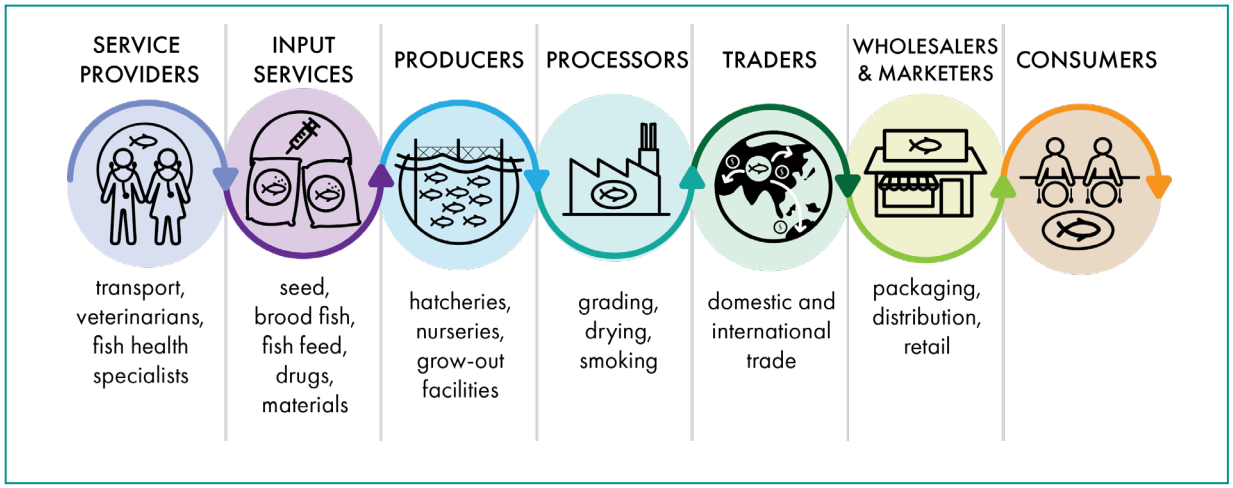
A National Aquatic Pathogen List (NAPL), one of the most important components of a NAOHS, underpins any aquatic health protection programme, and is essential for health certification, disease surveillance and monitoring, prevention, emergency response planning, and control of pathogens and diseases in aquaculture facilities and natural environments. Clearly established criteria for listing/delisting of pathogens and diseases (based on internationally accepted guidelines) should be established. Listed pathogens may include those causing diseases that are endemic, emerging or exotic to the country. They are typically of significant importance to aquatic health, human health, or to the country's economy. It is recommended that a country's NAPL should include both the scientific names of nationally listed aquatic animal and plant pathogens, as well as the names of the diseases that they cause. Guidelines for the preparation of a NAPL are presented in **Annex 6**, while the WOAH criteria for listing aquatic animal diseases can be found in Chapter 1.2 of the Aquatic Animal Health Code (WOAH, 2021a).

12.4 RISK ANALYSIS

12.4.1 Guidance on risk analysis along the value-chain (Stages 1–3)

Elements of value-chain analysis and risk analysis can be combined to provide a risk-based and people-centered approach to planning disease control measures for aquaculture systems. A value-chain approach to manage disease risks (**Figure 8**) is one of the methodologies used to develop the biosecurity strategies in Stage 1 of the PMP/AB. Useful references for conducting value-chain analysis and risk analysis for aquaculture production facilities include FAO (2011), Chapters 2.1 and 4.1 of the Aquatic Code (WOAH, 2021a), MacKinnon *et al.* (2023). FAO is also currently preparing a brief stepwise guidance document to support countries in applying risk analysis to the aquaculture value-chain.

FIGURE 8
General representation of an aquaculture value-chain



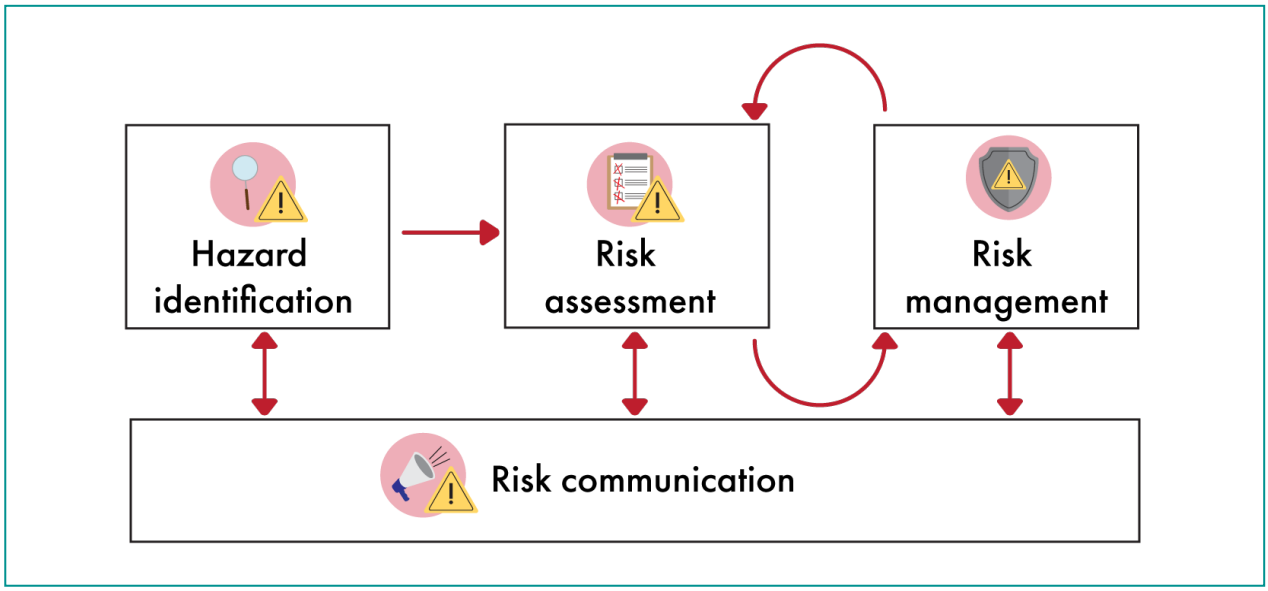
Hazard analysis and critical control points (HACCP) is another risk management system, applied mainly in post-harvest processing systems (WHO/FAO, 2009), that is increasingly being applied in the aquaculture industry. HACCP provides a logical approach to identify and control pests, pathogens and environmental hazards associated with aquaculture production and processing facilities.

Critical control points (CCPs) are points in the risk pathways where efforts can be targeted to minimize or reduce the risk of pathogen or pest introduction and spread, which also means that these points can be the focus of risk management, a major component of the risk analysis process (WOAH, 2021a). It has been proposed, for example, to control parasitic infections and other diseases in fish culture (Reilly and Käferstein, 1997), and was noted to have been effective in controlling foodborne digenetic trematode infections in aquaculture in several Southeast Asian countries (Jahncke *et al.*, 2002). Jahncke *et al.* (2002) applied HACCP management to control viral infections in shrimp production and processing.

12.4.2 Guidance on Import Risk Analysis (Stage 3)

Import risk analysis (IRA) is a systematic and transparent decision-making process to manage disease risks associated with the importation of live aquatic organisms and their products for human consumption, aquaculture purposes, medical uses, feeds for livestock, etc. The import risk analysis pathway, as based on the Aquatic Code (WOAH, 2021a), involves four major steps: hazard identification, risk assessment, risk management, and risk communication (see **Figure 9**).

FIGURE 9
The four components of the risk analysis process



- During hazard identification, hazards (pathogens) that could be present in the aquatic organism or its products to be imported that might produce adverse consequences to the importing country are identified.
- During the risk assessment step, the risk (likelihood x consequence) to the importing country posed by each potential hazard is estimated by determining the likelihood of the pathogen gaining entry to and becoming established in the importing country, and the biological, environmental and economic consequences of this happening.
- During the risk management step, the estimated risk is compared to the country's acceptable level of risk (ALOR) to determine if the risk is acceptable. If the estimated risk is greater than the ALOR, then risk management options are investigated to determine if the risk posed by the pathogen can be reduced to an acceptable level.

- Risk communication is the process by which stakeholders are consulted, information and opinions gathered and risk analysis results and management measures communicated.

The following publications are recommended as guidance for understanding risk analysis in aquaculture and how to conduct an IRA: Murray (2004); Bondad-Reantaso, Arthur and Subasinghe (2008); Arthur and Bondad-Reantaso (2012), and Chapter 2.1 of the Aquatic Code (WOAH, 2021a).

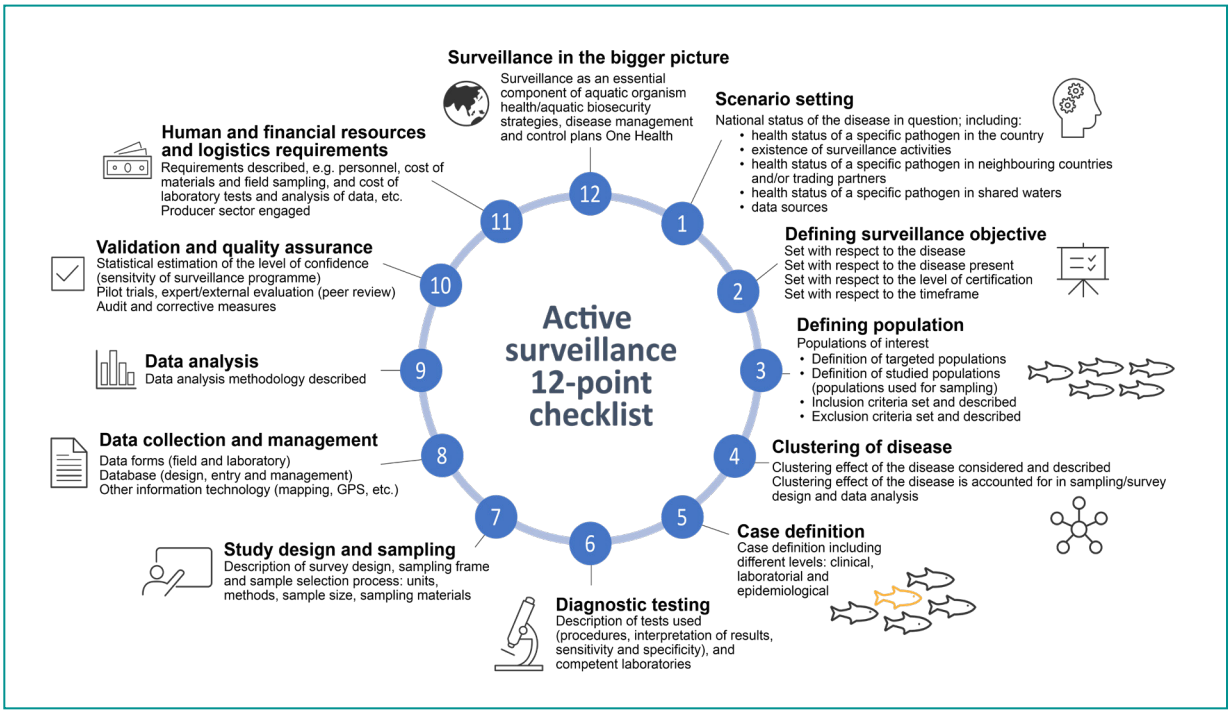
12.5 GUIDANCE ON PASSIVE AND ACTIVE SURVEILLANCE (STAGES 2 & 3)

Passive and active surveillance programmes are systematic tools aimed at gathering data to support national aquatic biosecurity. Passive surveillance, by which aquaculturists, fishermen, field officers and the general public may report unusual morbidity and mortality of aquatic species to the CA, is often key to initiating a rapid response to mass mortality events (MMEs) and early response to emerging diseases. Active surveillance programmes are established to demonstrate the presence or absence of diseases of national concern, determine their distributions where present, and detect emerging or exotic diseases that require investigation. Surveillance activities are also often used to provide information for disease control programmes and to support health certification requirements, IRA and international trade.

Guidance on designing an active surveillance programme for populations of aquatic organisms can be found in FAO/NACA (2000, 2001), Cameron (2002), Corsin *et al.* (2009), FAO (2016), Bondad-Reantaso *et al.* (2021) and WOAH (2021a). A 12-point checklist for the design and implementation of an active surveillance of diseases of aquatic organisms, offering a novel approach to assist multdisciplinary teams in developing countries, is given in **Figure 10**.

FIGURE 10

The 12-point active surveillance checklist showing the steps, descriptions and criteria and elements to complete each step



Source: **Bondad-Reantaso, M.G., Fejzic, N., MacKinnon, B., Huchzermeyer, D., Seric-Haracic, S., Mardones, F.O., Mohan, C.V., Taylor, N., Jansen, M.D., Tavornpanich, S., Hao, B., Huang, J., Leaño, E.M., Li, Q., Liang, Y., & Dall'occo A.** 2021. A 12-point checklist for surveillance of diseases of aquatic organisms: A novel approach to assist multidisciplinary teams in developing countries. *Reviews in Aquaculture*, 13(3): 1469 – 1487. https://doi.org/10.1111/raq.12530

12.6 GUIDANCE ON EMERGENCY PREPAREDNESS AND RESPONSE SYSTEMS (STAGES 1–3)

Emergency preparedness and response (EPR) systems for responding to MMEs and disease outbreaks in aquatic populations are needed in Stages 1–3. These are contingency planning arrangements that can minimize the impacts of serious disease outbreaks, whether at the national, subnational or farm level. Such systems have the objective of containing (preventing the further spread) or eradicating diseases, thereby greatly reducing the impact, scale and costs of outbreaks. An effective EPR system ensures that there are pre-agreed protocols and resources in place to act quickly in responding to suspected outbreaks of disease. Importantly, they establish a clear structure for effective and rapid decision making with clearly defined responsibilities and authority.

The following can serve as guidance in assessing emergency preparedness of a country and for dealing with MMEs in aquatic populations: Arthur *et al.* (2005) and Perera *et al.* (2018), while examples of disease strategy manuals (technical plans as part of contingency planning) include Tang-Nelson, Bondad-Reantaso and Arthur (2019) and Tang-Nelson *et al.* (2020, 2021).

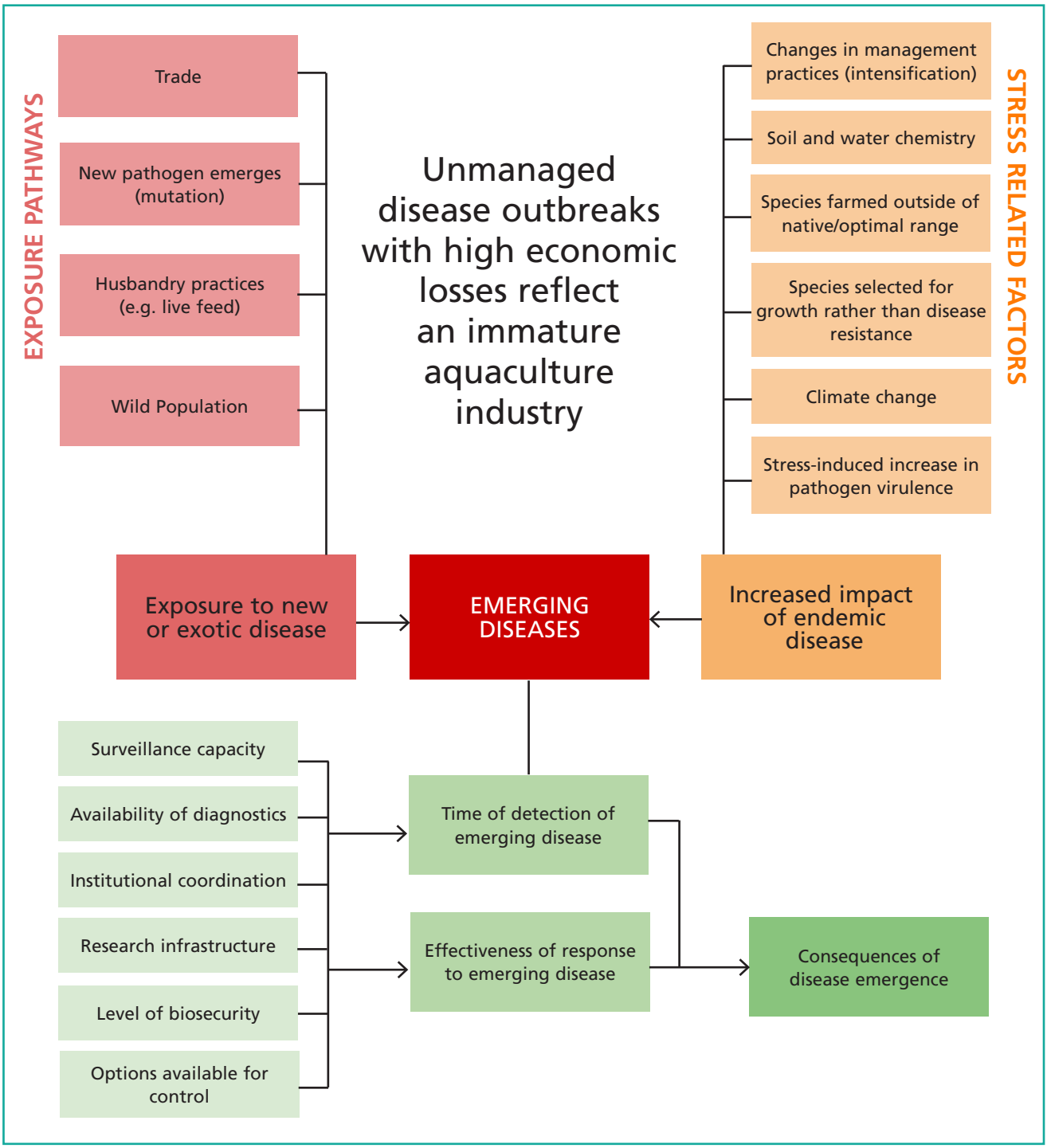
In addition, the FAO is currently drafting a new guidance document "Contingency planning for aquatic organism mass mortality events: guidance on effective preparedness, response, recovery and review", which will assist national CAs and other supporting government agencies to help plan for and deal efficiently and effectively with aquatic organism MMEs. It will also be useful to front-line workers responsible for aquatic plant and animal production and biosecurity (including aquatic veterinary, aquatic health and field officials), private and government extension officers, and researchers investigating MMEs in wild populations.

13. Conclusions and the way forward

Disease emergence in aquaculture development may occur due to the introduction of new pathogens through various exposure pathways in trade of aquatic organisms, in changes in aquatic health management practices, in ecosystem changes or due to an increased impact of diseases already present (**Figure 11**). Inability to deal with exotic, endemic and emerging diseases will negatively affect the sustainability of the sector. Dealing with the consequences of these diseases is dependent on the time of detection and effectiveness of response to the disease, which rely on good capacities in surveillance, diagnostics, institutional coordination, research infrastructure, biosecurity and disease control measures. These management measures should be practical and risk-based to allow efficient resource allocation (FAO, 2019).

The PMP/AB has an overarching goal to guide countries towards achieving sustainable health management and aquaculture biosecurity systems through the implementation of risk-based, progressive, and collaborative processes among enterprise, local-sector, national, regional and international levels with strong public and private sector engagement.

FIGURE 11
Pathways, factors and/or drivers for disease emergence in aquaculture: causal web



Source: **FAO.** 2020a. *Progress towards development of the Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB): Highlights of 2019 activities.* FAO Fisheries and Aquaculture Circular No. 1211. Rome, FAO. 42 pages. https:// doi.org/10.4060/cb0560en

Aquaculture is a unique production sector and requires special attention and specific approaches to manage aquatic population health and biosecurity risks. These risks can be difficult to control due to the dynamic nature of the aquatic environment, the high number of farmed aquatic species, the variable farming systems and their management, and the porous interface between the cultured and wild aquatic environment. Socioeconomic, infrastructural and technical challenges are factors that further compound these risks to the sector.

Many countries currently face significant disease challenges to their aquaculture sectors, which adversely impacts production and markets that in turn affect livelihoods, export earnings and limits food security.

The PMP/AB may serve as a stepping stone for these countries to slowly improve health management of aquatic organisms and aquaculture biosecurity over time, by establishing feasible, risk-based strategies that are sustainable and consider needs and priorities, resource availability and technical capacity. The PMP/AB is not intended to be prescriptive and can be adapted to suit the specific situation of a country and can be applied to manage risks in any aquaculture production sector – with application varying from the individual farm level, up to the national, regional and international levels. It recognizes the transboundary nature of disease emergence and spread and aquatic organisms as the most traded commodity. It is not necessary to complete all stages of the PMP/AB in order to make a significant improvement to a country's aquatic health management and aquaculture biosecurity systems.

Thus, even completion of only one or two key outcomes in Stage 1 of the PMP/AB can serve as starting point and will still make a positive impact.

The PMP/AB tools can be applied to support progression along the stages and build capacity in various areas of expertise, providing guidance on biosecurity action plans, PPP, e-learning courses, cost-benefit analysis of biosecurity systems and communication strategy.

Continuous development of new tools to support countries with piloting and implementing of the PMP/AB is a long-term target that requires commitment of collaborating and implementing partners.

It is very important that the PMP/AB is initiated by a multidisciplinary task force or team (e.g. aquaculture specialists, aquatic health professionals, aquatic plant pathologists, aquatic veterinarians, biologists, risk analysts, value-chain specialists, etc.) representing governance, industry and academic sectors based on PPP, with strong government commitment and allocation of resources. The pathway provides a platform for developing strong stakeholder engagement, which is necessary for buy-in of producers and application of practical and effective solutions across the aquaculture production value-chains.

With strong commitment of national authorities, it is hoped that the PMP/AB will aid in reducing the burden of diseases by improving health management and aquaculture biosecurity practices worldwide to support food security and nutrition, social and economic development and resilience, rural livelihoods, food safety and public health, and the environmental sustainability of the aquaculture sector.

The PMP/AB builds on existing frameworks and initiatives by relevant aquaculture stakeholders working together to achieve a common goal through complementarity and integration. A good example is the Fish-Vet Dialogue, a virtual event (http://infofish.org/Fish-VetDialogue/) co-organized by FAO, WOAH and the Norwegian Veterinary Institute supported by Norad and in collaboration with INFOFISH, aimed at establishing functional linkages, sharing of responsibilities and combining relevant competencies to address biosecurity challenges affecting the aquaculture industry.

As aquatic animal and plant diseases are an economic and societal challenge, disease prevention is an aquaculture strength that benefits the sector itself, wild resources and the environment. Effective biosecurity progression at all levels is a good news story - a public good for the global community and national economy.

The PMP/AB offers a great opportunity for longevity, sufficiently responsive to environmental and anthropological challenges, enabling policy environments, and adoption of sound aquaculture production and good biosecurity practices.

Concerned countries, stakeholders and entities are encouraged to join efforts in attaining the purpose of PMP/AB in reducing disease burden, improving health and welfare, minimizing global spread of diseases, optimizing the socioeconomic benefits from aquaculture, attracting investment opportunities and achieving One Health goals.

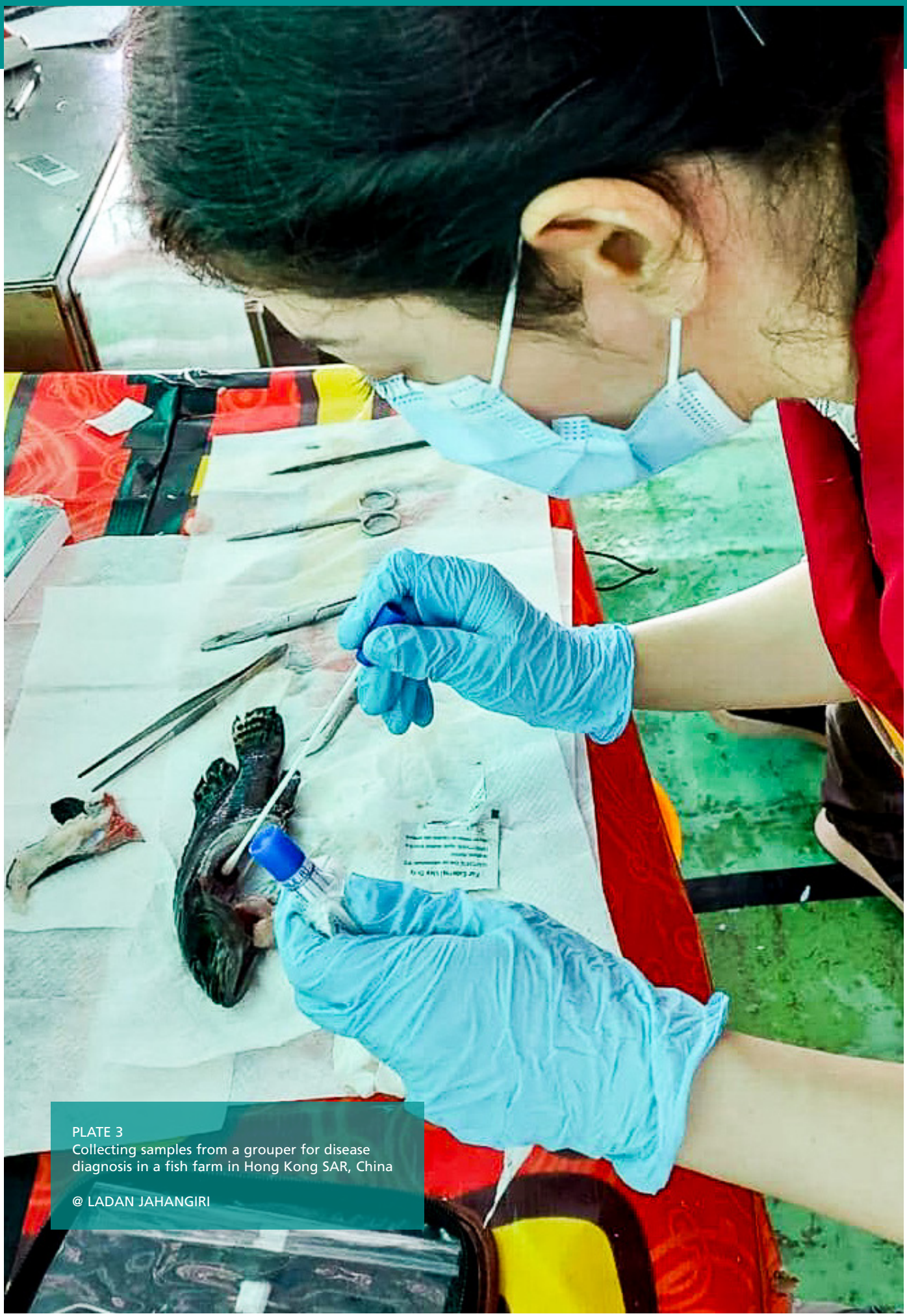


PLATE 3
Collecting samples from a grouper for disease diagnosis in a fish farm in Hong Kong SAR, China

@ LADAN JAHANGIRI

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a	
b	c

PLATE 4
Scenes from a sea bass cage farm in Gaeta, Italy

a A sea bass fish cage
b Fish farmers doing maintenance work on a fish cage
c Fish farmers harvesting sea bass from a cage

Glossary

Aquaculture	the farming of aquatic organisms with some sort of intervention in the rearing process to enhance production.
Aquaculture biosecurity	in the context of the PMP/AB, it refers to the cost-effective management of risks posed by pathogens to aquaculture through a strategic approach at the enterprise, local-sector, national and international levels with shared public–private responsibilities.
Aquatic animals	all life stages (including eggs, gametes, germplasm) of fish, molluscs, crustaceans and amphibians originating from aquaculture establishments or from the wild (modified from WOAH, 2021a).
Aquatic health	the health of aquatic organisms.
Aquatic health professional	aquatic veterinarians, aquatic animal specialists, and plant health specialists with competence in one or more areas related to management of health and diseases of aquatic organisms.
Aquatic health services	all public and private-sector agencies, organizations, companies and individuals providing health services to the aquaculture industry and investigating disease in wild populations of aquatic organisms.
Aquatic organisms	aquatic animals and aquatic plants (refer to definitions for "aquatic animals" and "aquatic plants").
Aquatic plants	all life stages (including spores and gametes) of any plant, either partly or wholly grown in water, and rooted in sediment or free floating on the water surface, that originate from aquaculture establishments, or are removed from the wild for farming purposes, for release into the aquatic environment, for human consumption or for ornamental purposes (modified from FAO, 2016).
Biosecurity vulnerabilities	factors that can threaten the achievement of effective biosecurity, including management of the introduction, spread and release of pathogens, trade, and lack of infrastructure capacity in public and private institutions.
Commodity	a live aquatic organism or its products.

Compartment	one or more aquaculture establishments under a common biosecurity management system containing one or more populations of aquatic organisms with documented disease-free status for one or more diseases and for which surveillance and control measures are applied and basic biosecurity conditions are met for the purposes of domestic movements or international trade.
Competent Authority	the national authority (e.g. Fisheries and Aquaculture Authority, Inspection and Quarantine Authority, Food Safety Authority or Veterinary Authority) having the responsibility and competence for ensuring the implementation of aquatic health and welfare measures, international health certification and other standards and recommendations in support of the World Trade Organization's Sanitary and Phytosanitary (SPS) Agreement (modified from WOAH, 2021a).
Contingency planning	the preparation of a documented work plan designed to ensure that all needed actions, requirements and resources are provided in order to reduce the burden of diseases, and eradicate or bring under control outbreaks of specified diseases of aquatic organisms (modified from WOAH, 2021a).
Critical control points	steps in the aquaculture production chain at which control can be applied to prevent or eliminate a pathogen, pest or a food safety hazard, or reduce it an acceptable level. (also see "risk hotspots")
Disease	any condition that affects the normal functioning of an organism, which differs from physical injury, and leads to clinical signs.
Emerging disease	a disease that has a significant impact on aquatic health resulting from: **1)** a newly recognized or suspected pathogen that has not been detected previously and may be new to science; or **2)** a change in a known pathogen such as an abnormal increase in prevalence or pathogenicity, or its spread to a new host species or geographic area.

Enabling environment	an enabling environment consists of the development, implementation and enforcement of supportive legal and policy frameworks; institutional strengthening including coordination and setting clear roles and responsibilities of key public and private entities; capacity strengthening of all actors so they can play their roles; and social dialogue, including stakeholder participation (modified from Zegers, 2015)
Enterprise	a private aquaculture-related business or company (e.g. a farm, feed supplier or processor).
Endemic disease	a disease resulting from a pathogen that has a constant presence or predictable occurrence of outbreaks in a population of aquatic organisms within a defined geographical area (cf. "exotic diseases") (modified from CDC, 2012).
Exotic disease	a disease resulting from a pathogen that is not known to be established in a specific country or geographical region (cf. "endemic diseases").
Gateway Pass	documentation describing the implementation of all outcomes within one of the four stages of the PMP/AB for the aquaculture industry of a country or a specific aquaculture sector.
Hazard	a biological, chemical or physical agent in, or a condition of, an aquatic organism or its products with the potential to cause an adverse effect on aquatic health or public health (modified from WOAH, 2021a).
Import risk analysis	the transparent process of assessing the disease risks associated with the importation an aquatic organism or its products into a country (modified from WOAH, 2021a)
Listed pathogens/ Listed diseases	pathogens or diseases assessed as being of national concern using nationally and/or internationally accepted criteria and included in a country's National Aquatic Pathogen List (NAPL) or National Aquatic Disease List (NADL).
Monitoring measurement	ascertaining changes in infection parameters, such as incidence, prevalence, and spatial and temporal distribution of a disease.

National aquatic organism health strategy	Broad yet comprehensive strategies to build and enhance capacity for the management of national aquatic health and biosecurity. They contain important elements and action plans at the short-, medium- and long-term, including programmes and projects that will assist in developing national approaches to the overall health management of aquatic species. An implementation plan is included that identifies the activities that must be accomplished by government, industry and academia.
One Health	An integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. (OHHLEP, 2021)
Pathogen	Microorganisms, including virus, bacterium, fungus or parasite, capable of causing disease.
Progressive management pathway for aquaculture biosecurity (PMP/AB)	a pathway aimed at enhancing aquaculture biosecurity capacity at the regional, national, local-sector and enterprise levels by building on existing frameworks, capacity and appropriate tools using risk-based approaches and public–private sector partnerships.
Quarantine	maintaining a group of aquatic organisms and the water in which they live, in isolation from direct or indirect contact with other aquatic organisms or surrounding water systems in order to undergo controlled health observations and appropriate testing and treatment (modified from WOAH, 2021a).
Risk	the likelihood of the occurrence and magnitude of a negative biological, environmental or economic impact on aquatic organisms or human health (modified from WOAH, 2021a).
Risk hotspots	the most important concentrations of risk in the aquaculture value chain (modified from FAO, 2011). These are points in the value chain where biosecurity is most vulnerable. They may be a geographic location, management practice or an action by a stakeholder that decreases capacity to manage disease risks (also see Critical control points)

Surveillance

a systematic, active or passive process of data collection aimed at determining the health status of a given population of aquatic organisms. The data collected is collated, analysed and disseminated to guide disease control activities and appropriate measures to prevent, stop or limit the spread of pathogens and the diseases they cause.

- **Passive surveillance** is typically based on observation of clinical or behavioural signs of disease, or an assessment of mortality or production data, which are generated by an early detection system or from other information which is available to the Competent Authority.
- **Active surveillance** involves a systematic series of investigations of a given population of aquatic organisms to detect the occurrence of a pathogen for disease control purposes, and typically involves diagnostic testing of samples of a population

Value-chain

groups of people linked by activities to supply a specific aquaculture commodity. These chains have inputs that are used to produce and transport a commodity towards the consumer; this is the supply chain (modified from FAO, 2011).

Value-chain analysis

detailed study of the processes (production, marketing, processing, retailers, consumers etc.) throughout the value chain. This includes understanding the aquaculture production systems and how the stakeholders operate and the decisions they make (modified from FAO, 2011).

WOAH-listed diseases

aquatic animal diseases listed by the World Organisation for Animal Health's Aquatic Animal Health Code (WOAH, 2021a).

Zone

an area in one or more countries containing a population of aquatic organisms with a specific health status with respect toa disease, in which surveillance and control measures and basic biosecurity conditions are applied. The zone should be defined by the Competent Authority (modified from WOAH, 2021a).

Annexes and appendixes

Annex 1

PMP/AB key outcome descriptions

The key outcomes for each of the four stages of the PMP/AB are described below. This includes a description of the indicators and typical activities needed to complete each key outcome. Typical activities are suggested, but not required, to complete the key outcomes for each stage.

PMP/AB Stage 1 Key Outcomes

1 Key stakeholders are identified and production systems, marketing networks and associated socioeconomic drivers are well described and understood for aquaculture sectors (value-chain analysis)

- **Indicator description:** This should include a value-chain analysis that describes the processes, places and people through which farmed aquatic organisms, their germplasm/gametes or their products pass during the production process. This should consist of an overview of all aquaculture production systems in the country and the key stakeholders involved, from suppliers, through producers, to the marketing system, processors and retailers. Importations and exportations of aquatic commodities should also be described. These processes are always changing and should be reviewed and updated on a regular basis.
- **Typical activities:** Formation of public–private PMP/AB taskforce; stakeholder consultation workshops; consultation with national and international experts, as needed; analysis of existing data; value-chain mapping.

2 Key threats to aquaculture and biosecurity vulnerabilities are identified and described

- **Indicator description:** It is important that all important pathogens (i.e. those causing endemic diseases) that have been detected in farms are well described and understood, including what is already known regarding their distributions and impacts in the country. Surveillance or monitoring activities are not necessary at this stage of the PMP/AB. Pathogens causing potentially significant diseases that are emerging or not known to exist in the country (i.e. exotic diseases), but that may threaten aquaculture biosecurity, aquaculture production, wild populations, ecosystems, and/or human health, should be considered for national listing. Other factors that can threaten the achievement of good biosecurity (i.e. management practices, legal and informal trade, and lack of capacity in public and private institutions) should also be identified.
- **Typical activities:** Stakeholder consultation workshops; national expert consultation; analysis of existing epidemiological data and current industry practices; summary of information about the occurrence of pathogens, diseases and other vulnerabilities; description of current risk mitigation practices; national legislation review.

3 Risk hotspots, critical control points and risk mitigation measures are identified

- **Indicator description:** This is a practical approach that combines risk analysis and hazard analysis and critical control points (HACCP) with value-chain mapping. Risks along the value-chain should be identified and characterized, and areas with the highest levels of risk (i.e. risk hotspots) should be prioritized. Formal risk pathways should be developed for each risk hotspot to identify critical control points and potential control measures to mitigate the risks. At this stage, risk management efforts should be focused on reducing the impact of listed endemic pathogens in the country.
- **Typical activities:** Expert consultations; gap analysis; preliminary risk assessments, and value-chain analysis to identify risk hotspots along the value chain; HACCP and risk analysis to identify critical control points and potential risk mitigation measures; socioeconomic impact analysis of risk mitigation measures; analysis of epidemiological data.

4 The enabling environment for aquaculture biosecurity is reviewed and developed

- **Indicator description:** Legal framework for aquaculture and aquatic health should be reviewed and revised to facilitate implementation of the national- and sector-level biosecurity strategies. The National Aquatic Pathogen List (NAPL) or National Aquatic Disease List (NADL) should be based on internationally accepted criteria, including pathogens/diseases that are significant for international trade or pose a threat to aquaculture production or the environment (wild resources). The public sector should have the capacity to conduct sector-level risk analysis. Producers and other key stakeholders are informed of the risks of listed endemic diseases and are consulted regarding implementation of risk mitigation measures. The majority of aquatic health professionals should be adequately qualified to diagnose and control the most important (nationally listed) endemic diseases in the country. Laboratory capacity must be sufficient to support the diagnoses. Detection, or suspicion, of the presence of listed aquatic pathogens, and diseases should be reported to the Competent Authority(ies) through an established communication plan or reporting system.
- **Typical activities:** Conduct a gap analysis (e.g. The FAO Aquatic Organism Health Capacity and Performance Self-Assessment Survey Questionnaire); training in the field and laboratory to support disease detection and monitoring for priority endemic diseases; training to support basic capacity in emergency management; risk analysis training; stakeholder consultations; review and development of legal framework; identification of Competent Authority(ies); draft national list of aquatic pathogens; undertake WOAH Evaluation of Performance of Aquatic Animal Health Services.

5 Aquatic organism health or aquaculture biosecurity strategies that aim at reducing the impact of listed endemic diseases are developed and endorsed at enterprise, local-sector and national levels (Gateway Pass)

- **Indicator description:** The sector- and national-level biosecurity strategies are developed by key stakeholders from the public and private sectors to manage risks associated with listed endemic diseases, as identified through completion of key outcomes 1–4. The strategies should be endorsed by the Competent Authority(ies).
- **Typical activities:** Multi-stakeholder consultations to draft biosecurity strategies; review and endorsementof draft strategies by relevant Competent Authority(ies).

PMP/AB Stage 2 Key Outcomes

1 Aquatic organism health or or aquaculture biosecurity strategies developed in Stage 1 are implemented by public and private stakeholders

- **Indicator description:** Aquaculture biosecurity activities are implemented at the sectoral and national levels based on risk-based strategies developed in Stage 1. Control measures are targeted at critical control points, which may include enhanced biosecurity practices, quarantine, movement controls, and cleaning and disinfection protocols at critical points along the value chain.
- **Typical activities:** Education and awareness raising of stakeholders and implementation of biosecurity measures.

2 The management of biosecurity vulnerabilities and occurrence of listed endemic diseases are monitored

- **Indicator description:** The occurrence and distribution of nationally listed endemic diseases should be determined through surveillance and monitoring activities. It is also important to document the implementation of aquaculture biosecurity activities described in the national and sector-level biosecurity strategies to ensure that control measures achieve the desired impact. A national mechanism should be in place for monitoring implementation of control measures to provide evidence of compliance with biosecurity requirements. The results of this compliance assessment should be documented and provided to key stakeholders.
- **Typical activities:** A surveillance and monitoring system for listed endemic diseases is established; surveillance data is analysed; inspections and reporting; audits and certification of biosecurity management are conducted; compliance assessments.

3 There is evidence that the biosecurity system strengthens aquatic health resilience and reduces the impact of diseases within the aquaculture sector

- **Indicator description:** It is important to determine the effectiveness of the implemented control measures in reducing the impact of listed endemic diseases affecting the aquaculture sector in the country. Production volume should be positively impacted by the activities implemented. The results of the impact assessment should be documented and provided to key stakeholders.
- **Typical activities:** Analysis of surveillance and monitoring data and impact assessment.

4 The enabling environment is further developed, with the necessary standards and plans, and enhanced by co-operation between public and private sectors

- **Indicator description:** There should be evidence of the country's commitment to developing an aquaculture biosecurity and health management system. This includes allocation of sufficient resources to ensure effective implementation of health control strategies. The legal framework should support surveillance, monitoring, prevention and control activities. Aquatic health professionals should be able to diagnose and make prevention and control recommendations for listed endemic pathogens and the diseases they cause; laboratory capacity must be sufficient to support the diagnoses. There should be mechanisms and incentives in place to enhance public–private partnerships and stakeholder confidence in the aquaculture biosecurity measures being implemented.

- **Typical activities:** Develop national policies for aquaculture biosecurity; strengthen legal framework; develop a National Aquatic Pathogen List using established scientific criteria; develop an Aquatic Health Information System; implement laboratory and field training to enhance aquatic health expertise and capacity; establish a network of laboratories accredited by the Competent Authority(ies) for confirmatory diagnosis of listed pathogens and diseases; conduct multi-stakeholder consultations.

5 Aquatic organism health aquaculture biosecurity strategies are enhanced and revised, based on evidence gained from programme implementation (Gateway Pass)

- **Indicator description:** The biosecurity strategies should be revised based on acquired knowledge or new research, and enhanced to include specific and measurable performance indicators, and provisions for: rapid detection and response activities, contact tracing, port/border controls, import risk analysis and contingency plans for response to emerging and exotic diseases, prudent use of veterinary drugs or other chemical treatments, maintenance or improvement of ecosystem health, and zoning/compartmentalization (if applicable). Mitigation measures should be implemented to address all significant aquatic health risks. Key stakeholders should be consulted during revision of the biosecurity strategies before endorsement from the Competent Authority(ies).
- **Typical activities:** Gap analysis to identify critical gaps in knowledge; targeted research to gain better understanding of the epidemiology of diseases caused by listed pathogens; evaluation of biosecurity measures (i.e. cost-benefit analysis, compliance, impact); stakeholder consultation; targeted research.

PMP/AB Stage 3_Key Outcomes

1 Revised aquatic organism health or aquaculture biosecurity strategies are implemented

- **Indicator description:** Aquaculture biosecurity activities are implemented at the sectoral and national levels based on the control measures developed and revised through implementation feedback in Stage 2; activities in Stages 1 and 2 of the PMP/AB should be continued and enhanced as per evolving data and experience. Control measures are targeted at critical control points, which may include enhanced biosecurity practices, port/border controls, contingency planning, and rapid disease response.
- **Typical activities:** Continuation of activities in Stages 1 and 2; efficient and effective outbreak prevention and/or management; inspections and audits to ensure compliance; targeted research to address gaps in knowledge and improvement of existing control strategies; strengthened port/border controls based on import risk analyses; accurate commodity identification; national movement controls; a traceability system for control of infectious disease outbreaks established.

2. Continuous surveillance is conducted for the detection and monitoring of emerging and listed diseases

- **Indicator description:** There is evidence of high-quality surveillance activities for the early detection of listed exotic pathogens and their associated diseases or emerging diseases on farms. Monitoring of listed endemic diseases is aimed at detecting any changes in parameters such as prevalence, geographic distribution, pathogenicity, and seasonality of infections. Outbreaks of listed or emerging diseases are fully investigated.

- **Typical activities:** Implement targeted monitoring activities for listed endemic diseases to detect changes in infection dynamics and distributions; conduct surveillance activities to demonstrate and maintain freedom from listed exotic pathogens and diseases or early detection of emerging diseases; analyse surveillance and monitoring data.

3. Disease incidence and impact are reduced

- **Indicator description:** Through monitoring programmes, there is evidence that endemic diseases caused by listed pathogens are being controlled, i.e. data demonstrate a decline in outbreaks in endemic areas of the country, as well as no spread to unaffected areas. Production losses attributed to these diseases are reduced.
- **Typical activities:** Analysis of surveillance and monitoring data; impact assessment to determine effectiveness of biosecurity programme; response audits; transparent reporting and quality control of monitoring data; socioeconomic impact analysis and reporting.

4. Enabling environment is strengthened and relevant legislation, standards and plans are established or revised to support the aquaculture biosecurity strategies

- **Indicator description:** There is further development of the enabling environment to support full implementation of the aquatic organism health or aquaculture biosecurity strategies at the national, local-sector and enterprise levels. Legal framework can support sustainable aquaculture and safeguard the country against the introduction of listed exotic or emerging diseases caused by listed pathogens, as well as reduce the impact and prevent further spread of listed diseases present in aquatic populations. Robust health certification supports national and international market access, and import controls protect vulnerable aquatic resources. Aquatic health professionals have the support required to perform their duties efficiently. There is an early detection system in place that includes contingency plans for responding to mass mortality events and detection of exotic or emerging diseases. The country has enhanced research and diagnostic capacity and expertise.
- **Typical activities:** Strengthen legal framework; training to strengthen capacity of support personnel (e.g. diagnosticians, aquatic health professionals, field officials); training to strengthen laboratory capacity for rapid detection of emerging diseases or listed pathogens/diseases; development and testing of emergency preparedness; prudent use of veterinary drugs or chemical treatments; research for the development or improvement of existing diagnostic or treatment strategies; zones/compartments are established using World Organisation for Animal Health (WOAH) or International Plant Protection Convention (IPPC) guidelines; health certification for exports and port/border controls for imports meet standards set by WOAH/IPPC in support of the World Trade Organization's Sanitary and Phytosanitary Agreement.

5. Commitment is demonstrated, including investment, from public and private stakeholders to safeguard progress (Gateway Pass)

- **Indicator description:** Public, private and international stakeholders clearly demonstrate their commitment to sustaining the aquaculture biosecurity system. A national multi-agency taskforce is in place, with capacity for public–private co-regulation to enhance consistent aquaculture biosecurity implementation. The country promotes improvement in aquaculture biosecurity at the regional level to ensure sustainability of the aquaculture biosecurity and health management systems.

- **Typical activities:** Documentation to support stakeholder commitment; evidence of resource investment in national and sectoral-level biosecurity; sharing of information and improved cooperation within the region, particularly with countries sharing waterbodies.

A country is in Stage 4 of the PMP/AB once Stages 1 to 3 have been completed.

PMP/AB Stage 4 Key Outcomes

1 Risk management activities are sustained and improved based on evidence

- **Indicator description:** Activities in previous stages of the PMP/AB are deemed to be effective and are revised based on ongoing collection of data and biosecurity implementation experience.
- **Typical activities:** Continuation of activities in Stages 1–3

2 Systems for preparedness and response to emergencies, and capabilities, are fully developed

- **Indicator description:** Contingency planning and emergency response systems implemented in previous stages of the PMP/AB are deemed to be effective and are revised based on ongoing collection of data and biosecurity implementation experience.
- **Typical activities:** Continuation of activities in Stages 1–3.

3. The enabling environment is maintained and continuously improved as necessary

- **Indicator description:** The country's capacity to fully implement the aquatic organism health or aquaculture biosecurity strategies is maintained and continuously improved based on science-based evidence and implementation experience.
- **Typical activities:** Continuation of activities in Stages 1–3.

4. Robust socioeconomic situation is achieved for all (including small-scale producers and food security for consumers)

- **Indicator description:** There is a reduction of losses from diseases in the aquaculture sector and evidence of improvement of health in production systems and surrounding environments at the farm and national levels. This results in socioeconomic benefits for the country and aquaculture sector, including small-scale producers, with related improvement of investment opportunities supporting aquaculture development.
- **Typical activities:** Continuation of activities in Stages 1–3.

5 National and international stakeholders have confidence in national aquatic health services and ecosystem health

- **Indicator description:** Stakeholders clearly demonstrate ongoing commitment to support aquaculture, public health and ecosystem health. This "One Health" approach thrives due to the institutions and co- regulation mechanisms developed in Stages 1–3. International stakeholders should be supported in the development of national aquaculture biosecurity systems to further reduce the risk of international spread of aquatic pathogens. There should be strong engagement in promoting sustainable and safe trade in aquatic commodities, increased market access and a reduction of non-tariff trade barriers on imports related to aquatic health concerns.
- **Typical activities:** Continuation of activities in Stages 1–3.

a	
b	c

PLATE 5
Scenes from a seaweed farm in Calatagan, Batangas, Philippines

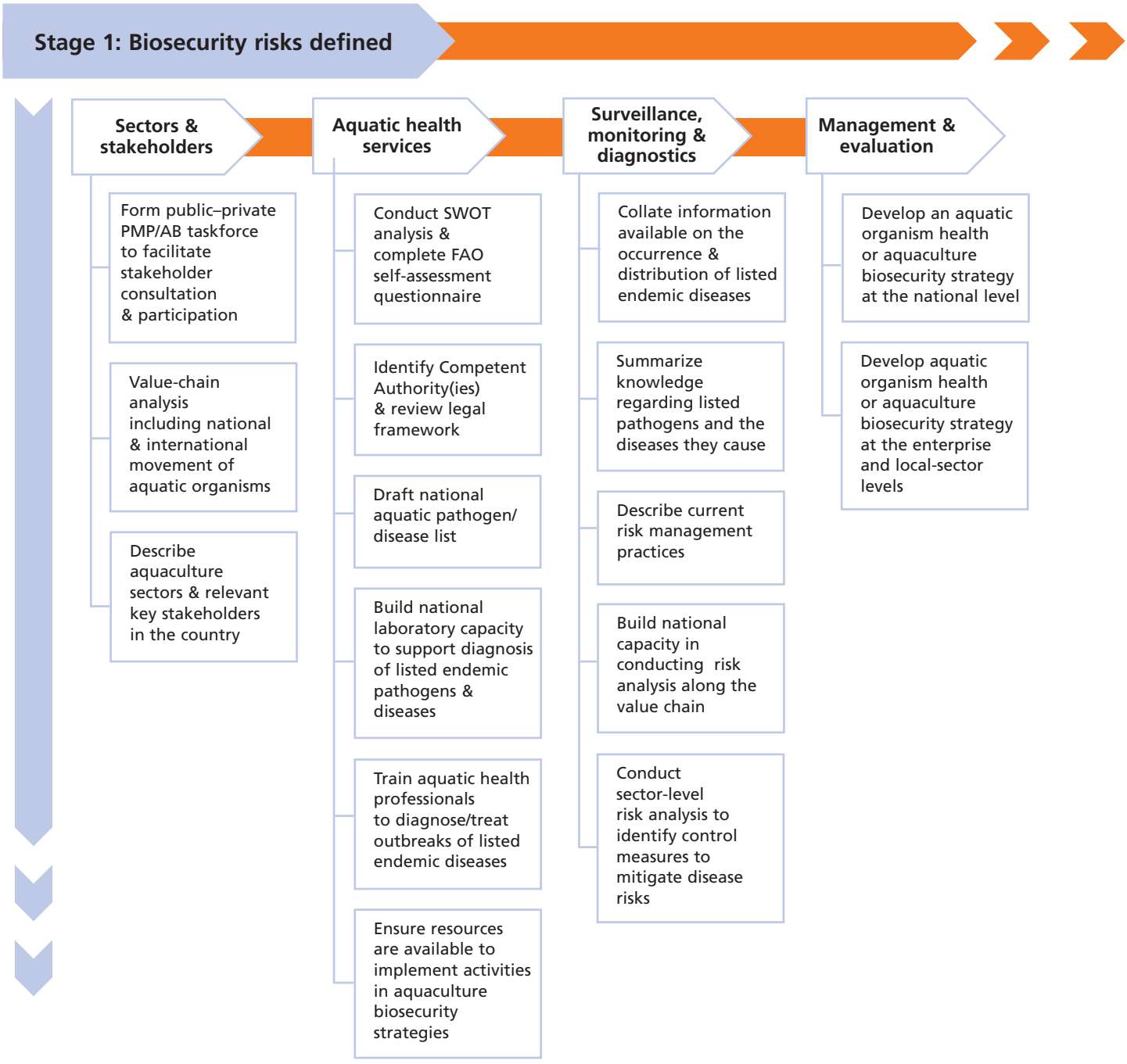
a Farmers preparing their boats for seaweed collection
b A farmer during harvesting of seaweed
c A woman checking the harvested seaweed

PLATE 6
Shrimp ponds in Sri Lanka

@ BIN HAO

Annex 2:

Flowchart for PMP/AB stage completion[1]



[1]This is a general overview of the stepwise process and activities for completing Stages 1 to 3 of the PMP/AB. Details can be found in the PMP/AB checklist and supporting PMP/AB guidance. The PMP/AB is not intended to be prescriptive and can be completed through different activities or combinations of activities. It may be applied by any country, no matter the national approach for aquaculture biosecurity currently in place.

Stage 2: Biosecurity systems initiated

Sectors & stakeholders

- Develop and strengthen public- private partnerships, & ensure aquaculture biosecurity activities being implemented are feasible, effective, & acceptable to stakeholders
- Identify Competent Authority(ies) & review legal framework

Aquatic health services

- Implement aquatic organism health or aquaculture biosecurity strategies
- Draft national aquatic pathogen/ disease list
- Adopt national aquatic pathogen/ disease list
- Build national laboratory capacity to support diagnosis of listed endemic pathogens & diseases
- Train aquatic health professionals to diagnose/treat outbreaks of listed endemic diseases
- Ensure resources are available to implement activities in aquatic organism health or aquaculture biosecurity strategy
- Form public–private PMP/AB taskforce to facilitate stakeholder consultation & participation
- Value-chain analysis including national & international movement of aquatic organisms
- Describe aquaculture sectors & relevant key stakeholders in the country

Surveillance, monitoring & diagnostics

- List all farms in the aquaculture sector & their geographical locations in the country
- Conduct surveillance to collect information regarding the occurrence of listed endemic diseases & identify the potential source of spread
- Review & conduct further risk analyses along the value chain to reassess the identification & prioritization of risk hotspots
- Conduct research studies to develop more effective control measures for mitigating the introduction & spread of listed pathogens and the endemic diseases they cause
- Store data from surveillance activities in the Animal Health Information System (AHIS)

Management & evaluation

- Audit implementation of the aquatic organism health or aquaculture biosecurity strategy to ensure compliance
- Evaluate results from the auditing & address gaps in compliance
- Adapt risk mitigation measures featured in the aquatic organism health or aquaculture biosecurity strategy to remain effective & efficient, based on acquired knowledge or new research
- Enhance aquatic organism health or aquaculture biosecurity strategy to include provisions for addressing One Health concerns & emerging and exotic diseases of national concern: i.e., rapid detection & response activities, port/border controls, import risk analysis & contingency plans for incursions of emerging & exotic diseases, prudent use of veterinary drugs & chemical treatments, maintenance or improvement of ecosystem health, & zoning or compartmentalization (if applicable)

Stage 3: Biosecurity systems and preparedness enhanced

Sectors & stakeholders

- Form a PMP/AB Technical Working Group with capacity for public private co-regulation to safeguard biosecurity practices
- Share & compare aquatic organism health or aquaculture biosecurity strategy with international stakeholders
- Publish a report describing the performance of the aquatic organism health or aquaculture biosecurity strategy
- Obtain evidence of public commitment to safeguarding progress through financial, infrastructural & human resources

Aquatic health services

- Implement revised/ enhanced aquatic organism health or aquaculture biosecurity strategy, including contingency plans for the control of exotic pathogens& emerging diseases and port/ border
- Ensure legal framework can support full implementation of the aquatic organism health or aquaculture biosecurity strategy
- Build capacity in the aquatic health services to respond rapidly to emergencies, control risks of pathogen introduction associated with feed, & prevent the introduction & spread of listed exotic pathogens & emerging diseases
- Establish a laboratory quality assurance system
- Build national laboratory capacity to support surveillance activities for listed exotic pathogens & emerging diseases, or ensure national laboratory is available for this purpose
- Build national laboratory capacity to support rapid detection and diagnosis of listed pathogens & emerging diseases, or ensure national laboratory is available for this purpose
- Enforce prudent use of veterinary drugs and chemical treatments

Surveillance, monitoring & diagnostics

- Conduct active surveillance to allow for early detection of listed exotic or emerging diseases, and identify the potential source of introduction
- Trace movements of live aquatic organisms, gametes & germplasm, and their products
- Conduct research studies to develop more effective control measures for mitigating the introduction and spread of listed pathogens and exotic or emerging diseases

Management & evaluation

- Audit implementation of the enhanced aquatic organism health or aquaculture biosecurity strategy
- Evaluate results from the audit & address gaps in compliance
- Analyse the impact of the enhanced aquatic organism health or aquaculture biosecurity strategy on aquaculture production volume
- Analyse the impact of the enhanced aquatic organism health or aquaculture biosecurity strategy on the risk of introduction or spread of listed exotic pathogens & emerging diseases

Stage 4: Sustainable biosecurity and health management systems established

Sustain, monitor and continuously improve activities from stages 1 to 3.

PLATE 7
Worker processing salmon in
Bosnia and Herzegovina

@ MELBA REANTASO

Annex 3

PMP/AB checklist

Indicator	Complete (Yes/No)	Comments
PMP/AB Stage 1: Biosecurity risks defined **Sectors and stakeholders: Key Outcome 1**		
1. A list is available of all aquaculture sectors and relevant key stakeholders in each, including producers, aquatic health professionals, industry partners (i.e. feed manufacturers, seed suppliers, etc.) and government officials (local/state or provincial/national).		
2. There is a descriptive overview of the systems involved in aquaculture production (i.e. live aquatic organisms, germplasm/ gametes/sporophytes, and products), including suppliers, producers, processors, marketing system and consumers (i.e. value-chain analysis). National movements of live aquatic organisms and importation/exportation of relevant commodities are included.		
Sectors and stakeholders: Key Outcome 4		
3. A public–private taskforce for the PMP/AB is formed and includes representation from key stakeholders in industry, government and non-governmental organizations.		
4. There is a mechanism in place to consult with stakeholders on potential aquaculture biosecurity activities to be implemented.		
5. There is a system in place for farmers and other stakeholders to report suspected cases of disease caused by nationally listed aquatic pathogens to the Competent Authority.		
Aquatic health services: Key Outcome 4		
6. Competent Authority(ies) on aquaculture biosecurity and aquatic health is/ are clearly identified.		
7. The current legal framework regarding aquaculture and aquatic health has been reviewed.		
8. A NAPL is drafted using internationally accepted criteria, and based on assessment of a comprehensive list of pathogens and diseases of concern. This list originates from a national (i.e. trade-limiting or important to aquatic organism/public/environmental health) and producer-level perspective (i.e. endemic pathogens causing diseases that impact production).		
9. Aquatic health professionals (public or private) are adequately trained to diagnose and treat some or all of the diseases caused by listed endemic aquatic pathogens.		
10. There is basic capacity in the country to conduct sector-level risk analysis.		
11. There is a protocol in place for mass mortality events to be investigated and reported to the Competent Authority.		
12. National laboratory capacity is sufficient (or there is cooperation with external laboratory expertise) to support the diagnosis of listed endemic aquatic pathogens and diseases.		
13. There are sufficient resources available to implement activities described in the aquatic organism health or aquaculture biosecurity strategies.		

Indicator	Complete (Yes/No)	Comments
PMP/AB Stage 1: Biosecurity risks defined **Surveillance, monitoring and diagnostics: Key Outcome 2**		
14. All aquaculture sites are documented, including geographic locations.		
15. A comprehensive list of pathogens and diseases that are assessed as posing a significant threat to national aquaculture production and/or wild aquatic populations is created using internationally established criteria.		
16. Fundamental knowledge regarding listed pathogens and diseases is available, including basic epidemiology, life cycles, characteristics, etc.		
17. Available knowledge about the occurrence and distributions of listed endemic diseases that impact the country's aquaculture sector and/or wild aquatic species is collated and summarized.		
18. Known biosecurity vulnerabilities are identified for the aquaculture sector.		
Surveillance, monitoring and diagnostics: Key Outcome 3		
19. Risk hotspots within the value-chain are identified, described and prioritized at the sector level (i.e. risk analysis based on value-chain analysis conducted in Statement #2).		
20. Risk pathways are developed for prioritized risk hotspots. For each step in the risk pathway, the likelihood (probability) of the risk of occurrence is assessed.		
21. Critical control points are identified within risk pathways for each prioritized risk hotspot.		
22. Current risk mitigation practices and gaps in knowledge related to managing the risk of introduction and spread of listed pathogens and diseases for each critical control point are described.		
Management and evaluation: Key Outcome 5		
23. A national aquatic biosecurity strategy has been developed by a public–private taskforce and endorsed by Competent Authority(ies).		
24. A sector-level biosecurity strategy has been developed by a public–private taskforce and endorsed by Competent Authority(ies).		
PMP/AB Stage 2: Biosecurity systems initiated **Sectors and stakeholders: Key Outcome 4**		
25. Mechanisms and incentives are in place to develop and strengthen public–private partnerships.		
26. There is a mechanism in place to educate stakeholders on the rationale for aquaculture biosecurity activities being implemented.		
27. There is a mechanism in place to engage with stakeholders on aquaculture biosecurity activities being implemented.		
28. There is collection of data/ information that demonstrates aquaculture biosecurity activities applied are feasible, effective and acceptable to stakeholders or identifies gaps requiring improvement.		
29. Regional cooperation is established regarding implementation of aquaculture biosecurity activities (especially with countries sharing water bodies).		
Aquatic health services: Key Outcome 4		
30. National policies for aquatic health and aquaculture biosecurity are developed.		
31. Current legal framework is deemed sufficient or revised accordingly to support aquatic organism health or aquaculture biosecurity strategies.		

Indicator	Complete (Yes/No)	Comments
PMP/AB Stage 2: Biosecurity systems initiated Sectors and stakeholders: Key Outcome 4		
32. The National Aquatic Pathogen List is adopted by the Competent Authority(ies).		
33. Outbreaks of diseases notifiable to the WOAH/IPPC are reported to the Competent Authority (and subsequently to the WOAH/IPPC, as required).		
34. National laboratory capacity is sufficient, or there is a formal collaborative agreement with an external laboratory, to support surveillance activities for endemic diseases caused by listed pathogens.		
35. A National Aquatic Health Infor-mation System (AHIS) is developed to collate data from laboratory diagnostic, monitoring and surveillance activities.		
36. Data from the national laboratory network are stored in the AHIS.		
37. The Competent Authority(ies) has/have an internal coordination mechanism including a direct chain of command (central to field level) regarding the detection and control of listed pathogens and diseases. This chain of command is defined in the national aquaculture biosecurity strategy.		
38. The Competent Authority(ies) has/have the capability to monitor the occurrence of all endemic diseases caused by listed pathogens.		
39. Aquatic health professionals in the field (public or private) are trained to recognize and report suspect cases of all endemic diseases caused by listed pathogens in the country.		
40. The Aquatic Health Services have the operational capacity to implement the aquatic organism health or aquaculture biosecurity strategies.		
Surveillance, monitoring and diagnostics: Key Outcome 2		
41. Information regarding the occurrence of listed endemic diseases in the country is continuously collected and collated.		
42. Value-chain analyses are repeated, and identification and prioritization of risk hotspots reassessed.		
43. Risk-based control measures are reviewed and revised accordingly to remain effective and efficient.		
44. Gaps in understanding of endemic diseases caused by listed pathogens, e.g. transmission and impact, are addressed through targeted research to help develop more effective control measures.		
45. Data from monitoring activities are quality controlled and securely stored in the AHIS.		
46. Investigations are performed on suspected outbreaks of endemic diseases caused by listed pathogens to determine the potential source and risk of spread, as per contingency planning.		
Management and evaluation :Key Outcome 1		
47. There is evidence (e.g. audit results) that activities described within the aquatic organism health or aquaculture biosecurity strategies are being carried out by public and private stakeholders. A report on this monitoring is issued by the Competent Authority(ies) on a yearly basis (or more frequently).		
Management and evaluation: Key Outcome 2		
48. Efforts to control listed endemic diseases are targeted at critical control points.		

Indicator	Complete (Yes/No)	Comments
PMP/AB Stage 2: Biosecurity systems initiated **Management and evaluation: Key Outcome 2**		
49. Control measures for listed endemic diseases include cleaning and disinfection activities at all critical control points along the production and marketing value-chain.		
50. Control measures for listed endemic diseases include control of movements of susceptible aquatic organisms and their products.		
Management and evaluation: Key Outcome 3		
51. There is evidence that biosecurity strategies have a positive impact on aquaculture production. A report on this evaluation is issued by the Competent Authority(ies) on a yearly basis (or more frequently).		
Management and evaluation: Key Outcome 2		
52. Gaps in knowledge of effective control measures for listed pathogens and diseases are identified and addressed. There is emphasis on acquiring knowledge that could assist in more effective risk management.		
53. There is a mechanism to modify control measures rapidly when they are determined to be ineffective.		
Management and evaluation: Key Outcome 5		
54. The aquatic organism health or aquaculture biosecurity strategies are revised based on acquired knowledge or new research, and enhanced to include specific and measurable performance indicators and provisions for: rapid detection and response; import controls and risk analyses; contingency plans for early detection and control of emerging and exotic diseases; prudent use of veterinary drugs or chemical treatments; maintenance or improvement of ecosystem health, and zoning/compartmentalization for listed endemic diseases (as applicable).		
PMP/AB Stage 3: Biosecurity systems and preparedness enhanced **Sectors and stakeholders: Key Outcome 4**		
55. A national, multi-agency taskforce is in place, with capacity for public–private co-regulation to safeguard and ensure ongoing implementation of aquaculture biosecurity practices.		
56. The aquatic organism health or aquaculture biosecurity strategies are shared with international stakeholders and strategies are compared.		
Sectors and stakeholders: Key Outcome 5		
57. A written report describing the performance of the aquatic organism health or aquaculture biosecurity strategies is developed by the Competent Authority(ies), including documentation of progress according to the performance indicators identified in the national plan. Key stakeholders endorse the report and are committed to safeguarding progress through provision of financial, infrastructural or human resources.		
Aquatic health services: Key Outcome 4		
58. The Aquatic Health Services have the basic capacity to conduct import risk analysis.		
59. The Competent Authority(ies) and other Aquatic Health Services have the legal framework and financial support or access to financial resources to respond rapidly to aquatic health emergencies.		
60. The Competent Authority(ies) can control the risks of pathogen introduction associated with aquatic animal feeds and plant seedlings.		
61. The Competent Authority(ies) has/have the capacity to prevent the introduction and spread of exotic pathogens and emerging aquatic diseases of national concern.		
62. There is a laboratory quality assurance system in place.		

Indicator	Complete (Yes/No)	Comments
PMP/AB Stage 3: Biosecurity systems and preparedness enhanced Aquatic health services: Key Outcome Key Outcome 4		
63. National laboratory capacity is sufficient, or there is a formal collaborative agreement with an external laboratory, to support surveillance activities for emerging diseases and listed pathogens of significant national concern.		
64. National laboratory capacity is sufficient, or there is a formal collaborative agreement with an external laboratory, to support rapid detection and diagnosis of emerging diseases and listed pathogens of significant national concern.		
65. The country demonstrates that prudent use of veterinary drugs or other chemical disease treatments is being enforced.		
66. Legal framework supports full implementation of the aquatic organism health or aquaculture biosecurity strategies. National legislation is in place to facilitate enforcement of policies related to aquatic health and aquaculture biosecurity.		
67. The Competent Authority(ies) and other Aquatic Health Services have the resources and competency to respond to aquatic disease emergencies.		
Surveillance, monitoring and diagnostics: Key Outcome 2		
68. A surveillance system is implemented to allow for early detection of emerging diseases and listed pathogens and diseases that have high national priority.		
69. Gaps in understanding of endemic and exotic diseases caused by listed pathogens (e.g. transmission and impact) are addressed through research to assist in the development of more effective control measures.		
70. Investigations are performed during suspected outbreaks of emerging or exotic diseases to determine the potential source, potential for disease transmission and spread, and to implement appropriate control measures.		
Management and evaluation: Key Outcome 1		
71. The Competent Authority(ies) audits/audit implementation of the aquatic organism health or aquaculture biosecurity strategies. Results are evaluated and gaps in compliance are addressed. A report on this monitoring and enforcement is issued yearly (or more frequently).		
Management and evaluation: Key Outcome 3		
72. There is documentation of a reduction or elimination of the occurrence of disease outbreaks caused by listed pathogens in susceptible populations where biosecurity measures are being implemented. Where there are limited or no reduction in outbreaks, control measures are assessed to determine areas that should be improved. A report on this evaluation is issued by the Competent Authority on a yearly basis (or more frequently).		
73. There is documentation that aquaculture biosecurity measures have reduced the risk of introduction of listed exotic pathogens and diseases into the country.		
Management and evaluation: Key Outcome 4		
74. Risk-based contingency plans are in place for control or eradication of emerging diseases and exotic pathogens of national concern. There are early detection and rapid response systems to prevent spread of infection.		
75. Control efforts for the introduction of listed pathogens and diseases into the country include risk-based import control measures.		
76. There are procedures in place to trace the movement of live aquatic organisms, gametes/germplasm, and their products for aquatic health and food safety. This includes accurate commodity identification and movement controls for specific aquatic populations in the country.		

Annex 4:

The FAO Aquatic Organism Health Capacity and Performance Self-Assessment Survey Questionnaire[1]

History

The FAO self-assessment survey questionnaire was developed in 2008 after the incursion of the epizootic ulcerative syndrome (EUS) in the Chobe-Zambezi River in Africa in 2007. At that time, the status of aquatic animal health capacity in countries bordering the Chobe-Zambezi River that have been affected by EUS was largely unknown.

A preliminary survey was undertaken in 2008 as part of an FAO Technical Cooperation Programme (TCP) project TCP/RAF/3111 Emergency Assistance to Combat EUS in the Chobe-Zambezi River. Nine countries (Angola, Botswana, Kenya, Malawi, Mozambique, United Republic of Tanzania, Uganda, Zambia and Zimbabwe) participated in the survey. The outcomes of the survey were presented in a regional workshop on Developing of an Aquatic Biosecurity Framework for Southern Africa held in Lilongwe, Malawi, from 22 to 24 April 2008. The workshop provided a platform to discuss an aquatic biosecurity framework for southern Africa based on survey findings and ensuing workshop discussions; and identified regional capacity-building needs to address aquatic biosecurity gaps in the region.

Since then, the application of the self-assessment survey was continued via several FAO projects as a mechanism to understand better the aquatic animal situation of countries that requested for FAO technical assistance in improving capacities for managing disease challenges in aquaculture.

The current version of the questionnaire was adapted from the 2008 version, which has been updated and modified so that its application can fit as a fundamental component of a new initiative that FAO and partners have developed called the Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB). The PMP/AB, comprised of four progressive stages, is risk-based, proactive and collaborative, and uses bottom-up and top-down approaches to assist countries in achieving sustainable aquaculture biosecurity and health management systems. The PMP/AB promotes strong stakeholder involvement to apply risk management measures at the national, sectoral and enterprise levels to build resilience to pathogens and their associated diseases and other aquaculture biosecurity vulnerabilities.

As parallel efforts, national strategic planning for aquatic animal health and aquatic biosecurity have been promoted by FAO for more than two decades, encouraging Member Nations to develop and formalize National Strategies for Aquatic Animal

[1] Prepared by Drs Melba B. Reantaso (FAO), Brett MacKinnon (formerly of FAO, now with City University of Hong Kong), and J. Richard Arthur (international consultant, Canada), updated 1 June 2022.

Health (NSAAH) or what is now called National Aquatic Organism Health Strategy (NAOHS).

Although initially conceived for the improvement of biosecurity measures for cultured aquatic animals, the PMP/AB has been expanded to include all cultured aquatic organisms (both aquatic animals and aquatic plants). This broader scope, reflected in a revised terminology, recognizes the important contributions of seaweeds to global aquaculture production, national economies and the well-being of many local communities.

A NAOHS is a broad yet comprehensive strategy to build and enhance capacity for the management of national aquatic biosecurity and aquatic animal and plant health. It contains the national action plans at the short–, medium– and long–terms using phased implementation based on national needs and priorities. The NAOHS outlines the programmes and projects that will assist in developing a national approach to overall management of aquatic organism health and includes an Implementation Plan that identifies the activities that must be accomplished by government, academia and the private sector. The draft framework of the NAOHS should be discussed with and accepted by key stakeholders via a public–private partnership. The final document should be distributed to national policy-makers, aquaculturists, other private stakeholders and the general public; and the NAOHS should be endorsed by the Competent Authority(ies) as an official policy document.

The development of a NAOHS, based on risk assessments and a gap analysis, is an important component and end-goal for completion of Stage 1 of the PMP/AB. Detailed and accurate completion of this questionnaire will assist a country to identify the key areas that need to be addressed in the NAOHS and focus on those areas that need to be addressed by specific projects and activities.

Objective

The objectives of this self-assessment survey questionnaires are to:

- obtain information on a country's national capacity and government agencies mandated to implement aquatic biosecurity programmes and support aquaculture through healthy production;
- decide which components and activities should be included in your country's NAOHS; and
- help guide national strategic planning for improving aquatic organism health and assuring adequate and rational support services.

Instructions

The questionnaire contains three main sections pertaining to: (1) legislation, policy and programmes; (2) implementation; and (3) capacity building. Please note that sections 1 and 3 contain multiple subsections.
The following guidance is provided in implementing the survey:

- review the questionnaire to determine the relevant stakeholders that will be involved in the survey;
- implement the questionnaire through email correspondence or another appropriate mechanism, e.g. focus group discussion;
- for some countries, it may be necessary to translate the document into the local language; however, the returns should be sent back to FAO in English; and
- ensure that all responses are correct and accurate.

If the information to respond to a question cannot be found, do not respond by writing "not applicable" – please write "information not found". If there is a question that relates to an item that is not relevant to the situation in your country, please state this categorically, i.e. "not relevant to the country". Similarly, if there is a closed question, then try to not simply write "yes" or "no," but include supporting information, if possible. Citations should be provided for any legal frameworks or documentation described.

If there is information about the country relating to its aquatic health system that you feel has not been adequately captured in the responses to the specific questions below (for example, if your country has undertaken a WOAH PVS evaluation) then such information can be included in the in the "additional information" section of this Annex (see Section 3.6).

Details of person(s) completing the questionnaire

Country:
Name:
Title:
Institution:
Mailing address:
Telephone:
Facsimile:
Email:
Date:

Section 1 Legislation, Policy and Programmes

1.1 Description of governance authorities

1.1.1 In the table below, please list all governance authorities (at the federal, state/provincial, etc. level), their mandates, and responsibilities for aquatic organism (animal and plant) health, aquaculture and food safety (related to aquatic organisms and/or products) in your country:

Agency/Ministry	Mandate/Authority	Responsibility

1.2 Legislation

1.2.1 Is there specific legislation (laws, acts or legal instruments) in place dealing with aquatic animal and/or plant health?
( ) Yes ( ) No

1.2.2 If yes, give the name of legislation related to aquatic animal and/or aquatic plant health and provide a citation (if possible):

1.2.3 If yes, indicate if aquatic organism health legislation is:

By separate act:
( ) Yes ( ) No

By separate regulation:
( ) Yes ( ) No

As part of broader veterinary, animal and/or plant health, aquaculture, fisheries, environmental protection or conservation legislation:
( ) Yes ( ) No

1.2.4. Is there specific legislation (laws, acts or legal instrument) in place dealing with antimicrobial resistance (AMR) (related to aquatic organisms)?
( ) Yes ( ) No

1.2.5. If yes, give the name of legislation related to AMR and provide a citation (if possible):

1.3 Policy and planning

1.3.1. Has/have a government authority(ies) been designated as responsible for national policy and planning for aquatic organism (aquatic animal and/or aquatic plant) health for your country?
( ) Yes ( ) No

1.3.2. If **yes**, indicate agency(ies) or department(s) and please briefly describe their responsibilities:

1.3.3. Has official national aquatic organism health policy been expressed in a national aquatic animal and/or plant health plan, programme, strategy or other document?
( ) Yes ( ) No

1.3.4. If **yes**, list the document(s) and provide their citations (if possible):

1.3.5. Do subnational entities (state, provincial, local government, private sector) play a role in setting national aquatic organism health policy?
( ) Yes ( ) No

1.3.6. If yes, briefly describe their role(s):

1.3.7. Does your country have a national aquatic organism (animal and/or plant) health policy for:

(a) preventing the entry of exotic pathogens and diseases of aquatic organisms (foreign aquatic animal and/or plant pathogens and diseases)?
( ) Yes ( ) No

(b) preventing the spread of exotic pathogens and diseases of aquatic organisms (foreign aquatic animal and/or plant pathogens and diseases)?
( ) Yes ( ) No

(c) controlling serious diseases of aquatic organisms present in your country (endemic diseases)?
( ) Yes ( ) No

1.3.8. If yes, list the document(s) and provide their citations (if possible):

1.3.9. Which of the following areas are addressed in national aquatic organism (animal and/or plant) strategy or health policy?

National diagnostics services:	( ) Yes ( ) No
Risk analysis:	( ) Yes ( ) No
Farm-level treatment and prevention:	( ) Yes ( ) No
Emergency preparedness and disease control:	( ) Yes ( ) No
Foreign animal/plant disease control:	( ) Yes ( ) No
Domestic disease control:	( ) Yes ( ) No
Importations (imports):	( ) Yes ( ) No
Exportations (exports):	( ) Yes ( ) No
Zoning:	( ) Yes ( ) No
Compartmentalization:	( ) Yes ( ) No
Use of veterinary drugs and biologics:	( ) Yes ( ) No
Manpower requirements:	( ) Yes ( ) No
Training requirements:	( ) Yes ( ) No
Infrastructural requirements:	( ) Yes ( ) No
Financial requirements and planning:	( ) Yes ( ) No
International treaties, memberships and linkages:	( ) Yes ( ) No
Communication (interagency, stakeholder):	( ) Yes ( ) No
Other(s):	

1.3.10 If yes, list the document(s) and provide their citations (if possible):

1.3.11. What are the current priorities for your country with regard to national aquatic organism (animal and plant) health policy (list in order of importance)? Are small-scale producers a priority in your country?

1.4 Disease diagnostics

1.4.1. Is there a national aquatic organism (animal and/or plant) pathogen list (NAPL) or disease list (NADL) in your country?
( ) Yes ( ) No

1.4.2 If yes, list the pathogens and diseases below (and if possible, cite the relevant legislation and provide the criteria for inclusion of a pathogen or disease in the national list(s):

1.4.3 Is there adequate national capacity to diagnose diseases of aquatic organisms caused by pathogens on the NAPL or listed on the NADL, and emerging diseases?
( ) Yes ( ) No

1.4.4 Does your country have national standards for the diagnosis of diseases of aquatic organisms caused by pathogens on the NAPL or listed on the NADL?
( ) Yes ( ) No

1.4.5 If yes, please describe what the national standards are based on:

1.4.6 Is there adequate national capacity to diagnose aquatic animal diseases listed by the World Organisation for Animal Health (WOAH) to the specifications listed in the WOAH Aquatic Manual?
( ) Yes ( ) No

1.4.7 If yes, indicate capacity to diagnose disease using WOAH standards for the following groups:

(a)WOAH-listed molluscan diseases: ( )Yes (all) ( )Yes (some) ( )No

(b)WOAH-listed crustacean diseases: ( )Yes (all) ( )Yes (some) ( )No

(c) WOAH-listed finfish diseases: ( )Yes (all) ( )Yes (some) ( )No

1.4.7 Does your country have an officially designated national laboratory(ies) for aquatic animal and/or plant disease diagnostics?
( ) Yes ( ) No

1.4.8 If yes, please provide contact information:

1.4.9 Are any laboratories in your country accredited as international or national reference centers for aquatic organism (animal and/or plant) disease diagnostics?
( ) Yes ( ) No

1.4.10 If yes, please indicate laboratory(ies), accrediting body and type of accreditation:

1.4.11 Does your country's government and private aquaculture sector have access to other public or private-sector laboratory-based disease diagnostic services for the diagnosis of diseases of aquatic organisms caused by pathogens on the NAPL or listed on the NADL and/or for WOAH-listed diseases?
( ) Yes ( ) No

1.4.11 If yes, briefly describe this service/s, including the name and contact details of the responsible institutes/companies and the range of services available:

1.5 International trade in aquatic organisms and national border controls

1.5.1 Is your country a member of the World Organisation for Animal Health (WOAH)?
( ) Yes ( ) No

1.5.2 If yes, who is the Competent Authority of your country has the responsibility for submission of notifications and reporting to the WOAH?

1.5.3 Is your country a member of the International Plant Protection Convention (IPPC)?
Yes ( ) ( ) No

1.5.4 Is your country a member of the World Trade Organization (WTO)?
( ) Yes ( ) No

1.5.5 Does your country have regulations that support or strengthen government control of imports and exports with respect to aquatic organism (animal and plant) health?
( ) Yes ( ) No

1.5.6. If yes, briefly describe these controls, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and the legislation that provides authority for this control:

1.5.7. If yes, please describe (in general) any associated aquatic animal and/or plant health certifications that you provide to the importing country, including the name and contact details of the government agency/ies or department(s) that provides this certification:

1.5.8 If yes, is this certification performed:

(a) for health status and/or freedom from specified pathogens (https://www.oie.int/standard-setting/aquatic-manual/access-online/)?
( ) Yes ( ) No

(b) to whatever standards the importing country requires?
( ) Yes ( ) No

(c) to other standards based on general appearance of health (e.g. by visual inspection) or using testing protocols devised by agencies within your country?
( ) Yes ( ) No

1.5.9 Does your country have regulations that support or strengthen government control of imports and exports with respect to food safety (related to aquatic organisms and/or products)?
( ) Yes ( ) No

1.5.10 If yes, briefly describe these controls, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and the legislation that provides authority for this control:

1.5.11 If yes, please describe (in general) any associated food safety (related to aquatic organisms and/or products) certification that you provide to the importing country, including the name and contact details of the government agency/ies or department(s) that provides this certification:

1.5.12 If yes, is this certification performed:

(a) for health status and/or freedom from specified pathogens (https://www.oie.int/standard-setting/aquatic- manual/access-online/)?
( ) Yes ( ) No

(b) to whatever standards the importing country requires?
( ) Yes ( ) No

(c) to other standards based on general appearance of health (e.g. by visual inspection) or using testing protocols devised by agencies within your country?
( ) Yes ( ) No

1.5.13 Are aquatic organisms and/or their products imported to your country?
( ) Yes ( ) No

1.5.14 If yes, describe any associated aquatic animal and/or plant health certification that you require to be provided by the exporting country:

1.5.15 If yes, describe any associated food safety (related to aquatic organisms and/or products) certification that you require to be provided by the exporting country:

1.5.16 If yes, describe any other official controls or risk management measures to which imported aquatic organisms or aquatic organism products are subject (e.g. veterinary/plant health inspection at the port of entry, quarantine, or end-use controls such as prohibitions on the release of aquatic organisms, transportation water, ballast water, etc. into natural waters):

1.5.17 Is there expertise in your country for Import Risk Analysis for pathogens of aquatic organisms?
( ) Yes ( ) No

1.5.18 If yes, provide contact details of the agency/ies or department(s) with this expertise, risk analysis methodology followed (e.g. WOAH, IPPC), and provide examples (and where applicable, citations for published documents) of import risk analyses that have been undertaken:

1.5.19 Is evaluation of risks for diseases/pathogens of aquatic organisms linked with evaluation of other risks? (e.g. ecological, pest, aquatic invasive species, genetic risks, food safety)?
( ) Yes ( ) No

1.5.20 If yes, briefly describe how is this accomplished (e.g. by interagency committee):

1.6 Control of domestic movements of aquatic organisms and other domestic activities that may spread pathogens and their associated diseases.

1.6.1 Does your country have any regulations controlling the in-country movement of aquatic organisms?
( ) Yes ( ) No

1.6.2 If yes, briefly describe these controls, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and the legislation that provides authority for this control:

1.6.3 Does your country have any regulations pertaining to traceability of within-country movement of aquatic organisms?
( ) Yes ( ) No

1.6.4 If yes, briefly describe these controls, including the name and contact details of the responsible agency(ies) or department(s), programme(s) in place, and the legislation that provides authority for this control:

1.6.5 Does your country have any regulations pertaining to aquatic animal or plant waste disposal and water effluents as well as biomass of dead aquatic organisms resulting from disease outbreaks and from processing facilities in relation to preventing the spread of aquatic animal and/or plant pathogens and diseases?
( ) Yes ( ) No

1.6.6 If yes, briefly describe these controls, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and the legislation that provides authority for this control:

1.7 Aquaculture activities related to aquatic organism health

1.7.1 Does your country use FAO's Code of Conduct for Responsible Fisheries (CCRF) to guide the development of policies and/or standards related to aquaculture?
( ) Yes ( ) No

1.7.2 Does your country have any regulations controlling treatments, drugs or veterinary biologicals applied in aquaculture (i.e. antimicrobials, medicated feed, vaccines, etc.)?
( ) Yes ( ) No

1.7.3 If yes, briefly describe these controls, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and the legislation that provides authority for this control (including the legislation that defines the permitted and banned substances which may be applied):

1.7.4 Does your country have any regulations controlling the quality of inputs for aquaculture farms/premises (e.g. seed, feed, genetic resources, etc.)?
( ) Yes ( ) No

1.7.5 If yes, briefly describe these controls, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and the legislation that provides authority for this control (including the legislation that defines the permitted and banned inputs which may be applied):

1.7.6 Does your country have any regulations pertaining to the welfare of cultured aquatic organisms?
( ) Yes ( ) No

1.7.7. If yes, briefly describe these controls, including the name and contact details of the responsible agency(ies) or department(s), programme(s) in place, and the legislation that provides authority for this control:

1.8 Emergency preparedness/contingency planning

1.8.1 Does your country have any contingency or emergency response plans for containment or eradication of serious pathogens and diseases of aquatic organisms?
( ) Yes ( ) No

1.8.2 If yes, briefly describe these plans, including the name and contact details of the responsible agency/ies or department(s), programme(s) in place, and any legislation that supports emergency response activity:

1.9 Disease surveillance/monitoring

1.9.1 Does your country have any programmes for surveillance or monitoring of diseases of aquatic organisms?
( ) Yes ( ) No

1.9.2 If **yes**, briefly describe these programmes, including the name and contact details of the responsible agency/ies or department(s), and any legislation that supports surveillance or monitoring activities:

1.9.3 Does an aquatic organism (animal and/or plant) health information system (for storing, retrieval and analysis of disease diagnostics and surveillance data/information) exist in your country?
( ) Yes ( ) No

1.9.4 If **yes**, list the responsible institution(s) and describe what facilities exist:

Section 2 Implementation

2.1 Are there mechanisms in place for stakeholder consultations prior to the adoption and/or implementation of new legal framework related to aquatic organism health?
( ) Yes ( ) No

2.2 If **yes**, briefly describe these mechanisms, including the name and contact details of the responsible agency/ies or department(s):

2.3 Does your country have any extension services that support the prevention of diseases of aquatic organisms in aquaculture?
( ) Yes ( ) No

2.4 If **yes**, briefly describe these services, including the names and contact details involvement:

2.5 If **no**, indicate what agency, if any, is mandated to fulfil this function and provide contact details:

2.6 Does your country have any compliance services that monitor and enforce importations of aquatic organisms and/or their products, including aquatic animal and/or plant health and food safety regulations?
( ) Yes ( ) No

2.7 If **yes**, briefly describe the kind of monitoring and audit systems your country has in place, including the name and contact details of the responsible agency/ies, the number of staff involved and the legislation that supports compliance activity:

2.8 Does your country have any compliance services that monitor and enforces exportations of aquatic organisms and/or their products, including aquatic animal and/or plant health and food safety regulations?
( ) Yes ( ) No

2.9 If **yes**, briefly describe the kind of monitoring and audit systems your country has in place, including the name and contact details of the responsible agency/ies, the number of staff involved and the legislation that supports compliance activity:

2.10 Does your country have any compliance services that monitor and enforce domestic movements of live aquatic organisms, including aquatic animal and/or plant health and food safety regulations?
( ) Yes ( ) No

2.11 If **yes**, briefly describe the kind of monitoring and audit systems your country has in place, including the name and contact details of the responsible agency/ies, the number of staff involved and the legislation that supports compliance activity:

2.12 Does your country have any compliance services that monitor and enforce regulations related to disease prevention, management and control in aquaculture facilities/premises?
( ) Yes ( ) No

2.13 If yes, briefly describe the kind of monitoring and audit systems your country has in place, including the name and contact details of the responsible agency/ies, the number of staff involved and the legislation that supports compliance activity:

2.14 Please indicate whether the following aquatic animal and plant health expertise is available in your country by providing "Yes" or "No" answers within the table below. If the data/information is readily available, summarize the estimated total numbers of individuals in the country with particular levels of tertiary qualifications in each of the stated fields related to aquatic animal and/or plant health – only those actively employed in a capacity with direct relevance to the field of expertise should be included:

	Level of qualification				
Field of expertise in aquatic animal and/or plant health	**Doctorate degree**	**Master's degree**	**Veterinary degree**	**Bachelors degree**	**Other (specify)**
Pathology Animal: Plant:					
Parasitology (experimental) Animal: Plant:					
Parasitology (taxonomy) Animal: Plant:					
Virology Animal: Plant:					
Bacteriology Animal: Plant:					
Mycology Animal: Plant:					
Epidemiology Animal: Plant:					
Toxicology/water quality					
Molecular diagnostics (e.g. PCR, ELISA) Animal: Plant:					

	Level of qualification				
Field of expertise in aquatic animal and/or plant health	**Doctorate degree**	**Master's degree**	**Veterinary degree**	**Bachelors degree**	**Other (specify)**
Electron microscopy					
Aquatic biosecurity (e.g. risk analysis) Animal: Plant:					
Aquatic veterinary medicine Animal: Plant:					
Aquatic organism medicine/ pharmacology Animal: Plant:					
Aquatic organism health information systems Animal: Plant:					
Other (specify):					

Section 3 Capacity Building

3.1 Training

3.1.1 Does your country have any formal undergraduate training programmes in veterinary medicine, aquatic animal and/or plant health?
( ) Yes ( ) No

3.1.2 If yes, briefly describe these programmes, including the name and contact details of the responsible institute/s:

3.1.3 Does your country have any formal post-graduate training programmes (M.Sc. or Ph.D.) in areas related to aquatic organism health?
( ) Yes ( ) No

3.1.4 If yes, briefly describe these programmes, including the name and contact details of the responsible institute/s:

3.1.5 Does your country have any formal non-degree training programmes (short courses, work- study programmes etc.) in areas related to aquatic organism health?
( ) Yes ( ) No

3.1.6. If yes, briefly describe these programmes, including the name and contact details of the responsible institute/s:

3.2 Infrastructure

3.2.1 Does your country have any research institutions dedicated solely to aquatic organism (plant and/or animal) health?
( ) Yes ( ) No

3.2.1 If yes, briefly describe these institutions, including contact details, and investments provided by the government (if applicable):

3.3 Linkages and cooperation

3.3.1 List any international, regional or bilateral linkages, cooperation or joint projects related to aquatic organism health that your country has, indicating their nature and the participating agencies:

3.3.2 List any domestic linkages, projects or cooperation between government agencies, universities and/or private sector (e.g. farmer associations, non-governmental organizations, other civil society groups) related to aquatic organism health in your country, indicating their nature and the participating parties.

3.4 Funding support

3.4.1 Indicate the estimated total annual budget dedicated specifically to aquatic animal and plant health activities for your country (if this information is available)[2]:

(a) Amount from regular programmes:
Animal:
Plant:

(b) Amount from special funding/projects:
Animal:
Plant:

(c) Amount from foreign-assisted projects:
Animal:
Plant:

(a) Totals:
Animal:
Plant:

3.4.2 Is this amount considered adequate to meet current and future needs in aquatic organism health?
( ) Yes ( ) No

3.4.3 If no, indicate percentage increase required over the next 5 years?

[2] Please indicate whether this information should not be published.

3.5 Current challenges and constraints

3.5.1 List the main aquatic organism (animal and plant) health challenges that currently face your country with respect to:

(a) preventing the entry and spread of exotic pathogens and their associated diseases:

(b) preventing the domestic spread of serious pathogens and their associated diseases:

(c) meeting international/trading partner standards with regard to health certification of live aquatic organisms:

(d) controlling mortalities/losses due to pathogens and their associated diseases in aquaculture establishments:

(e) use of antibiotics and drugs for disease prevention and/or treatment:

(f) any other serious challenges related to aquatic organism health that your country is facing or is likely to face in the next 5 years:

3.5.2 List the major constraints to implementing an effective aquatic organism (animal and plant) health programme for your country, in order of importance:

3.5.3 List the good practices that work in your country to tackle the main aquatic organism (animal and plant) health challenges:

3.6. Additional information

3.6.1 Provide any additional information about your country's capacities or capabilities with respect to managing aquatic organism health or aquaculture biosecurity that is not mentioned in the responses to the above questions:

3.6.2 Provide additional information on aquaculture trends, aquaculture aspirations in next 5 years, resources and production data (if the data are readily available):

- length and tradition of aquaculture;
- production systems and species;
- total production, based on latest available statistics, with a breakdown by main species and by regions;
- breakdown of production (e.g. for consumption, export, stocking, etc.);
- water resources used for aquaculture (resource availability by water type – fresh, coastal/brackish, etc.; area utilized/unutilized; production areas used for finfish, molluscs, crustaceans, amphibians and aquatic plants);
- approximate number and sizes of aquaculture farms;
- processing facilities for aquaculture products; and
- shared water bodies.

References

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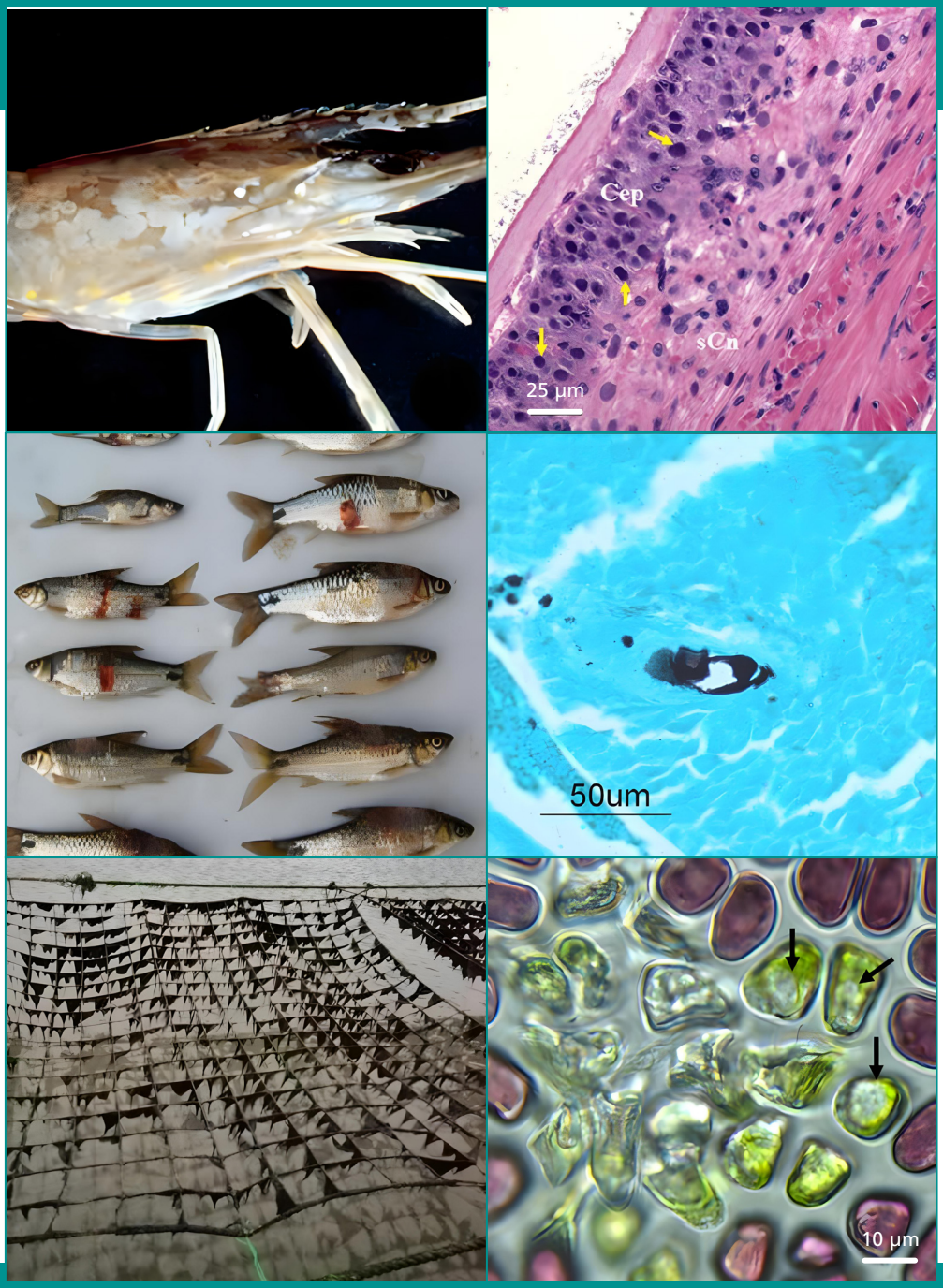


a	b
c	d
e	f

FIGURE 18
Examples of clinical signs and histopathological plates of diseases of aquatic organisms

a A juvenile *Penaeus monodon* that is displaying the distinctive white spots of white spot disease
@ DV LIGHTNER

b H&E histology of cuticular epithelium of a WSSV-infected *Penaeus indicus*, scale bar = 25 µm
@ DV LIGHTNER

c Dashtail barb (*Barbus poechii*) with Epizootic ulcerative syndrome (EUS) from Lake Liambezi, Chobe River, Namibia, 2007
@ BC VAN DER WALL

d Histological sections of EUS-infected dashtail barb (*Barbus thamalakanensis*) showing oomycete hyphae penetrating into the brain, scale bar = 50 µm
@ FAO

e Laver nets with laver blades infected with Olpidiopsis disease
@ H YANG

f *Olpidiopsis porphyrae* infecting *Porphyra* sp. Infected host cells appear green in the early stage of infection and show intracellular pathogen thalli, scale bar = 10 µm
@ M STRITTMATTER

Annex 5:

Guidelines for the preparation of a National or Regional Aquatic Organism Health Strategy[1]

> "Countries should develop and formalize national aquatic animal health strategies and health management procedures. Such strategies and procedures should adhere to international and regional standards and be important for countries within a region, particularly those sharing transboundary waterways."
>
> (FAO, 2007)

As parallel efforts, national strategic planning for aquatic animal health and aquatic biosecurity have been promoted by the Food and Agriculture Organization of the United Nations (FAO) for more than two decades, encouraging Member Nations to develop and formalize National Strategies for Aquatic Animal Health (NSAAH) and national aquatic biosecurity now called National Aquatic Organism Health Strategy (NAOHS) or Regional Aquatic Organism Health Strategy (RAOHS). The Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB), a new initiative by FAO and partners, although initially conceived for the improvement of biosecurity measures for cultured aquatic animals, has been expanded to include all cultured aquatic organisms (both aquatic animals and aquatic plants). This broader scope, reflected in a revised terminology, recognizes the important contributions of seaweeds to global aquaculture production, national economies and the well-being of many local communities.

Definitions for key terms appearing in this annex can be found in the Glossary of the main PMP/AB guidance document. In particular, readers should note that pathogen refers to "an organism (virus, bacterium, fungaus or parasite) capable of causing disease", while disease is defined as "any condition that affects the normal functioning of the organism, which differs from physical injury, and leads to clinical signs."

What is a national or regional aquatic organism health strategy?

A NAOHS is a broad yet comprehensive strategy to build and enhance capacity for the management of national aquatic biosecurity and aquatic organism health. This strategy can be applied to both wild and farmed populations of aquatic organisms. It contains the national action plans at the short-, medium- and long-term using phased implementation based on national needs and priorities; outlines the programmes and

[1] The FAO's involvement in encouraging and assisting FAO Member Nations to develop National Strategies on Aquatic Organism Health dates back to 1998 with the funding of regional project TCP/RAS/6714 "Assistance for the Responsible Movement of Live Aquatic Animals", with the participation of 21 countries in the Asia-Pacific Region. A number of subsequent activities by FAO and international, regional and national partners have lead to the preparation of regional strategies (e.g. for Middle Eastern countries and for southern African countries). Examples of completed national strategies include those for Bosnia and Herzegovina (http://www.fao.org/docrep/012/al088b/al088b00.htm), Indonesia, Malaysia and Suriname, among others.

projects that will assist in developing a national approach to overall management of aquatic organism health; and includes an implementation plan that identifies the activities that must be accomplished by government, academia and the private sector. The NAOHS should be a short (20–25 page) document clearly articulating a strategy for national aquatic biosecurity and aquatic organism health. The draft framework should be discussed in stakeholder consultation and approved in principle by them. The final document should be distributed to national policy-makers, aquaculturists, other stakeholders and the general public; and the NAOHS should be formally adopted by the national government as an official policy document.

Why do countries need to have a national or regional aquatic organism health strategy?

The development of a NAOHS will provide a country with a comprehensive plan of action for a clearly elaborated and agreed-upon programme to achieve national objectives for aquatic organism health and biosecurity. It will provide clear objectives for all relevant activities, define the activities that need to be accomplished to reach these objectives, and give an indicative time frame and priority for each activity. The development of a NAOHS involves an extensive process during which the current national aquatic organism health capacity and future goals are assessed and policies, priorities and needs are identified. It is an iterative process involving the national Competent Authority(ies) and extensive consultation with key stakeholders from other government agencies, academia and the private sector. National strategic planning for aquatic organism health and biosecurity is a proactive measure. Without such advance planning, a country can only react in a piecemeal fashion to new developments in international trade and the global situation with regard to serious transboundary diseases of aquatic animals and plants, and its aquaculture and fisheries sectors will remain highly vulnerable to new and emerging diseases that may severely affect capture fisheries and aquaculture production, leading to major social and economic impacts.

Where a RAOHS has already been formulated, countries within the region will need to take into consideration the considerable relevant work that has already been accomplished at the regional level.

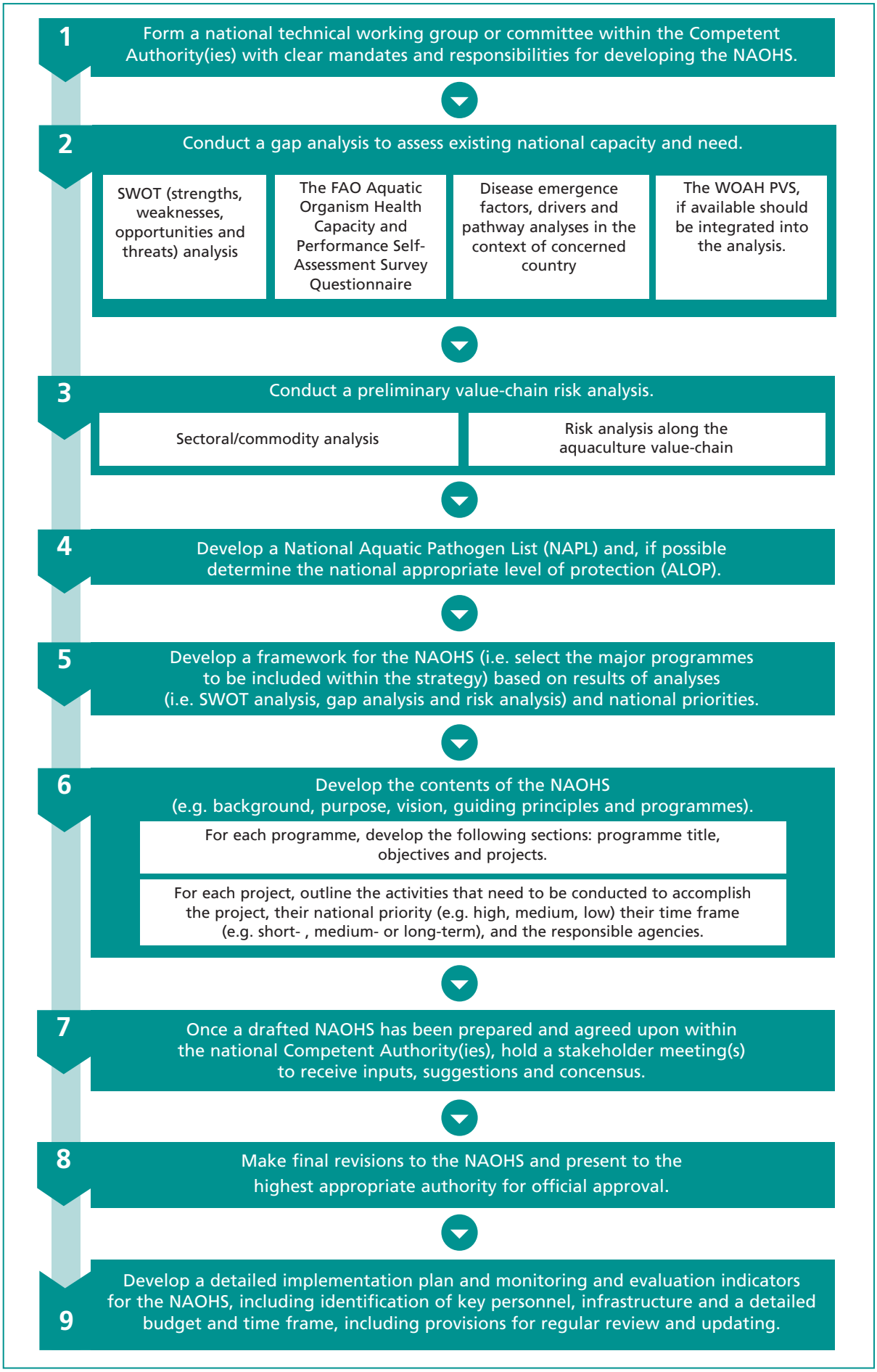
What are the essential elements neeeded to develop a NAOHS or RAOHS?

The factors essential to the development of a NAOHS include: a good driver of the process (i.e. Competent Authority, committee, commission, task force, focal person), with clear terms of reference (TOR); stakeholder consultation; approval from the highest authority; a detailed implementation strategy; monitoring and review; proposal development; and sufficient expertise and funding.

Overview of recommended steps in developing a NAOHS or RAOHS

The key steps recommended by the FAO that countries should follow in developing a NAOHS are shown in **Figure A5.1**.

FIGURE A5.1
Stepwise guidance in developing a NAOHS or RAOHS



Detailed guidance

National PMP/AB Technical Working Group

It is important that the national Competent Authority(ies) appoint a national technical working group (NTWG) or a national PMP/AB Technical Working Group, committee or task force that will be charged with developing the NAOHS and guiding progress towards its completion and implementation. The number of members can vary depending of the national situation, but might include three members with main responsibility for drafting the NAOHS and several others who will provide regular guidance and feedback. The members should be assigned to the committee by the head(s) of the Competent Authority(ies) (e.g. Chief Veterinary Officer, Deputy Minister, etc.) and have clearly defined positions, terms of reference and responsibilities. Inclusion of one or more members from the private sector should be considered. The NTWG should have a clear time table for development of the NAOHS and regularly scheduled meetings to report on progress and resolve any issues.

Gap analysis

Before deciding where your country is headed, in terms of aquatic organism health and biosecurity, you need to determine and concisely summarize exactly where your country currently stands with regards to expertise, capacity, infrastructure etc. in the various relevant areas. To assist national governments in establishing this reference point, the FAO has developed the National Aquatic Organism Health Capacity and Performance Survey (the FAO Aquatic Organism Health Capacity and Performance Self-Assessment Survey Questionnaire, see **Annex 4**). This self-assessment survey should be completed by the Competent Authority(ies), with the assistance of other government agencies, academia and the private sector, as required. Its purpose is:

- to obtain information on national capacity and the agencies mandated to implement aquatic organism health programmes and support aquaculture through healthy production;
- to seek opinions on the components and activities that might be included in a NAOHS; and
- to help guide national strategic planning for improving aquatic organism health and assuring adequate and rational support services.

Detailed and accurate completion of the FAO Self-assessment Survey will allow the NTWG to identify the key areas that need to be addressed in the NAOHS and to focus on those areas that need to be addressed by specific projects and activities.

SWOT analysis

Early on, a strengths, weaknesses, opportunities and threats (SWOT) analysis should be conducted to provide some initial critical insights into the key national factors that could influence the contents of the framework for the NAOHS. A SWOT analysis is an informal "brainstorming" session and can be conducted by the members of the NTWG or during a national stakeholders' workshop. It will be useful to circulate the results of the SWOT analysis to several key stakeholders (e.g. aquaculturists, academics, experts in other government agencies) for their comments.

Current disease situation

In the PMP/AB guidance for application, the four disease emergence pathways (i.e. aquatic health management and disease control, trade of aquatic organisms, knowledge of pathogens and their hosts and ecosystem change). As part of the gap analysis, it is recommended that countries analyse the current national disease situation by examining the above four broad categories of disease emergence pathways. Countries should describe important pathogens present in the country that have a potential or real impact on the aquaculture sector(s) and/or wild aquatic populations. Available knowledge of the epidemiological situation should be collated and summarized, including expert technical knowledge about the disease and the disease agent, as well as local field data regarding disease occurrence in the place in question (i.e. disease prevalence, incidence and distribution). This information is useful to establish or update the list of aquatic pathogens of national significance, which merit efforts to control their entry, establishment or spread within the country and/or region (see the following section on National Aquatic Pathogen List and ALOP). Knowledge of the current disease situation is also used to prioritize risk assessment and risk management efforts in a country (see section Sector-Level Risk Analysis)

Sector-level risk analysis

Risk analysis promotes strategic thinking regarding the application of national and/or sector level aquaculture biosecurity measures. In the context of the PMP/AB, sector-level risk analysis uses a value chain approach to the management of disease risks in aquaculture sectors. Value chain analysis is the process of understanding the aquaculture production systems and how stakeholders operate and the decisions they make within the production systems. Risk analysis is the evaluation of disease risks within aquaculture production systems and the identification of biosecurity measures to reduce those risks. A country may choose to prioritize resources and focus on the management of one or more pathogens of high national concern for a particular sector.

The following key questions may be answered by the risk analysis:

- Which processes within aquaculture production systems carry risk for disease spread?
- Which production systems carry more overall risk and therefore require more regulation/intervention? (i.e. small-scale farms)
- How can the country and/or aquaculture sector promote less risky aquaculture production practices?
- Where are the risk hotspots in the country?
- When are the high-risk times of the year?
- Where and when should surveillance programmes be targeted?

The sector-level risk analysis approach used in the PMP/AB draws on FAO's value chain approach to animal diseases risk management (FAO, 2011) and Hazard Analysis and Critical Control Points (HACCP) methodology (FAO, 2001). The risk analysis begins with a description of all aquaculture sectors present in the country, prioritization of the sectors in terms of level of production and value, followed by identification of all relevant key stakeholders. Stakeholders include primary producers, service providers (e.g. feed manufacturers, aquatic health professionals, industry partners), and government.

The value chain for the sector is then mapped and analysed to provide a descriptive overview of the systems and steps involved in the aquaculture production (i.e. live animals, germplasm/gametes, products), including suppliers, producers, processors, marketers, retailers, national trade, and consumers. The value chain analysis should include physical aspects, geographic locations, movement of commodities and

involvement of people, if possible. Associated socioeconomic drivers should be described and well understood for the sector.

The next step in sector level risk analysis involves risk profiling, where all serious pathogens appropriate to the species being cultured in the country are identified. Ideally, these pathogens are found on the country's NAPL. Any known risky management practices occurring along the value chain should then be identified to assist in determining which points pose a risk for transmission of pathogens of concern. Risk hotspots (i.e. areas with a high concentration of risk of pathogen introduction) along the value chain are identified, described and prioritized; these are points in the value chain where biosecurity is most vulnerable and may be related to a geographic location, management practice or stakeholder actions.

Risk pathways are then developed for each prioritized risk hotspot to highlight the likelihood (i.e. probability) for each step in the pathway to occur. A risk assessment can then be conducted based on the risk pathway analysis to estimate the overall probability of occurrence and consequences of outbreaks occurring at that point along the value chain. These risk assessments along the value chain will assist with prioritizing and focusing biosecurity efforts.

Finally, critical control points (i.e. points/steps at which control measures can be applied) are identified within the risk pathways to assist with the development of effective and practical risk management measures to mitigate the introduction and spread of pathogens. The expected benefits of these measures should be described in relation to livelihoods and food security, trade (and other national priorities), the environment, and international and regional communities.

The results of the sector-level risk analysis, in combination of the results of the gap analysis (e.g. FAO self-assessment survey questionnaires, SWOT analysis, disease emergence pathway analysis), are used to design the framework of the NAOHS (see section NAOHS FRAMEWORK). Risk analysis is not intended to be comprehensive and can be followed by a more in-depth analysis at a later date, depending on national priorities.

An introductory training course on sector-level risk analysis was also developed by FAO and piloted in the Federated States of Micronesia to assist with completion of Stage 1 of the PMP/AB (MacKinnon et al., 2020); this training course can be delivered to Member Nations upon request.

National Aquatic Pathogen List (NAPL) and ALOP

Countries should establish lists of serious pathogens of aquatic animals and plants that are of national concern. Such lists should include those serious pathogens and diseases that are established in national territory but which have not yet spread to all geographical areas, those that are under a national control or eradication programme, and those that are exotic but whose entry and spread are judged to pose serious risks to national aquatic resources. National aquatic pathogen lists should include, as appropriate, those pathogens and diseases listed by the World Organisation for Animal Health (WOAH), as well as other pathogens of national significance.

Having a national aquatic pathogen list (NAPL) is important in that it will help to identify the pathogens, and the diseases that they cause, that are of national concern, allowing the formulation of programmes to identify infected aquatic organisms (disease diagnostics) and measures to prevent their entry and/or spread into the country. The listed pathogens and diseases, along with the national appropriate level of protection (ALOP, see below) will allow the Competent Authority(ies) to better define specific needs with regard to biosecurity, including needs for specialized expertise, training, infrastructure, disease diagnostics, surveillance, etc.

Another important consideration is the country's appropriate level of protection (ALOP), which is a political statement as to the level of pathogen risk that the

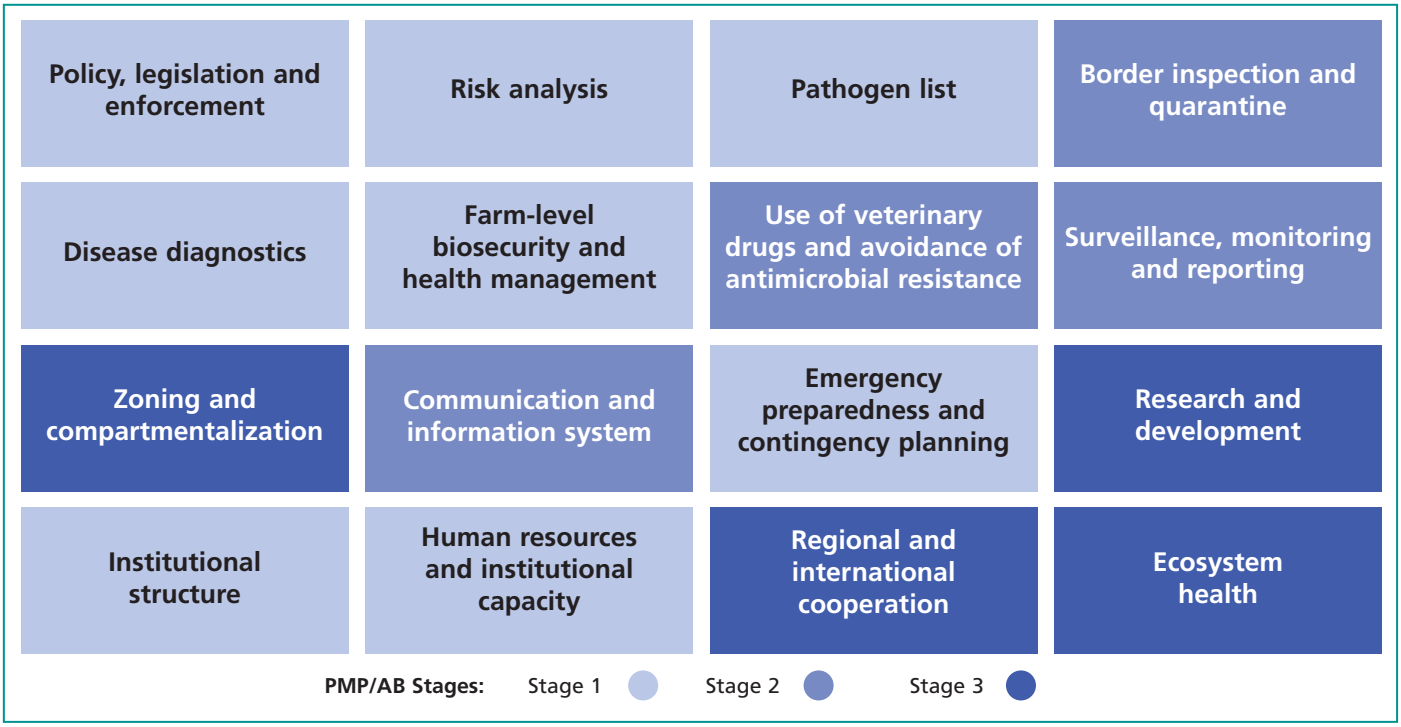
country considers acceptable when considering importations of live aquatic organisms and their products and their products. A high ALOP will mean a low acceptable level of risk (ALOR), which may require a higher level of biosecurity measures. Countries within the same region or having shared river basins or coastlines should attempt to harmonize their national ALOPs and aquatic pathogen lists, as weak biosecurity by one country may place neighbouring countries at risk of incursions by pathogens causing serious diseases of cultured and wild aquatic organisms.

A separate set of Guidelines for the Preparation of National Aquatic Pathogen Lists has been prepared by FAO to assist you in drafting or revising a NAPL (see **Annex 6**).

NAOHS Framework

The core of the framework for the NAOHS is the list of programmes (these are sometimes also termed the "elements") that will be included. The initial list of programmes can be determined by the NTWG, based on the results of the SWOT analysis, gap analysis, NAPL and risk analysis. The following is a listing of the possible programmes that could be included within a NAOHS framework, along with a brief description of each. It should be noted that the contents of a NAOHS will vary depending on an individual country's situation, and thus may not include all the programmes listed below (alternatively, additional programmes may be identified as having national importance and thus need to be included). Each programme (and their objectives) should be clearly associated with a risk hotspot, address an important gap identified, and/or improve national aquaculture biosecurity and/or aquatic animal health management to achieve national objectives. Aquatic organism welfare has recently received increased attention. Countries and regions who may deem it necessary to include this as an important element, may do so as appropriate.

FIGURE A5.2
Policies and Regulatory Framework of a NAOHS or RAOHS with the PMP/AB



Policy, legislation and enforcement

Policy refers to a national long-term (typically >20 years) government programme outlining what is to be achieved in broad terms. It includes the government's major goals and objectives for the sector and recommendations for its sustainable development. In contrast, a strategy is typically a mid-term (5–15 year) plan and outlines how the national policy is to be achieved. It contains specific objectives and outputs, a time frame, indicators of performance, and provision for monitoring and review. Legislation is, of course, the sum total of laws, regulations and other legally binding documents issued by the government to enforce its policies. The inclusion of a NAOHS as a component of national biosecurity policy and aquaculture development may be new to some authorities, and policy-makers may not realize the urgency of formulating effective national and regional aquaculture biosecurity strategies and acting on the respective programme activities needed to implement them. To have an effective national policy for aquatic organism health and biosecurity, identification of the Competent Authority(ies) on aquaculture and aquatic organism (plant and animal) health is essential. The advantages of harmonizing aquatic organism health policy among countries belonging to the same region or subregion are many and include facilitated trade in live aquatic organisms and their products and increased aquatic biosecurity for all countries. To address aquatic biosecurity adequately and to support improved national aquatic organism health policy, the national legislation should be reviewed and where necessary, updated and/or revised. In some cases, new legislation should be drafted to support aquatic organism health and aquatic biosecurity.

Risk analysis

Risk analysis is a structured process that provides a flexible framework within which the risks of adverse consequences resulting from a course of action can be evaluated in a systematic, science-based manner. Import risk analysis (IRA) is an internationally accepted method for deciding whether trade in a particular commodity (a live aquatic organism or its product) poses a significant risk to human, animal or plant health and, if so, what measures, if any, can be applied to reduce that risk to an acceptable level.

All countries having international trade in live aquatic organisms and their products should have a minimum level of capacity to assess possible risks due to pests (invasive aquatic alien species) and pathogens.

Aquatic pathogen lists

National aquatic pathogen lists (NAPLs) are essential for health certification, disease surveillance and monitoring, emergency response planning, prevention and control of diseases in aquaculture facilities, etc. Clearly established criteria for listing/delisting of pathogens (based on internationally accepted methods) should be established. Pathogens that cause WOAH-listed diseases that are relevant to national conditions form a good starting point; however, the WOAH-listed diseases are those of internationally traded commodities, while NAPLs must also consider other pathogens that cause serious diseases of both aquatic animals and plants of national concern. NAPLs need to be founded on a thorough knowledge of a country's disease status, which can only be obtained through passive and active disease surveillance programmes, generalized disease and pathogen surveys, adequate disease record keeping and reporting, and a national pathogen database. Guidance on the development of NAPLs can be found in **Annex 6**.

Border inspection and quarantine

Border inspection includes all those activities regulating the importation and exportation of live aquatic organisms and their products that are conducted by the national Competent Authority(ies) and national customs officers at international airports, land border posts and sea ports of international entry and exit.

Quarantine is the holding of aquatic organisms under conditions that prevent their escape, and the escape of any pathogens or "fellow travelers" they may be carrying, into the surrounding environment. Quarantine may be conducted preborder (in the exporting country), border (at the border post of the importing country) or postborder (at a quarantine facility operated directly by the Competent Authority(ies) or by the private sector, under the standards and supervision of the Competent Authority(ies). Quarantine is one of a number risk mitigation measures that may be applied to shipments of live aquatic organisms and their products to reduce the risk of introducing serious pathogens and pests.

Disease diagnostics

Adequate disease diagnostic capability and capacity is an essential component of any national or regional aquatic biosecurity programme. Disease diagnostics plays two significant roles in health management and disease control. The first role of diagnostics is to ensure that stocks of aquatic organisms that are intended to be moved from one area or country to another are not carrying infection by specific pathogens at subclinical levels, and is accomplished through screening of apparently healthy organisms. The second equally important role of diagnostics is to determine the cause of unfavourable health or other abnormalities in order to recommend measures appropriate to a particular situation. The accurate and rapid diagnosis of a suspicion or an outbreak of disease in a cultured or wild population is essential to preventing further losses through correct treatment, and to disease containment and, where possible, eradication. Diagnostics is also a key supporting element of quarantine and health certification, surveillance and monitoring, zoning (including demonstration of national freedom from a disease), etc. Diagnostics includes both simple, pond-side methods and more advanced laboratory-based techniques requiring a high level of expertise and infrastructure.

Farm-level biosecurity and health management

Farm-level biosecurity and health management includes such aspects as farm registration programmes, development of standard operating procedures (SOPs) and better management practices (BMPs), certification programmes for broodstock and postlarvae or fry, pond-side diagnostic techniques, disease reporting, farm-level-contingency planning for disease outbreaks, staff training, promotion of farmer associations, etc. FAO has been promoting a 10-point good biosecurity practice guidance that includes: (1) know your host, (2) know your pathogens, (3) know your systems, (4) know your contamination pathways, (5) source healthy seeds, (6) maintain good husbandry, (7) use antimicrobials prudently, (8) respect food safety, (9) respect the environment, (10) have a biosecurity plan.

Use of veterinary drugs and avoidance of antimicrobial resistance

Access to safe and effective veterinary drugs is essential to the success of semi-intensive and intensive aquaculture, as in some instances entire stocks may be lost if such drugs are not available. However, veterinary drugs, if inappropriately used, may be ineffective or may lead to unacceptable residue levels in aquaculture products. The present of residues in exported aquaculture products that are above the importing country's acceptable levels may lead to bans on importation, with severe impacts on a country's aquaculture industry. It is thus essential that countries establish mechanisms

(e.g. laws, regulations, guidelines, SOPs) to ensure the prudent use of veterinary drugs, along with testing and monitoring programmes to ensure trading partners that national aquaculture products are safe and meet importing country standards. Antimicrobial resistance (AMR) is the development of bacterial strains that are resistant to antibiotics that have been inappropriately used in aquaculture and other farming systems. AMR is a growing problem, as the use (and misuse) of some antibiotics critical to human medicine by aquaculture and terrestrial farming systems has led to the development of "superbugs", reducing the effectiveness of some essential antibiotics in treating infections in humans.

Surveillance, monitoring and reporting

Disease surveillance is a fundamental component of any official aquatic plant or animal health protection programme. Surveillance and monitoring programmes are essential for the detection and rapid emergency response to significant disease outbreaks and form the basis for early warning of exotic incursions or newly emerging diseases. They are also increasingly demanded by trading partners to support statements of national disease status and are the basis for disease free status on country, zone or compartment level. Surveillance also provides the building blocks of information necessary to have an accurate picture of the distribution and occurrence of pathogens and diseases relevant to disease control and international movement of aquatic organisms and their products. Surveillance can be passive (reactive and general in nature) or active (proactive and targeted). In both cases, there must be adequate reporting mechanisms so that suspected cases of serious disease are quickly brought to the attention of the Competent Authority(ies). Surveillance and monitoring efforts must be supported by adequate diagnostic capability (including appropriately trained expertise, suitably equipped laboratory and rapid-response field diagnostics, and standardized field and laboratory methods), information system management (i.e. a system to record, collate and analyse data and to report findings), legal support structures, transport and communication networks and linked to national and international (WOAH) disease reporting systems (e.g. pathogen lists or list of diseases of concern, disease notification and reporting procedures). Surveillance to demonstrate freedom from a specific disease requires a well-designed active surveillance programme that meets the standards outlined in the WOAH Aquatic Animal Health Code (2022).

Zoning and compartmentalization

Zoning and compartmentalization are mechanisms that allow a country or a particular geographical unit (e.g. country, subregion, drainage basin, coastal area, cluster of aquaculture establishments or even a single establishment) to establish and maintain officially recognized free from specified disease(s), even though surrounding units may be infected. A zone means an area in one or more countries containing an aquatic animal population with a specific aquatic animal health status with respect to a disease, in which surveillance and control measures and basic biosecurity conditions are applied. The zone should be defined by the Competent Authority. A compartment is one or more aquaculture establishments under a common biosecurity management system containing an aquatic animal population with a distinct health status with respect to a specific disease or diseases for which required surveillance and control measures are applied and basic biosecurity conditions are met for the purpose of international trade (see the WOAH Aquatic Animal Health Code, 2022). In addition to contributing to the safety of international trade, zoning and compartmentalization may assist disease control or eradication.

Communication and information systems

Communication includes activities that increase the flow of information between and among national policy-makers, researchers, Competent Authorities, regional bodies and international agencies and experts. Communication activities assist with problem solving and keep national experts, who may be working in relative isolation, up to date with regard to the regional and global aquatic organism health situation. It is especially important to an effective national aquatic biosecurity programme to establish and promote good communication and linkages between relevant authorities, aquatic organism health services, national veterinary services, plant protection authorities, and national fisheries and aquaculture authorities.

Communication may include development of national and regional aquatic organism (plant and animal) health information systems and networks.

Emergency preparedness and contingency planning

Emergency preparedness is the ability to respond effectively and in a timely fashion to disease emergencies (e.g. disease outbreaks, mass mortalities). The capability to deal with emergency disease situations requires a great deal of planning and coordination (including establishing operational, financial and legislative mechanisms) and making available required resources (i.e. skilled personnel and essential equipment). As long as there is importation of live aquatic organisms and their products, the possibility of serious disease outbreaks due to exotic pathogens will exist. Even under the best of circumstances, pathogens will occasionally escape detection, breach national barriers, become established, spread and cause major losses. The extent to which losses occur often depends on the quickness of detection (which depends on the effectiveness of disease surveillance, diagnostics and reporting programmes) and the rapidity and effectiveness with which governments recognize and react to the first reports of serious disease. As quick and effective reaction (containment and/or eradication) is largely dependent upon contingency planning, all countries need to develop such plans for key cultured species and diseases.

Research and development

Research capacity in aquatic organism health is necessary to the successful expansion of aquaculture development. Targeted and basic research can lead to better disease management, better understanding of national aquatic organism health status, support to risk analysis, improved diagnostic methods, etc. Where specific research capacity is lacking, countries must rely, to a large extent, on research conducted by scientists in other nations. Often, such "borrowed" research may not be directly applicable to local situations and experimental testing must be undertaken to adapt these findings. In other cases, little or no relevant information on the specific problem may be available. There are many mechanisms to improve access to research capacity. These include development of national aquatic organism health research laboratories, supporting linkages and research programmes within universities and the private sector, contracting of targeted research with foreign institutions, and development of a regional aquatic organism health center. Targeted national research needs to be supported to allow a better understanding of those aquatic diseases that have recently been introduced into national territory. The impact and spread of such diseases among indigenous species and the spread of such diseases among widely divergent catchments is often poorly studied. A better knowledge of such transboundary aquatic plant and animal diseases under local conditions is vital for the sustainable development of national aquaculture production and the maintenance of aquatic biodiversity.

Institutional structure (including infrastructure)

Infrastructure for aquatic organism health encompasses the essential facilities and systems serving a country and thus includes dedicated physical structures such as buildings for office space, diagnostic and other laboratories, quarantine facilities, tank rooms, experimental ponds, etc. Adequate and appropriate infrastructure is essential to the success of any national aquatic biosecurity programme.

Institutional structure includes the organizational hierarchy and inter- and intra-organizational relationships between the Competent Authority(ies) and other relevant governmental agencies. In some instances national organizational structures, hierarchies and lines of reporting and communication may need to be restructured in order to achieve efficient and effective national biosecurity.

Human resources and institutional capacity

Human resources and institutional capacity development refers to having the correct number of staff with the appropriate expertise to accomplish the essential tasks that have been identified as part of a NAOHS. This requires the hiring and/or training of scientists, aquatic health professionals, aquatic veterinarians and other staff possessing critical expertise and training in the key areas of aquatic organism health (often at the PhD, MSc and DVM (with specialized training in aquatic pathology) level, including, for example, disease diagnostics, aquatic biosecurity, aquatic veterinary medicine, risk analysis, aquatic epidemiology, emergency preparedness, extension services, enforcement, border control, information services, etc. In addition, a programme to maintain and upgrade expertise through short-term and other training, attendance at international conferences and meetings, international collaboration, etc. must be established.

Regional and international cooperation

Cooperation refers to the sharing of effort and resources (e.g. staff, infrastructure, funding) between and/or among countries, government agencies, universities, the private sector and other stakeholders to achieve common objectives or goals. Cooperation in research and training is possible via international agencies such as the FAO and WOAH and with foreign universities and experts. There is a great potential for regional cooperation and networking in almost all areas of aquatic organism health.

Examples include the development of standardized procedures for import and export of live aquatic organisms and their products, harmonization of legislation, shared communication structures (websites, newsletters), development of a regional aquatic organism health information system (pathogen database, regional disease diagnostic and extension manuals), cooperative research programmes, development of regional strategy and policy, regional disease reporting, a regional emergency response system, regional reference laboratory, regional risk analysis case studies, coordinated training efforts, etc. At the national level, cooperation between agencies, particularly those agencies responsible for fisheries and aquaculture, veterinary services, plant health, biosecurity and environmental/conservation issues, should be promoted.

Ecosystem health

The "One Health" concept, created in 2004, is holistic and transdisciplinary, incorporating the important linkages between human health, animal health, and ecosystem health. "Ecosystem health" is a term used to describe the state of an ecosystem relative to a desired management target. The health of an aquatic ecosystem can be assessed by identifying certain characteristics that indicate a healthy ecosystem (i.e. high biological diversity or the absence of algal blooms). With the increase in

globalization, aquatic ecosystems are continuously under pressure from a variety of anthropogenic stressors, resulting in significant environmental pollution, damage to biodiversity, deterioration of ecosystems, and habitat fragmentation leading to migratory movements of species. Studies suggest these environmental changes are linked to the evolution of emerging and re-emerging diseases in wild and cultured aquatic animal populations. Given the importance of ecosystem health to the health of aquatic organisms, it is important to implement conservation and restoration strategies and assess whether these management actions have been effective.

Develop the contents of the NAOHS

In preparing the NAOHS, it should be kept in mind that this is a relatively short and concise policy document that should be written in a form that is easily understood by all stakeholders and the general public. (It is suggested that once approved as policy, the NAOHS should be published as a booklet with a length of 20–25 pp.) The NAOHS can consist of the following (brief) sections:

A. Introduction

- Background
- Scope
- General information
- Aquatic resources and biodiversity
- Status of national aquaculture development
- Potential of aquaculture
- International trade in live aquatic organisms and their products
- Status of aquatic organism health in the country
    - description of Competent Authority(ies)
    - current programmes in place (e.g. surveillance, monitoring, quarantine, etc.)
- Aquaculture policy and aquatic organism health
    - Brief description of policy(ies) in place
    - Current NAPL
    - Current ALOP
- Gap analysis results (e.g. FAO self-assessment survey, SWOT analysis)
- Current disease situation in the country
- Sector-level risk analysis results
- The way forward

B. Process of NAOHS development

A concise description of the steps involved in formulating the NAOHS. This can be presented in point form, including any meetings or round table discussions, completion of the SWOT analysis and gap analysis, completion of the sector-level risk analysis, review of national policy and planning documents (and other documents related to aquaculture biosecurity and aquatic animal health), and development of the NAOHS framework (i.e. programmes and projects).

C. Statement of purpose - "the Why?"

A concise statement of what the NAOHS is intended to accomplish, for example:

"The purpose of the NAOHS is to reduce the risk of aquatic plant and animal diseses impacting on the sustainable development of aquaculture, aquatic biodiversity, food safety and food security and the economy."

D. The Vision - "the Where?"

A statement of where the NAOHS will lead your country, for example :

"To develop and maintain up-to-date an aquatic organism health management strategy in [country name] that will be able to support the sustainable development and management of the aquaculture sector, protect aquatic biodiversity, meet growing consumer demands for aquatic foods and products that are of high quality, safe, with maximum opportunity for profitability in all stages of the aquaculture product chain."

E. The Guiding Principles - "Doing the right thing"

The Guiding Principles provide guidance in all circumstances, irrespective of changes in goals, strategies, work plan, structure or management of the NAOHS. They should accept and incorporate relevant international aquatic organism health standards to ensure harmonization, transparency and equivalence and that the country be internationally recognized with respect to national aquatic organism health status.

The Guiding Principles may include principles based on, for example, FAO Technical Guidelines on Health Management for Responsible Movement of Live Aquatic Animals, as well as some general principles concerning economic, social and environmental conduct. The following statements are examples of Guiding Principles that might be included in a NAOHS:

"1. Aquatic organism health management should enable aquaculture to make a positive contribution to [country name] economy through being internationally competitive in the marketplace and economically viable at a national level.

2. Aquatic animal health management measures should facilitate aquaculture to develop in harmony with nature, managing and minimizing transient environmental impacts and avoiding significant, cumulative, long-term or irreversible changes to ecological systems, to cultural remains or to valued landscape and scenery.

3. Aquatic animal health measures should foster strong aquaculturists' links, recognizing and supporting the needs of private-sector aquaculturists and working with community initiatives to manage local environments for mutual benefit."

F. The Programmes And Projects

There are many possible arrangements for programmes and projects (note that projects are often termed "activities"). However, within the NAOHS, all programmes are interconnected, and thus progress in one area is often linked with progress in others. It important that all Programmes identified as important in the NAOHS framework are included.

When finalized each Programme should contain the following sections:

- objectives – a brief statement of what the programme will achieve;
- current status – a short background summary of the current status of activities related to the programme;
- projects – brief summaries of the projects to be implemented within the programme; and
- related activities – brief summaries of the key activities (projects) that will be accomplished within each Programme. Each activity will indicate:
  - which of the four PMP/AB scenarios it is designed to support,
  - the PMP-AB stage in which the thematic area first appears
  - the designated responsibility for completion:
  - the proposed timeframe (short term, medium term, long term)
  - a short description of the Activity.

F. Implementation

A brief section on how the NAOHS will be implemented should be provided. This may include, for example, how proposals for the various projects will be developed such that they can be submitted to external donor agencies for possible funding. It should also be stated that once the NAOHS has been approved as policy, a separate Implementation Plan (including a monitoring and evaluation and/or performance indicators) will be developed that will include detailed information on each Project, including staffing requirements, needed infrastructure and equipment, detailed time frame with measurable goals and an associated budget. It is useful to include a table at the end of the NAOHS summarizing all the Programmes and Projects, indicating the title, priority, time frame and responsibility for each Project.

Stakeholder Consultation

The NTWG will need to develop a plan for stakeholder consultation throughout the entire process of developing the NAOHS. This may include the holding of stakeholder meeting(s) at various points in the process (and particularly, once the draft NAOHS has been prepared) where the reason for developing the NAOHS is presented, along with the draft framework and contents. During these meetings, stakeholders are informed and comments and suggestions for changes to the NAOHS are discussed.

During the final stakeholder meeting, the NTWG should seek approval in principle of the NAOHS. This process ensures that all stakeholders are informed, consulted and will have a feeling of "ownership" or at least agreement on the contents of the NAOHS. Use of the Internet via a Website may also be an effective way to identify and inform stakeholders and seek their inputs to the NAOHS.

Final Revisions

Once the NTWG has entered any final changes and satisfied with the NAOHS, and stakeholder approval has been achieved, the final version of the NAOHS must then be officially adopted as government policy. This will involve approval or signing by the Minister or head(s) of the Competent Authority(ies).

Senior officials should be kept informed during the development of the NAOHS.

Detailed Implementation Plan

Once the NAOHS has been officially adopted by the government, the NTWG (or an newly established group or committee) should be charged with developing a detailed plan for its implementation. Such a plan should include identification of key personnel for each Programme and Project, needed infrastructure, equipment, training, etc. and a detailed budget and time frame, including provisions for regular monitoring, review, evaluation and updating. The Implementation Plan should include the development of detailed proposals for each Project, so that these can be circulated to international and regional funding agencies for possible financial support. However, in the end, once the government has approved the NAOHS and its Implementation Plan, it is the government's responsibility to allocate adequate funding and other support to accomplish the strategy.

Monitoring and evaluation

To ensure the effectiveness and continuous improvement of the NAOHS towards its goals and objectives, monitoring and evaluation (M&E) is essential. Monitoring and evaluation indicators form the basis for transparent and precise reporting on the results achieved by the NAOHS.

Data on specified indicators will be continuously and systematically collected. These indicators may include:

- whether the NAOHS is achieving its goals and objectives;
- whether the NAOHS is having the expected impacts;
- whether there have been factors that are outside of the control of NAOHS (if yes, these factors should be articulated so that their influence will be taken into consideration); and
- how the strategy could be improved

Such information enables the NTWG and stakeholders to keep track of the progress of the NAOHS.

Evaluation enables the NTWG and stakeholders to make judgments (at a particular point in time and based on the collected data from continuous monitoring) about the extent to which the goals or objectives of the NAOHS are being achieved. The results of evaluation should be clearly reported to all stakeholders.

While NTWG can conduct M&E, involving a third party (e.g. international experts) in the process will result in a stronger assurance to stakeholders.

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TABLE 1.
Sample summary of programmes and projects

Programme/Projects	**Time frame for completion** (**S** = short-term, **M** = medium-term, or **L** = long-term)	**Priority** (**L** = low, **M** = medium, or **H** = high)	**Responsibility**	
Programme 1. Policy, Legislation and Enforcement				
Project 1: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Project 2: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Programme 2. Risk Analysis				
Project 3: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Project 4: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Programme 3. National Aquatic Pathogen List				
Project 5: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Project 6: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Programme 4. Border Inspection and Quarantine				
Project 7: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Project 8: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Programme 5. Diagnostics				
Project 9: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				
Project 10: [project name]	[S, M or L]	[L, M, or H]	[name]	[title/department]
Indicative activity:				

Source:
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Appendix 1

Example of a Terms of Reference and Composition of a Committee for the Development of a NAOHS

Terms of reference for the committee on the National Aquatic Organism Health Strategy for Country X

1. Purpose

The Committee will provide strategic direction and leadership in the process of revision, finalisation and approval of the National Strategy on Aquatic Animal Health for Country X (NAOHS) document to ensure Country X has a well-defined and guided policy on aquaculture biosecurity and aquatic health management.

2. Term

The Committee will come into effect / be operative from the 1st of August 2021 and will terminate one (1) year after the date of effect or if the process of NAOHS requires less or more time; as determined with the consensus of the Committee.

3. Members

No.	Members	Position	Responsibility
1	**Senior Director** of Fisheries Biosecurity Division	Chairperson	Take a lead role in implementing the tasks/ mandate of NAOHS; direct reporting of the outcomes of NAOHS meetings to the Director-General.
2	**Head of Section** of Fish & Public Health	Vice-Chairperson	Assist the Chairperson in implementing the tasks/mandate of NAOHS and act as the Chairperson in the event of an absence of the Senior Director.
3	Fish & Public Health Section	Secretariats	Take notes and finalize minutes of meetings and important decisions reached and receive progress reports on every activity planned.
4	Aquaculture Development Division	Member	Contribute to agenda settings, discussions and decisions representing the interests of the aquaculture industry.
5	Planning & Development Division	Member	Contribute to agenda settings, discussions and decisions representing the interests of fisheries programme planning and development.
6	National Fish Health Research Center	Member	Contribute to agenda settings, discussions and decisions representing the interests of fisheries

***Note:** Every membership will have a permanent and an alternate member that are name-appointed and only these appointed members are allowed to attend the NAOHS meetings

4. Roles and responsibilities

The committee as a whole will be entrusted to:

i. Develop the agenda, responsibility and estimated time-frame for the preparation, revision, approval and endorsement of the NAOHS.
ii. Conduct scheduled meetings and / or other medium of communication deemed appropriate.
iii. Ensure the progress and completion of activities / programmes that are decided by the committee as integral parts of the NAOHS.
iv. Appoint new or exclude any appointed members based on logical and necessary reasons through a consensus.
v. Appoint any sub-groups / working groups / advisory groups / technical groups regarding NAOHS as a supporting entity to the committee.
vi. Record and retain information regarding meetings, discussions, progress reports, drafts and any other information that are vital to the NAOHS.
vii. Report and submit documents regarding the details of planning, progress and completion of the draft NAOHS to the Director-General of Fisheries Country X.
viii. Ensure the completed NAOHS receive endorsement from the Director-General of Fisheries Country X and approval from the Minister by the first quarter of the year 2022.

The membership of this committee will commit to:

i. Appoint by-name a permanent and an alternate member to this committee.
ii. Attend all scheduled meetings regarding the NAOHS.
iii. Wholeheartedly commit to the success of the NAOHS document within and outside work areas.
iv. Share all communications and information regarding NAOHS across all members of the committee.
v. Make good decisions and take immediate action so as to not hold up the success of the NAOHS.
vi. Notify all members of the committee as soon as possible regarding any issues that arise that may affect the development of the NAOHS.

The membership of this committee will expect:

i. To be provided by accurate and complete information regarding NAOHS in an acceptable time-frame.
ii. To be provided an acceptable time-frame to make key decisions regarding NAOHS.
iii. To be alerted to any potential risks or issues that may impact the development of the NAOHS.
iv. Honest and open discussions without any misleading assertions from any members.

5. Meetings

i. All meetings regarding NAOHS will be chaired by the Senior Director of the Fisheries Biosecurity Division.
ii. At the absence of the Senior Director, only the Head of Fish & Public Health Section may be appointed as chairperson.
iii. The meeting quorum will be appointed by at least 11 members of the committee as appointed.
iv. Only the named permanent and / or alternate member may attend the meetings.

v. All decisions must be made by consensus (i.e. members are satisfied with the decision even though it may not be their first choice). If not possible, the chairperson may make the final decision.
vi. Minutes and agendas will be recorded and distributed by the Fish & Public Health Section, appointed as secretariat to the committee.
vii. Meetings will be held at least three (3) times as scheduled by the committee through consensus.
viii. If required, sub-group meetings may be arranged outside the scheduled times convenient to the sub-group members.

6. Ammendments / Modifications / Variatons
This Terms of Reference may be amended, varied or modified in writing after consultation and agreement through consensus of the committee members.

Endorsed by,	Approved by,
Senior Director of Fisheries Biosecurity Division Date:	**Director-General** of Fisheries Country X Date:

Annex 6:

Guidelines for the preparation of National Aquatic Pathogen Lists[1]

> "In establishing specific quarantine and health certification requirements, it is necessary to identify pathogens of importance and justify exclusion of others. These requirements are restricted to conditions justified as necessary to avoid or reduce the disease risks associated with the movement of live aquatic organisms to acceptable limits. Requirements should not be a disguised restriction of trade."
>
> **(modified from FAO/NACA, 2000)**

A national aquatic pathogen list (NAPL) is an essential component of any national aquaculture biosecurity programme and should be developed/endorsed by the country's Competent Authority on aquatic animal health and aquaculture biosecurity. The NAPL is required for many biosecurity related activities, such as health certification, disease surveillance and monitoring, emergency response planning, prevention and control of diseases in aquaculture facilities, etc.

Countries should establish lists of serious pathogens of national concern. Such lists should include:

- serious pathogens and diseases that are established in national territory but which have not yet spread to all geographical areas;
- those that are under national control and/or eradication programme; and
- those pathogens that are exotic but whose entry and spread are judged to pose serious risks to national aquatic resources.

Several important transparent and transnational reporting systems exist for aquatic animal diseases (Bondad-Reantaso *et al*. 2022). These include the following:

- the World Animal Health Information System (WAHIS) of the WOAH (https://www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home);
- the Animal Disease Notification System (ADNS) of the European Union (https://ec.europa.eu/food/animals/animal-diseases/not-system_en);
- the Emergency Prevention System for Animal Health (EMPRES-AH) of the Food and Agriculture Organization of the United Nations (FAO, http://www.fao.org/ag/againfo/programmes/en/empres/home.asp); and
- the Quarterly Aquatic Animal Disease (QAAD) Reports (Asia and Pacific Region) that was developed by the Network of Aquaculture Centres in Asia-Pacific (NACA), the FAO and the OIE through an FAO Technical Cooperation Programme (TCP) Project TCP/RAS 6714 (A) and 9065 (A) – 'Assistance for the Responsible Movement of Live

[1] The concept of a National Aquatic Pathogen List (NAPL) as an element of what is now known as National Strategy on Aquatic Organism Health (NSAOH) evolved through several projects under FAO's Technical Cooperation Programme (TCP), particularly a regional TCP - TCP/RAS/6714: Assistance for the Responsible Movement of Live Aquatic Animals and a number of national TCPs (e.g. TCP/SUR/3402, TCP/INS/3501). The development of these guidelines was led by Dr Richard Arthur (FAO International Consultant) and FAO officers (FAO retiree Dr Rohana P. Subasinghe and Dr Melba B. Reantaso) and the guidelines were subsequently applied to several national TCPs (e.g. TCP/SUR/3401, TCP/INS/3402, TCP/MAL/3501).

Aquatic Animals', implemented by NACA in 1998, with the participation of 21 countries throughout the region (FAO/NACA, https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12530#raq12530-bib-0022, 2000, https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12530#raq12530-bib-0021, 2001)

National pathogen lists should include, as appropriate, those pathogens and diseases listed by the above reporting systems, as well as other pathogens of national significance (FAO, 2007).

As parallel efforts, national strategic planning for aquatic organism health and aquatic biosecurity have been promoted by the Food and Agriculture Organization of the United Nations (FAO) for more than two decades, encouraging Member Nations to develop and formalize NAOHS or national aquaculture or aquatic biosecurity strategy. The Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB), an ongoing initiative by FAO and partners, although initially conceived for the improvement of biosecurity measures for cultured aquatic animals, has been expanded to include all cultured aquatic organisms (both aquatic animals and aquatic plants). This broader scope, reflected in a revised terminology, recognizes the important contributions of seaweeds to global aquaculture production, national economies and the well-being of many local communities. The preparation of a National Aquatic Pathogen List (NAPL) should thus encompass, as appropriate to a country's national situation, pathogens and diseases of aquatic animals and plants.

Definitions for key terms appearing in this Annex can be found in the Glossary of the main PMP/AB guidance document. In particular, readers should note that pathogen refers to "an organism (virus, bacterium, fungus or parasite) capable of causing disease", while disease is defined as "any condition that affects the normal functioning of the organism and differs from physical injury, and leads to clinical signs."

National Aquatic Pathogen List for Regulation of International Trade (NAPL List A)

Diseases included on the NAPL List A should consist of serious pathogens of concern that merit the effort required to control their entry, establishment or spread within the country and region. Such lists should include those serious pathogens and diseases that are established in national territory, but which have not yet spread to all geographical areas, those that are under national control and/or eradication programmes, and those pathogens that are exotic but whose entry and spread are judged to pose serious risks to national aquatic resources. National pathogen lists should include, as appropriate, those pathogens and diseases listed by the OIE, as well as other pathogens of national significance (FAO, 2007). Although this usually means that diseases of commercially important species are given priority, diseases of other species that may be of socioeconomic importance (e.g. those affecting artisanal fisheries) should not be overlooked (FAO/NACA, 2002).

The World Organisation for Animal Health (WOAH, https://www.woah.org/en/home/) provides standards for the improvement of aquatic animal health and welfare worldwide. WOAH's Aquatic Animal Health Code (https://www.oie.int/en/what-we-do/standards/codes-and-manuals/aquatic-code-online-access/?id=169&L=1&htmfile=sommaire.htm) includes the criteria for listing aquatic animal diseases, the diseases which are listed by the WOAH, procedures for notification to the WOAH, and criteria for listing species as susceptible to infection with a specific pathogen. All WOAH Member Nations have an obligation to report and notify listed and emerging diseases to the WOAH efforts to prevent the transboundary spread of important diseases of aquatic animals. Listing and de-listing of diseases are assessed against the criteria in

Chapter 1.2. of the Aquatic Code (https://www.oie.int/index.php?id=171&L=0&htmfile=chapitre_notification.htm#chapitre_notification) by the WOAH Aquatic Animal Health Standards Commission twice a year and the list is updated once the proposals from the Commission have been adopted by the Member Countries.and are summarized below:

- International spread of the pathogen (via aquatic animals, aquatic animal products, vectors or fomites) is likely.

  AND

- At least one country may demonstrate country or zone freedom from the disease in susceptible aquatic animals.

  AND

- A precise case definition is available and a reliable means of detection and diagnosis exists.

  AND

- Natural transmission to humans has been proven, and human infection is associated with severe consequences.

  OR

- The disease has been shown to affect the health of cultured aquatic animals at the level of a country or a zone resulting in significant consequences, e.g. production losses, morbidity or mortality at a zone or country level.

  OR

- The disease of aquatic animals has been shown to, or scientific evidence indicates that it would affect the health of wild populations, resulting in significant consequences, e.g. morbidity or or mortality at a population level, reduced productivity or ecological impacts. It is recommended that pathogens to be included in a country's NAPL List A should, where possible, meet the above criteria for listing.

National reportable or notifiable diseases

Aquatic diseases/pathogens of the NAPL List A can be further categorized as reportable or notifiable to make it more feasible for a country to focus surveillance and disease response activities, and to meet international reporting obligations to the WOAH[2] (if applicable).

- **Reportable diseases**
  Reportable diseases may or may not be present in the country and are subject to "control programmes" by the Competent Authority (CA). Control programmes may include active surveillance and disease response activities to eradicate, contain, or control the diseases. Producers/owners, aquatic animal health

[2] Member Nations should comply with disease/pathogen notification requirements specified in Articles 1.1.3. and 1.1.4 of the WOAH Aquatic Animal Health Code. **WOAH**. *Aquatic animal health code*, 2022, Paris, WOAH. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/aquatic-manual-online-access/)

professionals, and laboratories are required to immediately report the diagnosis or suspicion of an aquatic animal being infected with one of these diseases to the CA.

- **Notifiable diseases**
  Notifiable diseases may or may not be present in the country are not subject to "control programmes" by the CA. Only laboratories are required to contact the CA regarding the diagnosis or suspicion of an aquatic animal being infected with one of these diseases in the country. The CA can choose to undertake disease response activities when notified of the presence of notifiable diseases. Aquatic animals may need to be certified as being free from notifiable diseases to meet import requirements of trading partners.

List B. Other Pathogens of National Importance

There are many pathogens that may be important to national aquaculture and/or wild stocks of aquatic organisms that are not included on your NAPL List A. Often these pathogens may be ubiquitous and thus already widely distributed in your country. Still these pathogens may cause disease and/or serious losses to national aquaculture, and thus countries may have aquaculture biosecurity programmes in place for farms, facilities, service providers, or enterprises along an aquaculture sector's value chain (e.g. via biosecurity action plans (BAP), better management practices (BMPs), good aquaculture practices (GAPs) and/or standard operating procedures (SOPs)) that include measures to prevent the occurrence and spread of these pathogens both within and between aquaculture operations. These pathogens and the diseases they cause can be placed on the List B and should be addressed by measures to control their domestic spread, but are usually not of concern for international trade.

Steps in Preparing a National Aquatic Pathogen List

The logical sequence of activities to compiling a NAPL is shown in **Figures A6.1, A6.2** and **A6.3**.

FIGURE A6.1
Steps 1 to 2 in developing a national aquatic pathogen list

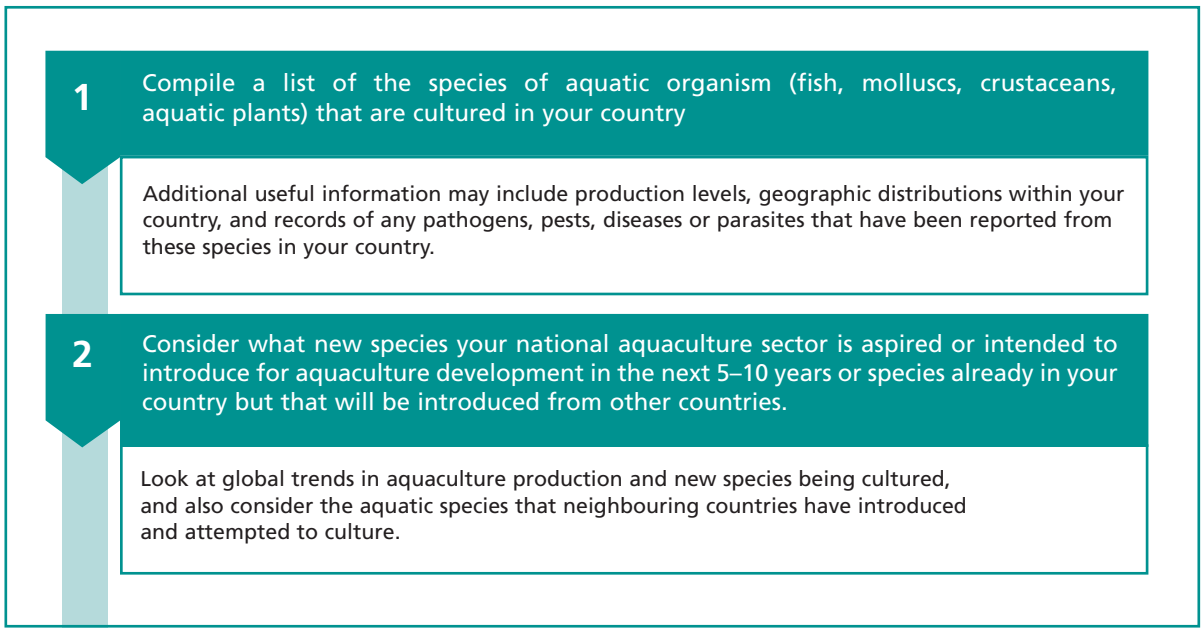


FIGURE A6.2
Steps 3 to 7 in developing a national aquatic pathogen list

3 Consider your country's special circumstances

For example:

- are you a land-locked country with no sea coast and thus no possibility for the culture of marine fish, shrimp, molluscs and seaweeds? (and thus pathogens and diseases that are clearly restricted to marine environments are of no concern); or
- are temperate-climate freshwater salmonids of aquaculture interest in your country? (if not, then the WOAH-listed diseases that affect only salmonids are of no concern). However, if your country has highland areas suitable for salmonid culture, you may want to include the WOAH-listed salmonid diseases on your NAPL, even though salmonid culture has not yet been attempted (e.g. rainbow trout, brown trout, etc.)? (then the WOAH-listed diseases that affect only salmonids are of no concern). However, if your country has highland areas suitable salmonid culture, you may want to include the WOAH-listed salmonid diseases on your NAPL, even though salmonid culture has not yet been attempted.

4 From 1, 2 and 3, compile a list of aquatic species that are (or are likely to become) important to aquaculture and international trade for your country

5 Start compiling your NAPL by comparing each of the species on your list with the listings of susceptible species that are given under each WOAH-listed disease in each of the disease-specific chapters of the WOAH Aquatic Animal Health Code and the Manual of Diagnostic Tests for Aquatic Animals (https://www.woah.org/en/what-we-do/standards/codes-and-manuals/aquatic-manual-online-access/).

Look not only for the exact scientific name of each of the aquatic animal species on your list, but also for other susceptible species within the same genus and family (this gives a good indication of whether the aquatic animal species you are considering is also likely to be affected by the disease under consideration.) All susceptible species to diseases listed by the WOAH have been assessed. Where there is insuffcient evidence of susceptibility, the species are enlisted separately in the Aquatic Manual.

6 In considering diseases for inclusion on List A and List B (see Step 9), the use of a criteria matrix will assist with organizing and retaining information

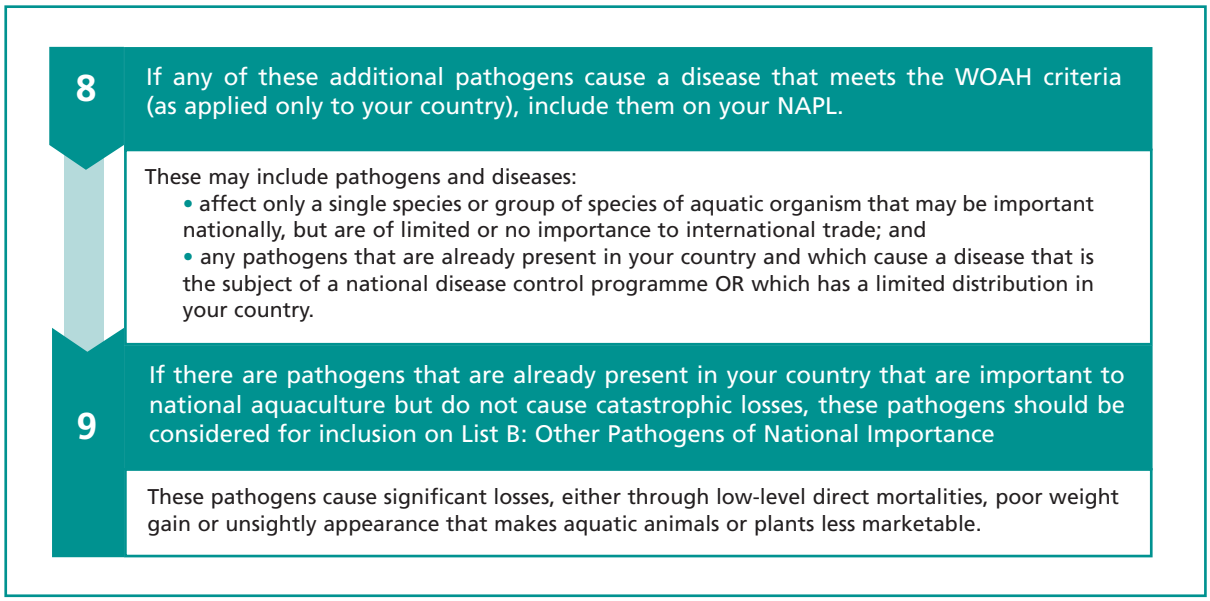
The use of a criteria matrix will assist with organizing and retaining information (note that you may later have to justify to policy-makers and aquaculturists why a particular pathogen has been placed on your lists (or why it hasn't). **Table 1** is an example of such a criteria matrix.

7 Consider other pathogens and the diseases that they cause that are not listed by the WOAH, but that may be of national importance to your country

This can be achieved by:

- doing a literature search (e.g. the Internet is a good starting place) for records of pathogens and diseases for the key aquaculture species that you compiled in point 4;
- searching for and consult any regional pathogen lists (e.g. the European Union list of diseases; the Network of Aquaculture Centres in Asia-Pacific (NACA) disease list) and any NAPLs or National Aquatic Disease Lists (NADLs) of neighbouring countries (contact your counterparts in the national Competent Authorities); and
- seeking suggestions or opinions of national experts in pathogens and diseases of aquatic animals and plants and ask them to review your draft NAPL.

FIGURE A6.3
Steps 8 to 9 in developing a national aquatic pathogen list



Preparation of an NAPL should be a consultative process that includes representatives from all stakeholders, such as national policy-makers, aquatic plant and animal disease experts, and stakeholders from the aquaculture sector (including farmers, service providers etc.), importers and exporters, and non-governmental organizations. The process needs to be transparent to enable understanding and acceptance by the aquaculture sector, importers and sellers of ornamental aquatic organisms, and trading partner countries.

NAPLs need to be reviewed and updated periodically based on the changing global, regional and national situations. Mechanisms must be in place so that new pathogens and diseases can be easily added and those that are no longer meet listing criteria can be removed.

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WOAH. 2019b. Chapter 1.1 Notification of diseases, and provision of epidemiological information. *Aquatic Animal Health Code.* https://www.oie.int/index.php?id=171&L=0&htmfile=chapitre_notification.htm#chapitre_notification

Table 1. Criteria matrix for decision-making (includes two examples for a hypothetical country)

Pathogen (Disease or syndrome)	Listed disease? (indicate listing agency or country)	Infectious aetiology? Or infectious agent strongly associated with disease, but aetiology not yet known?	Pathogenicity/ socioeconomic impact (including public health concerns) (low, medium, high)	Repeatable and robust means of detection/ diagnosis exists? (Yes/No)	Affects species cultured in country or likely to be cultured? (Yes, No, ?)	Affects wild aquatic organism species present in country? (Yes, No, ?)	Already present in country? (Yes, No, Unknown)	National control programme present for this disease/ pathogen?	Concern to international trade? (Yes/No)	Listing Decision (Yes, No) If yes, List A or List B?	Notes/ References
Aphanomyces invadans (Epizootic ulcerative syndrome, EUS)	Yes (WOAH)	Yes (known)	High	Yes	Yes	Yes	No	Yes	Yes	Yes, List A	Outbreaks have occurred in neighbouring countries in drainage basins shared with our country.
Lernaea spp. Lernaeosis (anchor worm disease)	No	Yes (known)	Low (can be high locally)	Yes	Yes	Yes	Yes	No	No	Yes, List B	Genus infects many freshwater fish species. Should be controlled in aquaculture facilities.

Annex 7:

Photos of PMP/AB-related events

PLATE A7.1
First multistakeholder meeting,
April 2018,
World Bank headquarters,
Washington DC,
United States of America
@ MELBA REANTASO

PLATE A7.2
Second multistakeholder meeting,
January 2019,
WOAH headquarters
Paris, France
@ MELBA REANTASO

PLATE A7.3
Second multistakeholder meeting,
January 2019,
WOAH headquarters
Paris, France
@ MELBA REANTASO

PLATE A7.4
Technical Working Group meeting,
March 2019, FAO headquarters
Rome, Italy
@ MELBA REANTASO

PLATE A7.5
Technical Working Group meeting,
July 2019, FAO Liaison Office,
Washington DC,
United States of America
@ MELBA REANTASO

PLATE A7.6
FAO COFI Sub-Committee on Aquaculture 10th Session, August 2019, Trondheim, Norway
@ MELBA REANTASO

PLATE A7.7
Technical Working Group meeting, July 2022, Gaeta, Italy
@ PAULO PADRE

PLATE A7.8
Round-table discussion on development of a framework for the cost-benefit analysis of aquaculture biosecurity systems, January 2023, Clark, Philippines
@ PAULO PADRE

PLATE A7.9
Technical Working Group meeting, February 2023, Chiang Rai, Thailand
@ PAULO PADRE

PLATE A7.10
FAO/NACA Workshop for the development of a NACA regional strategy on aquatic organism health, March 2023, Phuket, Thailand
@ YUAN DERUN

The Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB) was developed as a new paradigm shift in the way challenges posed by diseases of aquatic organism are being handled. While aquatic food systems continue to increase their contribution to food security and nutrition and livelihood and income, diseases will remain as one of the most significant impediments to the the sustainability of the aquaculture industry. Recognizing the transboundary nature of aquatic diseases, effective biosecurity systems are needed at enterprise, national and international levels. When put in place proactively and preventatively, biosecurity measures are less expensive than solution-based, reactionary responses to outbreaks.This publication informs on the history of the development of the PMP/AB; the drivers, factors and pathways that led to aquatic disease emergence; and the need to place biosecurity in parallel with any aquaculture development by all producing countries.
The PMP/AB has four stages and uses the principles of being risk-based, progressive and collaborative and the important role of public–private sector partnership. Countries at whatever stage of aquaculture development has an entry point to PMP/AB. Through guidance documents, toolkits and capacity building, countries will be guided towards sustainable management of the aquatic organism health. One of the strengths of PMP/AB, is that regardless of the extent at which it is applied, it can make a positive impact. It is hoped that with the help of PMP/AB, disease burden is reduced, One Health goals achieved and the contributions of aquatic food systems to food security are ensured.

Norad

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