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Report of the

FAO/MSU/WB FIRST MULTI-STAKEHOLDER CONSULTATION ON A PROGRESSIVE MANAGEMENT PATHWAY TO IMPROVE AQUACULTURE BIOSECURITY (PMP/AB)

Washington, D.C., United States of America, 10–12 April 2018

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PREPARATION OF THIS DOCUMENT

This document presents the *Report of the FAO/MSU/WB First Multi-Stakeholder Consultation on a Progressive Management Pathway to Improve Aquaculture Biosecurity (PMP/AB),* which was held at the World Bank Headquarters, Washington, D.C., United States of America from 10 to 12 April 2018. The report was prepared by Drs Sharon McGladdery (FAO Consultant, Canada) and Melba B. Reantaso (FAO, Rome), with final editing and revision by Dr J. Richard Arthur (FAO Consultant, Canada). A draft version of the report was circulated to all who participated in the consultation, and all relevant comments received were integrated in this final version. It is intended that this document will be circulated to interested stakeholders (i.e. competent authorities and other relevant government agencies, aquaculture producers and academia, including relevant fora) to provide information, raise awareness and build consensus on the PMP approach towards dealing with aquatic animal disease challenges in aquaculture and to promote its further development and adoption by all stakeholders.

ABSTRACT

This report presents the results of a multistakeholder consultation, where 45 participants from government, the private sector, academe, and international agencies and donors took stock of the drivers of aquatic animal disease emergence and shared experiences in dealing with aquaculture biosecurity challenges.

The PMP/AB, with four stages, focuses on building management capacity through both bottom-up and top-down approaches with strong stakeholder engagement to promote application of risk management at the producer level as part of a national approach. Stage 1 focusses on creation of a national strategy that has the confidence and support of the national stakeholders and addresses the principal hazards and risks that affect national aquaculture health and production. Stage 2 deals with implementation of a Biosecurity Action Plan in specific sectors/compartments where co-management is expected to continue and strengthen implementation and improvements. Stage 3 aims to establish sufficient management capacity to safeguard the level of investments by private and public entities and to manage disease and other risks through a combination of public efforts, policies, legislation, and producer interest and engagement. Stage 4 aims to reach a sustainable and resilient national aquaculture system acquired through the capacity to maintain stakeholder confidence, biosecure systems, emergency preparedness and preventive measures. The final stage is achieved through national long-term commitment to maintenance of the system through evidence of a national policy supported in law with legal and financial commitments, an evidence base that supports confidence in national aquaculture and ecosystem health, and an established capacity to prevent and respond to any biosecurity threat to aquaculture at a national level. The benefits of the PMP/AB at the national level include a strong mid- to long-term focus on national strategy development processes and promotion of a co-management approach; the bringing together of stakeholders with a variety of benefits; and the building of a strong basis for national, public and private co-management of biosecurity.

Refinement and implementation of the PMP/AB framework need active engagement by governance authorities and industry stakeholders to ensure stakeholder buy-in and a best-fit for country; however, the PMP/AB template will provide a degree of consistency between participating countries or regions. Further activities include the development of the technical aspects of the PMP/AB programme, wider consensus building, initial application and refinement, and resource mobilization. As with any new tool, guidance documents and resources for advocacy and training on PMP/AB will be needed to facilitate adoption at the national level.

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ACKNOWLEDGEMENTS

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ABBREVIATIONS AND ACRONYMS

AAT	African animal tripanosomiasis
ABCC	Associação Brasiliera dos Criadores de Camarão (Brazilian Shrimp Breeders Association)
AHPND	Acute hepatopancreatic necrosis disease
AU-IBAR	African Union Inter-African Bureau for Animal Resources
BMN	Baculoviral midgut-gland necrosis
BMPs	Best management practices
COFI	Committee on Fisheries (of the FAO)
CVO	Chief Veterinary Officer
ELISA	Enzyme-linked immunosorbent assay
EMS	Early mortality syndrome
ENGO	Environmental non-governmental organization
EUS	Epizootic ulcerative syndrome
FAO	Fisheries and Agriculture Organization of the United Nations
FfD	Fish for Development Program
FMD	Foot and mouth disease
GAqP	Good aquaculture practices
GPA	Global plan of action
GSI	Global Salmon Initiative
HACCP	Hazard analysis and critical control point
HN	*Halioticida noduliformans* of abalone
HPV	Hepatopancreatic parvovirus
IHHNV	Infectious hypodermal and hematopoietic necrosis virus
IMNV	Infectious myonecrosis virus
ISA	Infectious salmon anaemia
ISAV	Infectious salmon anaemia virus
KHV	Koi herpesvirus
LC-PUFAs	Long-chain polyunsaturated fatty acids
MBV	Monodon baculovirus
MEWA	Ministry of Environment, Water and Agriculture, Kingdom of Saudi Arabia
MSC	Marine Stewardship Council
MSU	Mississippi State University
NAAHP	National Aquatic Animal Health Program (South Africa)
NACA	Network of Aquaculture Centers in Asia-Pacific
NAQUA	National Aquaculture Group, Kingdom of Saudi Arabia
NGO	Non-governmental organization
NORAD	Norwegian Agency for Development
OIE	World Organisation for Animal Health (formerly Office International des Épizooties)
PCP	Progressive control pathway
PCR	Polymerase chain reaction
PMP/AB	Progressive management pathway to improve aquaculture biosecurity
PPP	Public-private partnership

PPR	Petit peste des ruminants (goat plague)
PRRS	Porcine reproductive & respiratory syndrome
PRRSV	Porcine reproductive & respiratory syndrome virus
PVS	Performance of Veterinary Services (OIE)
QA/QC	Quality assurance/quality control
SADC	Southern African Development Community
SEAFDEC-AQD	Southeast Asia Fisheries Development Center – Aquaculture Department
SERNAPESCA	Servicio Nacional de Pesca y Acuicultura (Chilean National Fisheries and Aquaculture Service)
SMEs	Small to medium-sized enterprises
SPF	Specific pathogen free
SPR	Specific pathogen resistant
SPT	Specific pathogen tolerant
SPS Agreement	Sanitary and Phytosanitary Agreement of the World Trade Organization
TAAD	Transboundary aquatic animal disease
TiLV	Tilapia lake virus
WAHIS	World Animal Health Information System (of the OIE)
WAS	World Aquaculture Society
WB	World Bank
WSSV	White spot syndrome virus
WTO	World Trade Organization
WWF	World Wildlife Fund

1. BACKGROUND

1.1 Introduction

The great potential of aquaculture to contribute to food and nutritional security and poverty alleviation has been significantly hampered in many instances by a lack of adequate biosecurity and resulting aquatic animal disease challenges. During the last three decades, the sector has faced a number of re-emerging and/or newly emerging diseases that have appeared at approximately every three to five years. While measures to prevent and reduce the impacts of diseases that affect aquaculture have been launched by stakeholders from the government, producer and academic sectors, these efforts have not adequately addressed the disease problems challenging the sustainability of this fastest-growing food-producing sector. The development of the human capacity and infrastructure required to adequately to address the disease issues faced by aquaculture has not matched the sector's rapid growth. One of the reasons for this mismatch is the great diversity of aquaculture, with more than 500 species farmed in all types of environments (freshwater, brackishwater, marine), systems (e.g. ponds, cages, recirculating systems, integrated multitrophic systems, polyculture, nurseries, grow-out facilities and hatcheries), management strategies (extensive, semi-intensive and intensive) and size of operation (ranging from backyard and subsistence level to small-, medium- and large-scale operations). The stakeholders and enterprises involved in the aquaculture supply and value chains are also diverse and in huge numbers; thus they are important considerations, as each segment is a source of risk. Pathogen emergence, re-emergence and spread have thus been constant constraints to sustainable aquaculture development across both developed and developing countries since the 1970s and continue to have a significant impact on country productivity, socio-economics and market access.

In view of the above, the Food and Agriculture Organization of the United Nations (FAO), Mississippi State University (MSU) and the World Bank (WB) convened the *First Multi-Stakeholder Consultation on a Progressive Management Pathway to Improve Aquaculture Biosecurity* (hereafter referred to as the "PMP/AB Consultation") at the WB headquarters in Washington, D.C. from 10–12 April 2018.

1.2 Purpose

The general objective of the PMP/AB Consultation was to seek feedback from stakeholders on the application of a proposed PMP/AB, its adaptability to the diversity of aquaculture production systems across countries and regions, and its potential to make a significant difference in reducing the emergence and/or re-emergence diseases that threaten sustainable aquatic production.

The PMP/AB is a step-wise risk management pathway that is based on similar frameworks that have been applied by the terrestrial animal production sector, i.e. the Progressive Control Pathway (PCP) used to promote development and self-monitoring of national strategies for important livestock diseases such as foot and mouth disease (FMD), African animal trypanosomiasis (AAT) and peste des petits ruminants (PPR). The approach is risk-based, collaborative and progressive in nature.

The specific objectives of the PMP/AB Consultation were to:

- take stock of the current aquatic animal health and biosecurity situation in aquaculture;
- introduce a new concept to address aquatic animal disease problems, the Progressive Management Pathway to Improve Aquaculture Biosecurity (PMP/AB) – a step-wise risk management pathway that introduces building blocks for biosecurity capacity relevant to national needs at every stage; and
- build consensus on the PMP/AB with the aim of developing a Global Plan of Action.

1.3 Process

A draft working document, *Development of a Progressive Management Pathway to assist national and international improvement of biosecurity in aquaculture production,* was prepared by an FAO team consisting of Keith Sumption, Melba Reantaso and Rohana Subasinghe and finalized with inputs from Mark Lawrence (MSU) and Franck Berthe (WB) (see Annex 1). This was circulated to the participants for comment and served as the main document during the consultation. In addition, four thematic papers were prepared, and expanded abstracts of these papers were also circulated prior to the consultation (these were presented during Session 2 and are summarized in Section 3 of this report).

The PMP/AB Consultation consisted of five sessions and was informed by a number of presentations as listed below (see Annex 2 for the detailed programme):

Session 1: Opening and introductions

- Opening and welcome remarks (FAO, MSU, WB)
- Introduction to objectives, mechanics and expectations

Session 2: Thematic presentations including Q & A

- Drivers and pathways of aquatic animal disease emergence
- Health management in small-scale aquaculture: opportunities for the Progressive Management Pathway (PMP) approach
- Effective extension services to support biosecurity systems
- Socio-economic impacts of aquatic diseases and economic drivers

Session 3: Working group discussions

- PMP/AB framework
- Ownership and stakeholder engagement and Stage progression system: achievements, outcomes, benefits and evidence

Session 4: Private-sector perspectives on biosecurity

- Marine shrimp farming: world reality and the challenges confronted by that sector in Brazil
- Some thoughts on biosecurity in animal production systems

- Aquaculture biosecurity in the Kingdom of Saudi Arabia: a public-private partnership success story
- Bottom-up approach in farmers support in Viet Nam

Session 5: The Way Forward and Closing
- The Way Forward
- Closing remarks

1.4 Participants

A total of 45 participants representing government, regional and international intergovernmental organizations, industry, academe and development and aid agencies and foundations participated in the meeting. The List of Participants and Group Photograph can be found in Annexes 3 and 4, respectively.

1.5 Products

The main product of the PMP/AB Consultation is this Report, which presents a narrative of the meeting, the major highlights of discussions, and a summary of the decisions that were reached, leading to:
- a better understanding of the root causes/drivers of aquatic disease emergence in aquaculture across different sectors, regions and production stakeholders;
- a better understanding of the PMP and how this agriculture-livestock framework might be used to enhance aquaculture biosecurity and aquatic animal health management; and
- consensus building on the PMP/AB and its applicability to improved aquaculture biosecurity.

2. SESSION 1: OPENING AND INTRODUCTIONS

2.1 Welcoming statements

Welcoming statements were presented by Dr Árni Mathiesen (Assistant Director-General, FAO Fisheries and Aquaculture Department), Dr Mark Lawrence (Associate Dean for Research and Graduate Studies, MSU) and Dr M. Xavier Vincent (Lead Fisheries Specialist /Global Lead for Fisheries and the Blue Economy, WB).

- Dr Árni Mathiesen extended his thanks to Dr Mark Lawrence (MSU), Dr Xavier Vincent (WB) and all participating in the PMP/AB Consultation. He noted that the broad range of expertise present clearly reflects recognition of the importance of biosecurity threats to food and economic security. He provided relevant aquaculture statistics underscoring the economic importance of this aquatic food production sector. However, major diseases affecting cultured aquatic species emerge or re-emerge every three to five years. Such events are very important to FAO, due to their impacts on small producers in the largest producing countries, where economic stability is often a constant challenge. Dr Mathieson noted his aquatic veterinary background and his deep personal interest in improving proactive prevention of disease emergence versus ongoing reactive responses to disease outbreaks and spread, which is not sustainable in light of human development and demographic food needs.

- Dr Mark Lawrence expressed the great honour to be co-hosting and supporting this important consultation. MSU is a Land-Grant University, established under President Lincoln, and has the largest concentration of aquatic animal health experts on campus, focusing mainly on catfish diseases, while Mississippi boasts the largest aquaculture production of all states in the United States of America. Disease problems worldwide impact everyone, Mississippi included. MSU hopes that this workshop can help address worldwide problems in this area that will help all stakeholders make positive progress.

- Dr M. Xavier Vincent extended regrets from the Senior Director for the WB, who was not able to attend, and expressed a warm welcome to all attendees. He noted that this workshop aligns very well with the WB's mandate to eliminate world poverty. He noted that the WB has five organizations, two of which cover fisheries and aquaculture development and, in 2005, the WB decided to reinforce investment in the aquatic sector after years of concentrating mainly on the agricultural sectors. The WB is set to double funding to provide opportunity, but also challenges aquaculture production to align well with both environmental and economic sustainability (the "Blue Economy"). He believes that it is especially important to learn from our collective disease experiences, including those from terrestrial farming development.

2.2 Introduction to objectives, mechanics and expectations

Dr Melba B. Reantaso (FAO Headquarters, Rome) briefly described the disease situation in aquaculture, mentioning some of the most significant diseases impacting the sector. These include acute hepatopancreatic necrosis disease (AHPND), epizootic ulcerative syndrome (EUS), infectious myonecrosis virus (IMNV), infectious salmon anaemia virus (ISAV), koi herpes virus (KHV), tilapia lake virus (TiLV) and white spot syndrome virus (WSSV). Globally, the trend in aquaculture is that every three to five years or so a serious emerging disease (i.e. a transboundary aquatic animal disease, TAAD) appears that spreads rapidly and causes major production losses. There is often a long time-lapse (usually years) from the time that a serious mortality event caused by an unknown and emerging pathogen is observed in the field, to its subsequent identification and confirmation, to achieving global awareness among aquaculturists and aquatic animal health experts, to the establishment of surveillance systems, and to disease listing and reporting/notification, up to the time when cost-effective risk management measures are identified and implemented. As an example, she presented the chronology of shrimp disease emergence from the 1970s to the present, showing how the number of diseases (mainly caused by viruses) increased from the 1970s, with only two major diseases, i.e. baculoviral midgut-gland necrosis

(BMN) and monodon baculovirus (MBV), to the 1980s, when the sector was challenged by several viral diseases, which included hepatopancreatic parvovirus (HPV), infectious hypodermal and hematopoietic necrosis virus (IHHNV) and WSSV, coinciding with the intensification of the shrimp aquaculture sector, to the 1990s, with new viral diseases emerging and increased problems with bacterial pathogens (mainly vibriosis), and to 2000 and beyond, with new problems due to viruses (IMNV), parasites (*Enterocytozoon hepatopenaei*) and bacteria (AHPND) appearing. Cognizant of the above scenario, the aquaculture sector and all its stakeholders need to rethink critically the drivers and pathways to aquatic animal disease emergence. The 4Ps (purpose, process, participation and products) of the PMP/AB Consultation can be seen in Sections 1.2 to 1.5.

3. SESSION 2: THEMATIC PRESENTATIONS AND PLENARY DISCUSSIONS

3.1 Thematic presentations

There were four thematic presentations, the highlights of which are presented below:

- **Drivers and pathways for aquatic animal disease emergence** (Melba Reantaso, Grant Stentiford and Sharon McGladdery; presented by G. Stentiford)

Dr Stentiford described the five elements to food supply that contribute to food security: sufficient (to meet the needs and wants of society), safe (minimal risk to people and environment), sustainable (available now and for future generations), shock-proof (resilient to shocks in production and supply chain) and sound (processes meet legal standards). He underscored the fact that aquaculture-based food production is growing in a very complex and diverse world setting. With respect to disease management, it needs to be able to withstand environmental challenges, transportation and market/consumer demands. In this context, drivers for aquatic animal health can be divided into four main groups:

1. *Trade in live animals and products.* Fish is a highly traded commodity (70 percent exposed to international trade). Aquaculture is highly diverse in terms of species (>500 farmed) as compared to terrestrial systems. Live animals (larvae, fry, adults) and their products (live, fresh, frozen) are traded internationally, and many species are farmed outside their native ranges. Invasive animals and pathogens can be traded with the primary commodity. Ornamental aquaculture trade is large and growing; there is some diversion of aquacultured products to unintended usage (e.g. angling baits)
2. *Knowledge of pathogens and their hosts.* Aquaculture has a unique aquatic medium where the health of the cultured population is not readily seen. There is slow collective awareness of new threats and a lack of basic pathogen (e.g. transmission routes) and host data (e.g. immunity, genetics). Diagnostics are usually focused on known/listed diseases. Breeding strategies are not in place for many species (e.g. specific pathogen free (SPF), specific pathogen resistant (SPR), selective breeding), and there is misuse of stock (e.g. SPF) in some cases. The limited availability of vaccines (for fish) and other credible control options (for invertebrates) limit viable disease protection options for crustacean and molluscan pathogens.

3. *Aquatic management and health control.* Constraints in aquatic animal health management and disease control include the following: multiple institutions involved in aquaculture production and aquatic animal health management (i.e. fisheries, aquaculture and veterinary authorities); inadequate or poorly implemented biosecurity measures; low capacity for emergencies; difficulty in the interpretation of international standards leading to inconsistent or weak implementation; perceived low incentive to report on known and emergent diseases (due to potential impacts on trade); weak regulatory frameworks and a lack of public-private sector partnerships; mismatch between research agendas and farmer/commodity sector needs; and few national pathogen/host inventories. The lack of long-term policies and strategies, and of effective implementation (where these exist), makes the actions to deal with disease emergence reactive (i.e. only when outbreaks or mortalities occur) rather than proactive (i.e. preventive actions, risk assessments, stakeholder engagement, etc.).
4. *Ecosystem changes.* The physico-chemical conditions in aquaculture are often suboptimum for the species being cultured. As aquatic animals are cold-blooded, they are highly responsive to stressors. Animals may be farmed outside their native/optimal range and in waters in which they are naïve to native microbial hazards. The aquatic medium is pathogen rich, and diversity changes with environmental conditions. Pathogens evolve and spill-over and spill-back relative to wild populations. Aquatic ecosystems change through direct human activity (i.e. dams, community expansion, etc.) and via indirect impacts (i.e. climate, global pollution, etc.). Farming in these situations is complicated by the physiology of the animals; e.g. poikilothermic constraints to adaptation and growth outside the animal's natural geographic range, rendering them susceptible to enzootic microbes and parasites.

Dr Stentiford concluded by stating that disease is the number-one issue in limiting yield, reducing profit and preventing investment; thus the need to critically understand the drivers and for closer government-academic-industry cooperation, such that society is working to tackle these grand challenges in the future. Completion of the crop cycle will become a core measure of sustainability. Aquaculture systems must better mimic the ecology of wild systems (i.e. host, environment, pathogen). Moving the majority of the aquaculture industry to "insurable" is a critical component of achieving growth targets.

- **Health management in small-scale aquaculture: opportunities for the Progressive Management Pathway (PMP) approac**h (Rohana P. Subasinghe)

Dr Subasinghe's presentation covered three aspects: fish as an important health food, disease as a major constraint to aquaculture, and biosecurity challenges facing small-scale producers.

Since malnutrition, stunting, wasting and obesity are serious global health problems, people should be fed with a balanced diet that provides the required daily intake of nutrients, including essential amino acids, micronutrients, vitamins and minerals. In this regard, fish is an important health food. It has the potential to contribute significantly to eliminating malnutrition, while improving global food and nutritional security. Fish provides more than 4.5 billion people with at least 15 percent of their average per capita intake of animal protein. Fish’s unique nutritional properties make it also essential to the health of billions of consumers. The lipid composition of fish is unique, having long-chain polyunsaturated fatty acids (LC-PUFAs), with many beneficial effects for child development and adult health, while providing protection against coronary heart disease. Fish is also known to be an important source of essential micronutrients, vitamins D and B, and minerals. Besides, fish is one of the most efficient converters of feed into high-quality food, and its carbon footprint is lower compared to other animal production systems.

Aquaculture is a highly complex sector due the aquatic environment and its’ transboundary nature. There are over 500 species cultured in different habitats with different food habits, different production systems and different production practices. It is predominantly a smallholder activity, with around 75 percent of the global production currently originating from small-scale aquafarms. Disease is a threat to the growth of aquaculture. The spread of pathogens along with the movement of infected hosts has not only caused losses and mortalities in commercial systems, but also affected small-scale, rural aquaculture and fisheries operations. Not only do diseases in small-scale aquaculture contribute to reducing global fish supply, they also affect the livelihoods of people involved in aquaculture and the communities in which they live, through reduced food availability and loss of income and employment. Besides the impacts of pathogen introductions and transfers, many other human activities (both agricultural and industrial) can also have negative impacts on rural, small-scale aquaculture and enhanced fisheries by increasing the risk of disease problems and stock losses.

Small-scale aquaculture requires targeted interventions to combat disease problems. Rural, small-scale farmers are generally resource-poor and have little or no knowledge of health management. As a result, their ability to respond to such situations effectively is limited. It is therefore important to understand better how the rural, small-scale aquaculture sector is managed, both by the farmers themselves and the others involved in the sectoral activities, and to develop appropriate interventions which can assist resource-poor farmers to prevent and control disease outbreaks through better health management.

Interventions that may improve the health management standards of the rural, small-scale aquaculture, inland fisheries (an overlooked small-scale production sector) and enhanced fisheries sectors include:

- developing appropriate national policies, enforceable regulatory frameworks and legislation to prevent the entry of pathogens, thereby safeguarding farms from disease incursions;
- improving small-scale farmer access to basic aquatic animal health services;
- focusing on research that addresses the basic needs of the small-scale farmers and small to medium-sized enterprises (SMEs);
- creating opportunities for small-scale farmers to practice preventative health management, by improving basic production and management skills;
- incorporating basic health management messages into small-scale aquaculture extension programmes;

- ensuring that basic health management measures are incorporated into programmes for fisheries enhancement and small-scale aquaculture within rural livelihood projects; and
- improving extension services and enhancing communication exchange to enable quick response to disease situations.

Dr Subasinghe concluded by saying that the PMP/AB, being an integrated, cross-sectoral and holistic approach, might provide hope.

- **Effective extension services to support biosecurity systems** (Larry Hanson)

Dr Hanson presented an overview of aquaculture extension in the United States of America, the qualifications of extension specialists, and their role in biosecurity and limitations. He began with a note on the history of the Land-Grant University system and the establishment of the Cooperative Extension Service to improve communications between farmers and researchers. In aquaculture, health issues often have immediate and critical impact on the success of an operation. Economic stress, such as disease, gets the farmers' attention. Therefore, much of the effort of extension workers is in helping the producers maintain healthy populations. They have an important role in disease risk management, as they have direct contact with the farmers on a daily basis. Extension specialists can recognize unusual mortality patterns and other signs that farmers, veterinarians, diagnosticians and researchers may miss and can quickly alert industry to biosecurity risks and needed modifications in management.

Extension specialists suggest preventive management; help the producers recognize early warning signs and with the collection and transportation usable samples; and facilitate farmers with disease management options (e.g. harvest, treatment, choosing appropriate chemicals and applicators). Good health management advice builds trust and provides the opportunity to promote regional disease prevention measures. Aquaculture extension specialists have broad training in aquatic system management and are familiar with common diseases that occur locally. They are on the front line and can recognize unusual events. Because they routinely interact with producers, veterinarians, diagnosticians and aquatic animal health researchers, they can facilitate the diagnosis of, and field research on, new and emerging diseases. Furthermore they are often more aware of local changes in the aquaculture business than the diagnosticians. The critical factors that can influence health management and biosecurity include the availability and cost of medicated feed, chemicals, harvesting options and the movement of fish.

The extension activities mostly depend on individual interactions and focused small-group field presentations. Additionally, the extension service has the infrastructure and resources to arrange seminars and workshops to provide direct contact between scientists and producers. When new disease situations do arise, the extension personnel are critical for field research, epidemiology and economic evaluation of the impact of the disease and in finding remedial measures. Because the aquaculture extension specialist is a trained biologist who sees the whole operation where disease outbreaks occur, he or she can often observe trends that scientists can use as leads to help resolve the underlying predisposing factors. When management options are discovered, these specialists facilitate field trials, disseminate the findings. and promote the adoption of new proven management practices. Furthermore, when regional management and biosecurity measures are developed that involve new regulations, extension specialists inform the producers and help the changes to occur seamlessly. For small to medium-size operations, extension is a critical conduit, providing real-time contact between aquatic animal health experts and the industry. This provides a faster recognition of health threats, more rapid response, and a better understanding of the process and buy-in to national action plans by the industry. This is essential for the bottom-up approach proposed to risk management in aquaculture in the PMP/AB.

Dr Hanson concluded by recognizing that extension services have limitations. They are effective in small to medium-scale operations that are open to sharing information, but are often not welcome in large systems, which may have their own researchers and veterinarians and are protective of trade secrets. Although biosecurity is often higher in large operations, disease situations may not be reported as rapidly. Extension must be well established and funded, so that the specialists can routinely work with the producers on a personal level and establish trust.

- **Socio-economic impacts of aquatic diseases and economic drivers** (Frank Asche)

Dr Asche began his presentation by mentioning the three dimensions of sustainability required in any sustainable industry: economic, environmental and societal. For all industries, economic sustainability (profitability) is necessary to get started and to continue operation. Lack of environmental sustainability is mostly slower acting, and will normally not be tested before expected short-run economic sustainability has been demonstrated. Societal sustainability is harder to relate to and normally kicks in when doing something unusual or new that may challenge what is acceptable.

Disease is a part of any biological production process and if one cannot handle the disease, an industry will not be sustainable. The many outbreaks in aquaculture is a sign of immaturity, as diseases impact all three pillars of sustainability. For diseases, prevention and treatment costs will be a part of a company's operational costs, and become a part of the governance system pertaining to that industry. Disease can threaten an industry's existence in the early years and can impact prices. If disease can be handled in time, an industry can rebound. Aquatic veterinary medicine is a new discipline, and aquatic veterinarians are needed for preventing and treating disease. While some disease challenges can be solved by vaccination, effective governance is necessary for prevention, especially given the fact that water is an excellent medium for disease transfer.

The economics of fish disease is basically the same as in agriculture. There are two categories: (i) prevention costs – a fixed cost that is present when there is no disease, but which makes any industry that is susceptible to disease more profitable over time; and (ii) disease costs – which include treatment, reduced growth, increased mortality and poorer capacity utilization. When profits are negative over a cycle, the company may become bankrupt, and if all companies become bankrupt, the industry will disappear.

Governance is the most important element in terms of yields, for which disease risk is an important factor. Foregone production is the most important economic effect of disease. The second largest problem causing lower yields is due to poor broodstock. Dr Asche emphasized that as in all development work, building capacity is essential, but the capacity must be adapted to local needs. He concluded that disease costs are substantial in aquaculture. Focusing on prevention is a sign of a maturing industry that also needs to be supported by innovation, preventive techniques and governance. Disease will remain an economic and societal challenge, and how it is handled will be one of several critical factors determining success for any aquaculture producer.

3.1.1 Thematic presentations: Plenary discussion highlights

Much of the plenary discussion centered on “bottom-up” (farmer-driven) vs “top-down” (government-driven) roles and responsibilities for responding to disease threats. Many factors with different risk management objectives overlap, and can conflict in an emergency disease response or a response to a new disease of unknown significance. Lack of information leaves the farmer in a scenario-based situation (“fire-fighting”) vs a knowledge-based, risk-assessed, government or industry management situation using strategic, disease-specific control measures (a targeted approach).

Trust was raised as a communication challenge. Farmers see eradication as a “first response” to a new or unidentified disease emergence as punitive vs supportive, especially where there are no mechanisms for compensation. Conversely, governments see farm-based control measures that fail to prevent disease spread or that “bury” its occurrence as a risk to the production environment and to health-certifiable access to local, regional or international markets.

In the context of PMP, it was felt that established, large-scale producers or sectors are better placed to take this on effectively. However, there is also strong evidence that information protection due to industry competitiveness and/or mistrust in government intervention leads to much more devastating losses than a collaborative, trust-based approach. As such, for PMP to succeed both national authorities and industry associations need to support the approach and work together towards its implementation.

3.2 Country presentations

Four country presentations were delivered by participants from Chile, Norway, the Philippines and South Africa.

- **Aquaculture Biosecurity approach in Chilean salmon industry "learned lessons"** (José Miguel Burgos and Alicia Gallardo)

Dr Gallardo presented Chile's experience during the infectious salmon anaemia (ISA) outbreak in their salmon industry. At the time, governance of the industry was divided between agriculture and fisheries, which were separate departments. This contributed to an uncoordinated response, and was further complicated by a disorganized and secretive salmon farming industry. As a result of the devastating losses, Chile developed a new governance organization, the Servicio Nacional de Pesca y Acuicultura, SERNAPESCA, that incorporated environmental stewardship, aquaculture health management, fisheries management and seafood safety within a single agency. During the outbreaks around 2007, Chile had only four fish veterinarians. Today, there are 150 aquatic veterinary inspectors and strong biosecurity oversight. It took four years to recover from the 75 percent loss in production due to ISA, and now Chile supplies over 50 percent of salmon to the Americas.

The salmon farming industry formed SalmonChile (the Asociación de la Industria del Salmón A.G.) to advise and work with government and establish good management practices among themselves. A Salmon and Trout Association was also formed by industry to reinforce biosecurity, along with an artisanal shellfisheries association (working alongside salmon). The World Wildlife Fund (WWF) standards for good management practices to the salmon industry were used. In addition, the Global Salmon Initiative (GSI, https://globalsalmoninitiative.org/) has invested in standards to reduce antibiotic use, leading to significant cost-benefit improvements in managing several major diseases.

Important elements of the Chilean Biosecurity Plan included:
- A working group to develop, review and ensure ongoing implementation of the plan was established.
- Diseases requiring control were listed based on risk assessment – including cost-benefit analyses.
- Critical control points were identified for biosecurity focus.
- Biosecurity plans were designed for production sectors (hatcheries, etc.) based on hazard analysis and critical control points (HACCP) principles for food safety.
- Legislation was reviewed and modified to be applicable to aquaculture, as appropriate.
- Capacity and expertise were increased in SERNAPESCA to provide better industry support.
- International cooperation efforts were established with key veterinary and food security organizations (e.g. OIE, FAO).
- Public-private research was reinforced and supported.

Chile also strengthened reference and official aquatic animal health laboratories and provided support to universities to undertake research focused on diseases of national concern (currently piscirickettsiosis and TiLV). This has rebuilt country capacity using clear definitions for emergency disease, integrated information, regional networks of expertise and well-defined policies, roles and responsibilities.

In closing, Dr. Gallardo underscored a factor not usually considered in biosecurity – "*The Human Factor*". One of the lessons learned by Chile is the importance of taking into account, and respecting the social and cultural importance of the aquatic animals to the farmers and their communities.

- **Norway: Aquatic animal diseases and biosecurity** (Yngve Torgensen)

Dr Torgensen's presentation revolved around Norwegian aquaculture and its management and included a specific example of how mitigation measures and aquaculture biosecurity were applied to infectious salmon anaemia (ISA) and finally, Norway's contribution to global aquaculture biosecurity.

Norwegian aquaculture is primarily marine, fjord-based, sea-cage farming. Currently there are 120 farms employing 30 000 people; 99 percent of Norwegian aquaculture is salmon and trout, with an export value of US$ 9 billion. The sector is highly technology-dependent, with computerized feed barns managing multiple, large, pen farms. Between 2000 and 2017, the number of sites halved but production biomass doubled. Norway is now looking at offshore production capacity using super-huge cages, some prototypes of which are already in field trial. Unlike in many other countries, the Norwegian aquaculture industry is highly dependent on private support services (i.e. veterinarians, feed, employees) and plays a key role in driving aquaculture-specific training and education to develop the professionals needed for industry growth.

ISA first emerged in the late 1980s; however, the causative viral agent was not identified until the 1990s. Biosecurity measures were therefore being applied against an infectious agent of unknown etiology. In addition, the industry was also dealing with two bacterial diseases by using massive antibiotic applications (at one point 50 000 kg of antibiotic was used to produce 50 000 kg of fish!). A key component of this was husbandry – overproduction relying on chemicals to reach market size. Since then, however, antibiotic use has been virtually eliminated due to effective vaccine development and significant improvements in welfare and husbandry practices. Norway also has a strong health certification programme for its production animals based on targeted surveillance. Well-boats are used for fish transportation and can be disinfected between shipments. Processing plants have stringent effluent treatment plans to protect downstream farms, and there are official guidelines for industry contingency planning.

The top five challenges recognized as the industry developed are:

1. Lack of knowledge of many aquatic animal pathogens.
2. Lack of understanding and awareness of health risks (usually learned the "hard way").
3. The common belief that biosecurity is complex and expensive.
4. Easy access to antibiotics etc., to circumvent biosecurity (farm-level cost-benefit analysis).

5. Access to vaccines and therapeutant licensing.

In working with FAO and OIE, it is clear that there are experienced people in the field, but they lack the resources to do their jobs effectively and need ongoing training as industry develops. In recognition of this, the Norwegian Agency for Development (NORAD) has instituted a "Fish for Development" program (FfD) to coordinate Norwegian expertise in helping developing countries improve sustainable fisheries and aquaculture production. This programme aligns well with the proposed PMP, and was developed by NORAD's acting Head of Evaluation Department, Hans Peter Melby (who is participating in this workshop).

- **Biosecurity in aquaculture: the Philippines** (Leobert de la Pena and Joselito Somga, presented by L. de la Pena)

Dr de la Pena started his talk by mentioning a few key references on shrimp biosecurity and continued by noting that strict implementation of a biosecurity programme is one solution to disease outbreaks that cause economic losses. He presented two definitions of biosecurity, as (i) "...the sum total of the activities and measures taken by aquaculture production facility to protect the cultured stocks from the possible negative impacts resulting from the introduction and spread of serious aquatic animal diseases" (modified from FAO, 2007) and as "...sets of practices that will reduce the probability of a pathogen introduction and its subsequent spread from one place to another" (Lotz, 1997). Biosecurity also means safe life and risk management and has goals that are related to prevention, control and eradication of risks to life and health and reduction of the economic impacts of disease.

He then described the biosecurity and aquatic animal health-related projects being implemented by the Southeast Asian Fisheries Development Center, Aquaculture Department (SEAFDEC-AQD) on research, vaccine development, epidemiology, emergency response, and technology extension and demonstration. He also described government interventions through the issuance of Fisheries Administrative Orders relating to fish health management as an element of the Code of Practice for Aquaculture, and preborder biosecurity related to guidelines for the importation and culture of whiteleg shrimp and for the importation and culture of SPF and SPR broodstock and postlarvae. The Philippine biosecurity measures developed in response to both shrimp and tilapia disease outbreaks were described in detail, and encompass all stages of production, probiotics in feed, and extensive water-quality management.

Dr de la Pena concluded his presentation with the following recommendations:

- Quarantine policies, regulations and measures should be effectively implemented (e.g. review and updating of regulations, addressing needs for human resources and technical competence).

- Biosecurity measures and good aquaculture practices (GAqP) should be adapted to small-scale/farm operators (e.g. awareness raising through seminars and training extension works on biosecurity and good aquaculture practices (GAqP);
- Rapid and early response to disease emergencies and outbreaks is needed (e.g. by building strong partnerships with stakeholders, and contingency plans for disease emergency).
- Government compensation for disease control measures is needed (i.e. for stock destruction, disease containment and possible eradication).

- **Aquaculture biosecurity in South Africa (**Kevin W. Christison and Belemane Semoli, presented by K. Christison)

Dr Christison noted that South Africa has a different approach to biosecurity due to having a relatively small aquaculture industry and relatively few biosecurity breaches. A value-chain based management system is used that is based on surveillance and certification for health status and food safety. Two branches within the Department of Agriculture, Forestry and Fisheries collaborate via a National Aquatic Animal Health Program (NAAHP). The NAAHP committee has developed a Regional Aquatic Biosecurity Plan for the Southern African Development Community (SADC) that includes a national disease list which is OIE based, as well as including those diseases of regional significance.

The emergence of epizootic ulcerative syndrome (EUS) in 2010 was the primary factor contributing to South Africa's development of aquaculture biosecurity measures. The response was based on the FAO approach using surveillance to map out EUS distribution. Due to a lack of capacity, much of this was undertaken using citizen-science and public awareness campaigns. The results showed strong reporting of gross lesions that were used for laboratory investigation and mapping of EUS positive/negative areas.

Another example was abalone mortalities due to infection by *Halioticida noduliformans* (HN), a rickettsial agent that causes ovocyte infections that develop into grossly visible tubercles and lead to mortality. Four farms have now closed due to HN. South Africa now undertakes targeted surveillance of all abalone farms on a regular basis, and suspect cases are sent for diagnostic testing. There is now a polymerase chain reaction (PCR) test for the rickettsial agent that has greatly sped up turn-around time on test results, and no new infections have been detected.

Basic biosecurity in South Africa was developed using the OIE framework of three critical control points:

(1) the disease is notifiable (mandatory reporting);
(2) early detection systems are in place via targeted surveillance; and
(3) import controls are in place for abalone farms and the country.

Challenges to effective aquatic biosecurity in South Africa include:

- the current legislative framework does not cover invertebrates as animals;
- Aquatic animal veterinary capacity is lacking. (This is being addressed by sending DVM candidates for further training, for example for MSc training at Stirling University, Scotland).

- Diagnostic capacity needs to be increased, including trained staff and laboratory infrastructure (e.g. reference laboratories).

3.2.1 Country presentations: Plenary discussion highlights

The four country presentations highlighted diverse approaches to disease management. For example, Asian countries farm hundreds of species with highly variable diseases and risk profiles, whereas aquaculture in the Americas and Europe concentrates on approximately ten species. Likewise, the scale of farming encompasses the gambit of small, subsistence family operations, to massive production facilities. Despite this variability, some common threads were noted. First-time outbreaks at a scale threatening industry survival in a country generally trigger *ad hoc* responses, with government authorities working along with industry to develop controls to reduce spread of the disease and depopulate affected farms or areas. These responses rely on the information available, which is often incomplete. Communications and lines of authority are often unclear, leading to delays in response or ineffective control measures. One result from this *ad hoc* approach is a breakdown in trust between authorities and industry, which takes time and significant efforts to rebuild. Countries with more technically advanced industries (such as salmon aquaculture) have some form of contingency plan for reporting a disease outbreak and triggering control responses; however, these countries also reported "lessons learned" that led to significant changes following each incident.

Another common theme among the country presentations was the danger of relaxing biosecurity measures implemented in the wake of a disease outbreak. In an emergency, resources are made available to contain and eradicate the disease. Once under control, and after a period of disease freedom, however, critical control points, such as broodstock health screening, postlarvae/seed sources, equipment disinfection and farm-to-farm travel begin to break down. At the same time, government investment in health screening, farm extension and outreach, and laboratory services tend to be cut back. This increases the risk of another disease outbreak and results in the need for a costly reactive response. It was agreed by all that "peace time" disease control is the hardest to maintain, but is the most important stage for disease prevention (vs response).

Some countries have achieved strong preventative measures based on disease outbreak experience, e.g. ISA in salmon in Norway and Chile. These measures are effective in protecting the country's industry, but also impact trade with other countries that do not have equivalent disease management programmes. It was noted that investment in disease prevention should take into account not only the risk of disease losses to the industry and country, but also the risk of loss of market access for healthy live aquatic animals and their products (fresh or frozen). Countries with established biosecurity measures also noted the importance of their development in collaboration with industry and cited examples of failure of "top-down" bureaucratic programmes, which have little or no industry buy-in. Industry needs to see the business benefits before it will invest in control measures. It was recognized that this is a collective challenge, especially in the growing context of the "good of the commons" (environmental and consumer market drivers) vs the economic interest of the farmers or their shareholders.

4. SESSION 3: WORKING GROUP DISCUSSIONS

4.1 Development of a progressive management pathway (Keith Sumption, Sabrina Bonnici and Melba Reantaso, presented by K. Sumption)

In this presentation on *Development of a Progressive Management Pathway to assist national and international improvement of biosecurity in aquaculture productions,* Dr Sumption described the Progressive Control Pathway (PCP) as step-wise approaches that are increasingly used for the reduction, elimination and eradication of a range of major livestock and zoonotic diseases including foot and mouth disease (FMD) , peste des petits ruminants (PPR, also known as "goat plague"), rabies and African animal trypanosomosis (AAT). It provides systemic frameworks for planning and evaluating field interventions and enables realistic disease control objectives to be defined and achieved. PCPs have been used since 2008 by FAO and become adopted as joint tools with the OIE (FMD, PPR) or developed/owned by global alliances (rabies, AAT).

He described its history and application to specific livestock diseases, e.g. FMD – where the PCP-FMD served as the motor for the global control strategy of the disease. He described the stages of application at the national, regional and global levels and the supporting mechanisms. which included e-learning courses, networking and country-focused support. For PCP-PPR, the four stages correspond to a combination of decreasing levels of epidemiological risk and increasing levels of prevention and control. The stages include an assessment plan, a control plan, an eradication plan and application for disease-free status. The PCP-AAT had five stages and a pre-entry level called "below Stage 1". Important considerations include: (i) movement from one stage to the next requires meeting a set of minimum requirements and implementation of a detailed plan implemented in the following stages. Independent validation is required. The PCP provides donors with a robust tool to monitor and evaluate progress and impacts and gives them confidence in supporting AAT-endemic countries.

The PMP/AB focuses on building management capacity through both bottom-up and top-down approaches with strong stakeholder involvement to promote the application of risk management at the producer level as part of the national approach. It is useful tool to establish a National Biosecurity Management System. It is capable of generating early warning information from monitoring and surveillance activities, contributing to the notification to OIE's World Animal Health Information System (WAHIS).

Four stages (risk assessment, biosecurity in specific sectors, national biosecurity management, and sustainable and resilient aquaculture biosecurity) are proposed. To move from one stage to another, a set of minimum entry requirements must be met and a detailed plan for implementation in the following stage must be prepared. "Gateway passes" are usually in the form of a Biosecurity Action Plan.

The PMP/AB may be applied at a national level, or targeted geographically. Each stage has well-defined outcomes that are achieved through a variety of activities. Evidence-based and transparent assessment of stage of a country (or zone) is proposed through data collection and audits. A fast-track system can be considered for enter into advanced stages (by providing evidence for meeting stages' entry requirements).

PMP/AB Stage 1 focusses on creation of a national strategy that has the confidence and support of the private and public stakeholders. Stage 1 addresses principal hazards and risks that affect aquaculture health and production. At Stage 1, an understanding of the level of biosecurity will be achieved by having a risk assessment plan: (i) identifying hazards (pathogens), mapping risks and gaps in the system, and identifying any negative impacts on the ecosystem; (ii) periodic checks (e.g. every trimester or every six months); and (iii) developing a Strategic Biosecurity Action Plan in order to progress to Stage 2. The aim is for a common agreement on a long-term vision. Each country will need to complete its Strategic Biosecurity Action Plan, which will be the gateway pass to enter Stage 2. Stage 1 achievement at the national level is the creation of a public/private task force that will establish co-regulation and co-ownership of the pathway between public and private-sector stakeholders.

PMP Stage 2 focusses on the implementation of a Biosecurity Action Plan in specific sectors/compartments. Co-management is expected to continue and strengthen the implementation and improvements. For this stage to move forward, additional biosecurity efforts at ports and borders must be included. In order to enter Stage 3, countries will need evidence (i.e. Strategic Biosecurity Action Plan implementation) and commitment (i.e. through a National Biosecurity Management System). Stage 2 biosecurity implementation can be achieved through constant training to all involved parties (private and public), while evidence is done through inspections, surveillance, monitoring, reporting and evaluation. A certain threshold can be achieved through a combination of all of the above that will be the gateway to Stage 3. All the achievements must be monitored and evidenced in order to move forward to Stage 3. Stage 2 achievements are through: (i) a task force that monitors and evaluates progress in engagement with enterprise and sectoral levels; (ii) evidence of sufficient stakeholder application of a biosecurity plan; and (iii) evidence that the task force is effective and that problems encountered are being addressed.

PMP Stage 3 focusses on zoning, restrictions of movement and reporting of any disease/emerging problems through constant surveillance in place. Once the management system is found to be capable of sustaining aquaculture health by defending and maintaining specific disease freedom, it can move forward to Stage 4. Stage 3 is aimed at national safeguarding and sustaining progress. The management capacity should be sufficient to safeguard the level of investments by private and public entities. Disease and risks should be managed by a combination of public efforts, policies, legislation and producer interest and engagement. At this stage, specific diseases should be under control within the country, with sufficient attention taken against any posed threats. The maturity of the system for monitoring aquaculture health, specific diseases, evidence of stakeholders' support and their participation in achieving this progress are required to move on to Stage 4. The system is expected to be an integral part of a National Policy and Plan for Aquaculture, and addressing the system, roles and responsibilities required to safeguard health of the sector, consumers and the environment. Stage 3 achievements include a national, multi-agency task force with capacity for effective regulation of biosecurity change with producers, i.e. evidence of performance indicators for a functional national system which addresses risks, increases systematic surveillance, and provides evidence of health status – pathogen freedom.

PMP Stage 4, the end stage, should achieve a sustainable and resilient national aquaculture system acquired through the capacity to maintain confidence, a biosecurity system, emergency preparedness and preventive measures. All such activities must be coordinated and maintained, to avoid a "downgrading" of the PMP status. Stage 4 is achieved through national long-term commitment to maintenance of the system for aquaculture and ecosystem through evidence of national policy supported in law with legal and financial commitments, an evidence base that supports confidence in national aquaculture and ecosystem health, and in the capacity to prevent and respond to any threat at the national level.

Dr Sumption concluded his presentation by emphasizing the benefits of the PMP. At the national level, it addresses the lack of clear national plans through a focus on national strategy development processes (mid- to long-term), promoting a co-management approach, bringing stakeholders together with a variety of benefits, and building the basis for national, public and private co-management of biosecurity.

4.2 Session 3: Plenary discussion highlights

The PMP approach to enhancing biosecurity for aquaculture was well received. Questions centered on whether or not the PMP approach should be disease-specific or generic. The presentation was deliberately generic, although based on disease-specific terrestrial examples. It was suggested that some well-known diseases be used for testing the PMP approach in a sector-specific aquaculture setting (i.e. for shrimp or salmon). However, it was also recognized that a generic approach would also be very useful for regions with diverse production systems and limited disease knowledge or management experience.

There was discussion about differentiating the PMP from established standards and protocols, developed principally for preventing disease spread via aquatic animal and product trade, The PMP is not designed to be a trade standard, but rather a mechanism to work towards international trade standards, where appropriate. Some countries and regions trade locally, so may not need to meet international standards in order to protect their industries from opportunistic or local disease risks.

The need for national or regional support for the PMP approach was clearly recognized, since the approach hinges on industry, government and non-governmental organization (NGO) collaboration to develop an implementable programme. This pivotal foundation was acknowledged as needing a significant investment of time (several years) for many countries and regions before any PMP can be effectively delivered. National support is especially important where basic disease expertise and laboratory or research facilities are limited.

Despite concerns about the logistics for PMP implementation, there was consensus across all participants that the approach has the potential to improve aquaculture biosecurity significantly, especially for countries that fall within Level I or II stages of biosecurity development.

4.3 Session 3: Working group discussions

The participants were divided into three Working Groups and tasked with considering the following questions related to the PMP framework and approach:

- Do the four stages adequately represent the range in national management of aquatic biosecurity?
- What positives do you see about the system described?
- What concerns do you have that need to be clarified or addressed?
- What difficulties do you foresee to adopt the approach at the national level? Is it likely some countries might adopt the approach on a voluntary basis without significant support?

Key responses and comments from the three Working Groups are summarized below:

- *Do the four stages adequately represent the range in national management of aquatic biosecurity?*

All working groups agreed that the four stages proposed adequately represent the range of progression from zero to internationally stringent aquaculture biosecurity measures. It was noted that there may be a need to refine some definitions within each stage, as presented in the draft document, as well as "achievement measures", but as a start for a PMP, the four stages were considered to be robust for application to aquaculture in its broadest context. New stages may become apparent after field trials (pilots). All groups stressed the need to define clearly the objective of the PMP/AB tool before initiating these trials. Discussion from all was supportive of an objective that:

- is applied on a voluntary basis by countries, regions and industry sectors;
- is not a measure for compliance with regulatory or policy-based standards (national or international); and which
- aims to engage all stakeholders, not just aquaculture producers (e.g. feed, equipment and pharmaceutical manufacturers; shared water users; and conservationists).

It was noted that action and support by government is needed to ensure effective PMP implementation in countries that wish to try it. It was also noted that it is important to underscore the fact that the PMP approach will not prevent the emergence of new diseases once implemented. It will solely reduce susceptibility to manageable risks. Thus, any expectation that the PMP will be a disease management "fix-all" needs to be addressed at the start for those agreeing to adopt the process.

Despite the need for government support, industry players should help smaller players and be involved to ensure buy-in. If the right mix isn't there, biosecurity progress will fail, as evidenced by a lack of significant progress in many countries over the last 15–18 years. It is essential to avoid too much bureaucracy and to make biosecurity measures realistic for industry development needs.

- *What positives do you see about the system described?*

The PMP offers a flexible approach that differs from prescriptive policy or regulatory measures. The principles are good, offering progressive and collaborative input, and include flexible measures that allow countries to define their own risks and risk tolerance before engaging in the biosecurity progressive pathway process.

- *What concerns do you have that need to be clarified or addressed?*

Some concerns focused on the definition of biosecurity in the context of PMP. What hazards will be addressed? How do we include small stakeholders? How do we engage government-private sector? Another concern was the importance of communication and coordination among a wide array of stakeholders. It was also flagged that indicators for shifts between stages along the PMP pathway need to be clearly established and agreed upon by key stakeholders. Last, but not least, the importance of distinguishing the PMP from existing standards (national good management practices (GMPs), codes etc.) was flagged. What is the added value of the PMP approach, especially as related to government expectations for trade?

- *What difficulties do you foresee to adopt the approach at a national level? Is it likely some countries might adopt the approach on a voluntary basis without significant support?*

Is the PMP approach specific for a disease or more generic? The PCP-FMD model on which the draft PMP/AB is based is disease-specific; however, a totally generic aquaculture model may be too complex. Is a disease-focus needed, e.g. for TiLV? This may help with other diseases or risk disengaging unaffected sectors and countries.

Another difficulty identified was the incentive for all stakeholders to work together on the project. How can we harness industry collaboration (small and large) when it has experience of either leading policy and procedure development, or circumventing standards that impact economic returns with no evident cost-benefit?

It is highly unlikely that countries that need to build biosecurity infrastructure and expertise will be able to engage and maintain a national level of interest without strong incentives. This includes private-sector appreciation of risks posed by not having a PMP for aquaculture, which will vary based on sector, geographic region etc.).

5. SESSION 4: PRIVATE-SECTOR PERSPECTIVES ON BIOSECURITY

Session 4 included four presentations detailing private-sector perspectives on biosecurity.

- **Associação Brasiliera dos Criadores de Camarão (ABCC), Brazil (**Dr Itamar Rocha, President)

Aquaculture development in Brazil is not encouraging. Disease is challenge along with competition with the Chinese export industry, especially for shrimp. This is the same for other South American countries. Quality assurance/quality control (QA/QC) producing farmers are challenged by small to medium production that does not invest in biosecurity (75 percent), so Brazil needs help and training to address best management practices (BMPs) for disease prevention and control.

Political impacts have also been a challenge, notably in trying to avoid antibiotics and improve husbandry production standards. WSSV and IMNV are still problems. Local markets will buy 5–6 gm emergency harvest product vs export quality product.

Simple controls are being taught to farmers in an effort to implement basic controls. Crab fences and bird predation controls are being introduced as step-one biosecurity. SPF stock may follow later. Probiotics are a commonly used strategy, along with weekly analysis of feed using wet mounts to assess biotic contamination. BMP training and accreditation processes are underway using institutional funding in an effort to move away from "Acts of God". Bird covers have significantly increased shrimp productivity and reduced disease introduction.

- **Merck/USA** (Dr Tim Kniffen, Technical Services Manager, Merck Animal Health, USA/Canada)

Coming from a swine background, Dr Kniffen is a technical services DVM for a United States of America/Canada-based industry specializing in advice for product use and training for aquatic veterinarians and staff. He is also a resource for research projects, diagnostic needs and aquaculture site reviews.

Dr Kniffen showed the FAO (2007) definition of biosecurity, but indicated that the business definition is broader and based on animal facility introduction and spread within the facility. He noted that biosecurity is essential but often perceived as:

- being difficult or complex,
- being costly in terms of time and money,
- needing specific education and training,
- being subject to evaluation and audit,
- needing maintaining (under healthy production situations),
- being subject to ongoing revision,
- being subject to human behaviour and habits,
- needing to be consistent throughout application, and
- needing to avoid unnecessary problems for producers, clients and customers.

The main challenges faced by the private sector are that:

- relevant data are hard to find/generate;
- new emerging diseases (PCR QA/QC) constantly test the system;
- biosecurity is both a science and an art;
- clear written guidelines are needed that are easily understood, implementable and practical;
- farm-dependent flexibility and details are needed; and
- farm management support is needed.

Dr Kniffen then discussed experiences gained from the mid-1980s swine industry "Mystery Swine Disease Syndrome". It was not until the 1990s that porcine reproductive & respiratory syndrome virus (PRRSV) was identified and effective controls could be brought in to place, e.g. shower-in/out, disinfection rooms, mortality handling on site, replacing gilts using known health status sources, and addressing airborne infection using air filtration systems. Costs due to PRRS were reduced from $250/sow every 10–12 months, to zero over that last 54 months after air treatment.

In comparing with aquaculture, there are varying biosecurity plans, with one example being that for salmon in Canada. This has led as a corporate priority throughout vertical integration that includes fallowing, stocking by year-classes, siting controls, smolt selection, transport controls, effluent treatment, broodstock screening, net/equipment cleaning, mortality handling and regular visits by veterinarians and contractors. Problems viewed from an industry perspective are: water quality, fish sources, shared equipment, birds, all-in/all-out capability, access to diagnostic laboratories, trust of regulators, economic justification for imposed biosecurity measures, data access, effective new/emergent pathogen response teams and access to rapid diagnostic techniques.

In closing, the Merck experience in products and programmes are Dairy Care 365 and AquaCare. These have been built on consensus building and training, providing a conduit between industry and regulators.

- **National Aquaculture Group, Kingdom of Saudi Arabia (**Dr Victoria Alday, Director of Biosecurity, National Aquaculture Group, Kingdom of Saudi Arabia)

Between 2010 and 2013, white spot syndrome virus (WSSV) was introduced to the Kingdom of Saudi Arabia and spread vertically through broodstock of *Penaeus indicus* (Indian prawn) to larvae and postlarvae. Weather appears to have been a triggering factor, but there was no coordination between farms, and thus no effective disease response by industry or national authorities.

A public-private partnership (PPP) to address the crisis was established between the Ministry of Environment, Water and Agriculture (MEWA) and the Saudi Aquaculture Society (SAS) to develop a national biosecurity strategy. This encompassed establishment of National Reference Laboratories, a list of reportable pathogens, a surveillance programme, certification to enable secure animal transfers, zoning and compartmentalization, emergency response contingency plans, pre-approved suppliers, quarantine testing of imports, a prohibition on use of wild broodstock, and restrictions on aquatic by-products and wastes under the World Trade Organization's (WTO) Sanitary and Phytosanitary (SPS) Agreement. Annual meetings were also established to review surveillance programme results.

Biosecurity at the company level was established by the National Aquaculture Group (NAQUA) and *P. indicus*, a WSSV susceptible species, was replaced by *P. vannamei* (whiteleg shrimp) from South and Central America. All stages of production are managed through vertically integrated aquaculture companies using SPF broodstock to enhance supporting biosecurity systems to manage crabs and other potential carriers. Surveillance is focused on all diseases and syndromes (using productivity parameters) and laboratories are equipped for PCR screening and 24/7 emergency response plans.

It took three years (from 2014 to 2017) to recover from WSSV using *P. vannamei.* Water, feed, algae and larval shrimp in ponds now undergo strict hygiene and zero use of antibiotics. This incudes increased water exchange to manage water quality. Fish production (which is easier than shrimp production) e.g. tilapia and sea bream, has more diagnostic tools available (enzyme-linked immunosorbent assay (ELISA), diagnostics, etc.), as well as vaccines and antibiotics, but SPF development is also being used for diseases of concern. The bottom-line is that improved biosecurity has clearly lead to reduced economic impacts. This is important to industry, which is all about production costs – now $0.10/kg of fish production.

Biosecurity needs government support, not police! This is a joint effort, but led by industry. SPF animals are essential for farming, with biosecurity throughout the production chain.

Challenges include:
- lack of biosecurity at the national level (import controls?) from a farmer perspective;
- lack of industry leadership;
- shortage of SPF stocks, hence a drive to use wild stock;
- contaminated feed; and
- a shortage of real-time diagnostics.

The Kingdom of Saudi Arabia is interested in expanding its biosecurity experience to a regional level to enhance regional capacity using their established PMP/AB framework.

- **ShrimpVet, Viet Nam** (Dr Loc Tran, Director, SHRIMPVET Laboratory, Viet Nam)

A bottom-up approach was difficult for the fragmented and massive small-production aquaculture industry in Viet Nam. As a result, it was decided to build a demonstration farm to show the value of changing to farm practices that take biosecurity into serious account. This also addressed the fact that many farmers have minimal education, such that documents may be hard for them to read. With no government support, ShrimpVet is the first private laboratory established in Viet Nam and has independent company ownership.

ShrimpVet has now expanded to include a diagnostic laboratory, a demonstration farm and two hatcheries employing 80 people in 2018.

Viet Nam produced 600 000 tonnes, with losses due to early mortality syndrome (EMS) of $ US 1 billion per year. This resulted in lots of collaboration from the private sector but also lots of antibiotic use, a lack of traceability and the ability to certify food safety and disease freedom, and a lack of vertical integration, which led to significant technical and trade barriers. Short-cuts, despite easy-access manuals, led to high risk/low efficiency practices and higher production costs ($US 1.5/kg as compared to $0.5/kg elsewhere).

ShrimpVet started a diagnostic laboratory for technical support from scratch. Because disease was being detected everywhere and there was no access to disease-free postlarvae, a second laboratory was established and then the demonstration farm and hatcheries (including algal food production). ShrimpVet used "The Good, the Bad and the Ugly" movie training analogy: good = probiotic, bad = commensals and ugly = EMS/AHPND.

The ShrimpVet diagnostic laboratory is now internationally certified and serves 40 countries and more than 6 000 clients. Broodstock are screened upon entry into Viet Nam, as is feed (*Artemia*) for EMS *Vibrio* freedom. ShrimpVet screens and freezes feed to produce free-nauplii. This has contributed to postlarvae that are free of antibiotics, although airborne contamination remains a risk. ShrimpVet is currently working on a High Tech Park in Ho Chi Minh City, a seven year project.

The Vietnamese Government is overwhelmed with fire-fighting problems; hence, the bottom-up approach is necessary and is working. A demonstration and hands-on training approach is essential to prove that science theory will work in the field. Partnership programmes include work with Skretting (Stravangar, Norway) for Internet technology-based communications designed to reach out to farmers, transparent sharing of information, and commitment to valid certification of freedom from disease and antibiotics.

5.1 Session 4: Plenary discussion highlights

The industry presentations, similar to the country presentations, demonstrated a diverse array of experience, investment and disease control management strategies. As with the countries, many industry sectors that have established and/or supported disease control programmes have done so based on experience with significant outbreak losses, impacting both direct and international market access.

Increased investment in biosecurity by industry has to have an economic benefit in order to be sustainable, for example, a higher market value or wider market access. This fundamentally needs consumer valuation in the context of both environmental sustainability and food safety and quality. Consumers have to understand the value-added benefits of biosecurity (disease prevention) in reducing investment in chemotherapeutants. The pharmaceutical industry has already responded to the need to move away from the prophylactic use of antibiotics (which has decreased to almost zero in some production sectors, while others continue to use those available "off-the-shelf") towards vaccines and immuno-stimulation. The farming industry is complementing this with genetic selection for SPF, SPR or specific pathogen tolerant (SPT) broodstock. It was noted, however, that anti-aquaculture interests persist with messaging from the early decades of aquaculture, and that this still resonates with many consumers. Because of this, and because government has been ineffective in addressing environmental nongovernmental organization (ENGO) and consumer concerns, the industry has a hard time messaging its progress made towards sustainable aquaculture development with due credibility. This means that industry needs to resort to third-party certifying bodies, such as the Marine Stewardship Council (MSC), which is costly and carries little weight for market access in the World Trade Organization (WTO) context. Some governments have assisted with MSC certification for aquaculture, but others have concentrated mainly on capture fishery certification.

With respect to production scale, it was noted that small and subsistence-level production is generally due to economic necessity as opposed to an investment choice. The former have little to no leeway for adding new costs to their operations and need stable assistance to help progress towards medium-scale production. The challenge, however, is that any economic gain is usually put towards getting out of subsistence farming instead of reinvesting in the business. Again, the economic benefit of staying with the farm has to be clear and show a stable future. As with previous plenary points, the fundamental investment has to be in establishing trust and opening communications on the risks and benefits resulting from enhanced aquaculture biosecurity. Achieving efficacy and benefits requires involvement by all stages of the production chain, including wild fishery neighbours, ENGOs and consumers. Without this involvement, misinformation becomes an additional, non-disease risk to industry success.

Finally, trust works both ways, and it was noted that some farmers could undermine sectoral success by taking short-cuts. Although they often have a traditional mistrust of government, industry associations and organizations have a role to play in ensuring that their members or neighbours understand the risk to all of individual breaches in biosecurity measures. Disease reoccurrence due to such breaches impacts production as well as market access, and farm insurance and/or government compensation programmes, where they exist.

6. DAY 2 WORKING GROUPS AND DAY 3 DISCUSSIONS

During Day 2, the participants were divided into two working groups as summarized below and each group given two tasks:

Working Group 1

- Task 1: Ownership and stakeholder engagement
- Task 2: Global Plan of Action

Members: Dan Baliao, Semoli Belemane, Edgar Brun, Miyoung Cho, Baboucarr Jaw, Tim Kniffen, Eduardo Leaño, Hans Peter Melby, Eoin Mac Aoidh, Belinda Richardson, Itamar

Rocha, Loc Tran, Jose Villalon, Franck Berthe, Larry Hanson, Mark Lawrence and Melba Reantaso

Working Group 2

- Task 1: Stage progression system: achievements, outcomes, benefits, and evidence
- Task 2: Global Plan of Action

Members: Victoria Alday, Randall Brummett, Vishnumurthy Mohan Chadag, Kevin Christison, Leobert de la Peña, Alicia Gallardo Lagno, Ahmed El-Sawalhy, Shivaun Leonard, Gillian Mylrea, Patrick Sorgeloos, Grant Stentiford, Yngve Torgersen, Janet Whaley, Rohana Subasinghe, Keith Sumption, Sharon Mcgladdery and Elena Irde

6.1 Ownership and stakeholder engagement

The questions and issues considered by Working Group 1 under this task included:

1. *Is the principle of co-regulation (stakeholder engagement from the bottom-up) supported?*
2. *Is the balance between public and private roles and responsibilities well-captured in Table 1 (risk ownership)?*
3. *Initiating and maintaining engagement: What is advised in Stages 1, 2 and 3?*
4. *Supporting PMP introduction: What are the priorities for management training and capacity development?*

The key responses and comments provided by Working Group 1 are summarized below:

1. *Is the principle of co-regulation (stakeholder engagement from the bottom-up) supported?*

- The language/terms need some work, but generally a resounding yes. Buy-in from public and private sectors is necessary for sustainability.
- Government should coordinate or initiate the process. Expectations for all stakeholders need to be well defined, but if there is buy-in and ownership all around then enforcement will be less of an issue.
- Some examples of successful participatory processes could be cited and conclusions drawn from those learnings. Guidelines could be established on how this participatory process is done.

2. *Is the balance between public and private roles and responsibilities well-captured in Table 1 (risk ownership)?*

- Split jury: 1) The private sector engagement beyond Stage 1 is not well-captured in the table vs 2) The table clearly implies that the private sector is part of the task force and involved throughout the Stages.
- Roles and responsibilities need to be clearly defined (but not necessarily a priori, they can be “to be determined” until the time that the task force is established. This

is a tool, so does not need to be too standardized or prescriptive, i.e. the principles are there, but it will be operationalized differently by each country.

- It is suggested to add a column to the table for involved stakeholders/responsible sectors. Should draw from livestock examples to not reinvent the wheel.

3. *Initiating and maintaining engagement: What is advised in Stages 1,2 and 3?*

Stage	**How and who should initiate establishing the AB task force(s)?**	**What is advised for establishing and maintaining the task force and stakeholder engagement?**
1	Government should convene (some governments will need to be more top-down depending on the state of industry, infrastructure etc.). Industry could bring specific actions (e.g. pathogens) to the process.	• Buy-in from all stakeholders • Political and financial will • Articulate a work plan/action plan
2	Government	Rely on buy-in established early on, but make sure there are formal mechanisms for discussion and engagement that map to the action plan.
3	Government (with the objectives and timeline in mind) should steward through the "gateway passes" and process to move between stages.	Public and private involvement at each stage will depend on requirements for "gateway passes"

4. *Supporting PMP introduction: What are the priorities for management training and capacity development?*

- Pre-stage 1 is establishing mechanisms to introduce PMP to member countries.

Stage	**Priorities**	**What forms of assistance are advised?**	**Who or what (categories) should be the focus for training?**
1	Comprehensive description of the sector; risk assessment and prioritization of risks; identification of capacity and technical gaps	Technical, process	Training task force. If possible, embed task force in existing national-level structures (e.g. ministries of fisheries and aquaculture)
2	Implementation; develop biosecurity plan (indicators, data	Personnel; e-learning platforms (more general or disease-specific)	Task force, public and private sectors

	collection etc.)		
3	Monitoring and evaluation		Everyone along the value chain (producers, extension etc.)

6.2 Stage progression system: achievements, outcomes, benefits and evidence

The points, questions and issues considered by Working Group 2 under this subsection included:

Assessment modalities:

1. *When is self-assessment of Stage sufficient?*
2. *When would joint assessment (country and external review) or an external assessment be valuable/advisable?*
3. *FAST Track options. The PMP is foreseen as a voluntary system, and countries may opt to use the PMP for national progress and to assist in gaining international support. What does the group feel about accepting "fast track progress" if a country considers it meets the criteria for entry into Stages 3 or 4?*
4. *Should such countries be required to demonstrate that they fulfill the evidence for the lower stages? Who should evaluate their position?*
5. *Supporting the introduction of the PMP system. What tools or support are needed to support national task forces to apply the PMP, assess progress or give science support?*

The key responses and comments for this subsection are summarized below:

- Discussions:

    - Before Working Group 2 could look at stage progression, there was lots of discussion on "ownership", generic vs species approaches and the role of individual farmers vs government authority.
    - There is a need to assess what guidelines, manuals, etc. are out there that can be used by a country to determine where it sits on the stage progression ladder.
    - Countries can then decide (a) if they wish to participate and if yes, (b) where they sit with respect to biosecurity development stage.
    - For generic vs specific disease application, it was suggested that the basic approach be generic, so that countries decide whether to take a general approach (assumed for countries with little/no programme or infrastructure), a sectoral approach (shrimp, finfish, molluscs), or a disease-specific approach that would be of use for a sector or to apply to development of a more generic PMP.

Stage	**Review of Draft Working Doc Table 2 Measuring achievement**	**Responsibility for monitoring progress**

1	*Adoption of a national strategic AB plan:* Buy-in by countries wanting to try the system and initiating resource searches, internal AB assessment to identify strengths and gaps, and risk-based identification of priorities for AB planning; e.g. through pilot projects for specific diseases of concern	Country aquatic animal health authority
2	*Implementation of AB plan at enterprise/sector level:* Evidence of AB plans including a standardized programme for staff education/ training, diagnostic services with some form of national accreditation, health surveillance (general and/or targeted) for farm animals, AB controls on stock intake and transfer (basic), and record-keeping	Country aquatic animal health authority
3	*Implementation of a national AB system at enterprise level and supported by national authorities* (may be regional, with Stage 4 national?): Some form of national/regional certification/accreditation for AB compliance with progression from basic to advanced (levels set by industry/government PMP plans)	Country aquatic animal health authority. NOTE: If used to support exports, importer may wish to audit AB system.

When is self-assessment of stage sufficient?

- We think this is possible, depending of the level.
- When biosecurity plans are for in-country reduction of disease losses and improvement of aquaculture sustainability (i.e. no export trade need or import controls).
- Needs to be coordinated with the competent authority, especially if the objective is for trade (application of SPS procedure).

When would joint assessment (country and external review) or an external assessment be valuable/advisable?

- For a region-wide application to a sector, or due to shared risk from a specific disease, where consistent or comparable measures are necessary to be effective (to everyone's' benefit).

Fast track options?

- Advance by sector depending on country interest.
- We think this could be flexible.

- This was seen as moot, since this is not a standard-setting objective, rather it is a guideline for countries to assess where they are and what help they may or may not need to make positive progress to address their disease risk priorities.

What tools or support are needed to support national task forces to apply the PMP, assess progress or give science support?

- A strong generic cost-benefit case, especially for countries with little or a fragmented system for biosecurity. This is needed to secure national buy-in and ensure collaboration as guidelines vs another standard-setting for compliance (i.e. not a police initiative, More like Block Parent?(link task 2 –Global Plan of Action)

6.3 Proposed global plan of action

The points, questions and issues considered by the Working Groups under this task included to:

1. *Develop a vision statement for a Global Plan of Action (GPA).*
2. *Discuss and develop a timescale, scope, and priorities for the GPA (i.e. provide a 10 to 20 year framework).*
3. *Discuss and develop recommendations for coordination of governance oversight and technical and scientific support.*
4. *Discuss and develop recommendations for mobilization of funding and engagement of donors for supporting the GPA and the PMP application at national levels.*
5. *Develop indicative timelines for the GPA.*

Considering countries have a wide difference in resources for AB, estimate the range in time (years) it may take for stage progression.

Working Group 1

- Ideas for a Vision Statement
    - Aquatic biosecurity for social and economic development
    - Control of economically important diseases by 2030
    - Aquaculture for sustainable rural livelihoods
    - Increase production by decreasing the risk of disease through risk-based, progressive, collaborative processes
    - Prevent new diseases spreading and control the impact of the global spread of disease over the next 30 years
    - Achieve biosecurity for aquaculture growth and increased production
    - Establish biosecurity plans in all countries

- Mission statement: Increase global fish health and production by increasing biosecurity and decreasing global spread of new and emerging diseases

- Timeline, scope and priorities

- There was some discussion around what is the Global Plan of Action and is it necessary. We need to clarify the global dimension; for example, if there is no global plan to eradicate a disease then do we need a GPA?
- Is the GPA a roadmap for the adoption process, or specific guidelines for countries as they adopt PMP?
- A targeted, purposeful, collective approach (a multipartnership coalition) would be an improvement over more opportunistic and variable approaches to disease control.

- Proposed scope
  - Educate governments on PMP.
  - Create the architecture/alliance that plugs into various existing animal health pieces (FAO, OIE etc.) and puts them all together for countries. Consider packaging in the problem statement PMP is solving for: there is frequent new disease emergence, with a long lag between emergence and control, and current methods have been ad hoc and not effective. There is the need for a coordinated national, regional and global approach. PMP could be potentially useful for increasing production, opening trade, clarifying set of regulations and expectations for industry etc.
  - Implement in a few countries (perhaps those already working with FAO on national strategies).
  - Collect learnings, reconvene experts, modify framework.
  - General rollout.

- Governance
  - Administrative structure is needed. FAO has developed the evaluation framework, so is recommended as the lead organization (joint FAO/OIE?).
  - A driving "group" or coalition under the umbrella of FAO/OIE would provide guidance and leadership.
  - Technical and scientific support as needed by FAO, OIE, academe etc.

- Mobilization of funding and donor engagement
  - Building the case for PMP (getting clear on the vision, metrics, cost-benefit analysis and wider economic argument of the impact on food production and livelihoods) would serve multiple purposes, garnering donor support among them.
  - Government engagement and contributing financial support helps with donor support.
  - Administrative structure for the PMP and defining of vision, goals and indicators is needed.

7. PRESENTATION ON CONCLUSIONS AND THE WAY FORWARD (DR ROHANA P. SUBASINGHE)

Dr Subasinghe began his presentation by listing the three objectives and expected outcomes of the PMP/AB Consultation (see Sections 1.2 and 1.5). He noted that the participants had successfully: (i) taken stock of the current aquatic animal health and biosecurity situation in aquaculture, and in doing so, had achieved a better understanding of the bottlenecks and root causes of aquatic disease emergence in the sector; and that (ii) the Progressive Management Pathway for Improving Aquatic Biosecurity (PMP/AB) had been successfully introduced as a new concept to address aquatic disease problems, with the participants achieving a better understanding on PMP/AB and how this tool might be used to address aquaculture biosecurity and aquatic animal health. He noted that the third objective, (iii) to build consensus on the PMP approach with the aim of developing a Global Plan of Action had been partially achieved, with some follow-up work being needed towards its completion.

Dr Subasinghe observed that:

- There was a general consensus and broad acceptance among the participants as to the usefulness of the PMP/AB approach, and that the approach will provide guidance towards moving countries forward.
- The PMP/AB approach should be applied to improve biosecurity for all forms of aquaculture production, regardless of the scope or objectives, whether small or large scale or of local or international scope.
- PMP implementation plans should be developed between industry stakeholders and government authorities to ensure a buy-in, best-fit for each country; however, a template that provides a degree of consistency between participating countries or regions will be needed.
- The stages of the PMP/AB can be considered "as being similar to an elevator", where you get on at your floor (which could be the basement!), and you stop at the floor that meets the needs of your aquaculture industry; however, everyone is in the same biosecure building, which will help with global communication and the sharing of experiences as everyone's aquatic biosecurity progresses.
- PMP will help countries determine their stage of biosecurity, access resources that can help them, and provide the confidence for a self-assessment that can lead to improved biosecurity and towards a system that could be subjected to outside assessment (e.g. PVS) for the further improvement of their veterinary services or aquatic animal health competent authorities, and from there, if necessary, become prepared for a 3rd party audit by a trading partner.
- There is a strong complementarity, with some countries establishing plans and aligning with progress towards international standards.
- The PMP/AB opens an essential opportunity to engage non-aquaculture stakeholders in aquaculture growth, i.e. fisheries, environmentalists and conservationists. Biosecurity progress at all levels is a good news story, and disease prevention is an strength that benefits the aquaculture sector itself, wild resources and the environment.
- However, further technical work is needed to adapt the PMP framework to aquaculture. The evidence base is inadequate, a business case must be made, knowledge of the socio-economic impacts of aquatic animal diseases must be improved, and the WB, FAO and other interested partners must explore further opportunities.

He then went on to outline some of the work that will need to be done to develop further and implement the PMP/AB approach. This includes:

- Developing the technical aspect of the PMP/AB, including:
  - a vision, goals and objectives;
  - a sectoral approach;
  - indicators;
  - assessment criteria and procedures;
  - linkages with OIE; and
  - a second joint consultative workshop.
- Building a wider consensus and promotion and advocacy, including:
  - presentation to FAO COFI 10th Session for endorsement in August 2019;
  - stakeholders to make their respective quarters aware of the PMP initiative;
  - WB to consider incorporating the PMP framework into its portfolio of investments with client countries;
  - presentations to be given by participants from regional and international intergovernmental organizations at relevant government council meetings;
  - development of regional approaches; and
  - pre-stage 1 advocacy.
- Initial application, including:
  - the WB and other development partners to try applying the concept in their relevant projects and programmes.
- Resource mobilization, including:
  - based on the COFI-SCA recommendation, create a global strategy for assisting developing countries to implement the PMP/AB; and
  - WB to continue exploring the possibility of establishing a global financial architecture to support the initiative and partnership.

Dr Subasinghe then outlined the next steps as: preparation of the workshop report (this document), capturing all the discussion points; revision of the PMP/AB framework; convening of a second PMP/AB Consultation, initial application; and FAO, WB and MSU to keep the participants informed of developments on a regular basis.

He then suggested the following timeframe for action (dates in parentheses reflect actual implementation dates):

- Completion of draft final workshop report – July 2018 (January 2019)
- Revised final report – March 2019 (June 2019)
- Second consultation – October 2018 (January 2019)
- COFI-AQ working document – May 2019
- Initiate applications – as convenient
- Resource mobilization – as soon as possible

7.1 Section 7: Plenary discussion highlights

In general, it was felt that Dr Subasinghe's presentation provided a good summary, and that the list of proposed actions is something that can be agreed upon.

Several countries (e.g. Chile, Kingdom of Saudi Arabia, Norway, United Kingdom. United States of America) will take home the message and stated an interest to participate in work towards the further development of the PMP/AB.

Everyone expressed an appetite to get involved with interim work and contributions, to help with questions and uncertainties and to reconnect via occasional remote engagement.

Other discussion points included:

- There is need for an interim or real-world scenario that can be used in further developing PMP/AB as well as dealing with risk communication and with state/stakeholder bans and combating misinformation.

- The European Union noted that it has well-established aquatic biosecurity expertise through its Member State network and would like to help support this initiative. The European Union imports 65 percent, with limited capacity for import controls; thus prevention through knowledge sharing and partnership instead of "policing" is considered to be the best approach.

- The WB stressed the need for a business case/marketing strategy, notably dealing with numbers of jobs, food volume and value, environmental measures etc., to underpin any case for WB funding. The WB recognizes the importance of fish protein for global food security but needs support from its member countries in order to invest in programmes and their objectives. The GloFish architecture and expanding to Blue Economy, including aquaculture should be explored. This will need FAO and WB collaboration to be achieved effectively, especially to inform Ministers of Finance who represent their nations' interests at the WB.

- The OIE appreciated the collaborative messaging from the meeting participants, the link between aquatic and terrestrial food-production sectors, and the eclectic mix of invitees. It also expressed interest in hosting the next meeting pending approval.

- The African Union Inter-African Bureau for Animal Resources (AU-IBAR) is fully committed to be involved at the African continental level using regional networks and aquatic health experts and noted the need for evidence-based advocacy for biosecurity and aquaculture.

- The Network of Aquaculture Centers in Asia-Pacific (NACA) stressed that for Asia-Pacific, aquatic animal health, biosecurity and prevention of spread of important and emerging diseases (for tilapia and shrimp) are priorities. It noted that PMP is good but needs further refinement and that major producers are already implementing parts of the PMP "automatically" for business protection purposes. It emphasized the need to make use of existing standards so that implementation will be easier and not confusing.

- The SEAFDEC-AQD encourages the rapid development of this PMP/AB guidance because of the disease challenges currently being faced. SEAFDEC/AQD welcomes working with all relevant stakeholders.

- It was noted that the next meeting of the World Aquaculture Society (WAS) will be held in Montpellier, France in September 2018 and that this provides an excellent opportunity to present the PMP approach to a wide array of international aquaculture interests.

8. CONCLUSIONS

The PMP/AB Consultation recognized the significant progress made by some countries and international standard-setting organizations, due mainly to experience with serious disease challenges to national or international aquaculture industries. However, other countries and regions continue to struggle with recurrent losses, exposure to high-risk stock and feed supplies (i.e. uncertified as SPF), or restrictions to market access due to lack of biosecurity programmes that meet trade standards. Generally, the largest aquaculture-producing countries in Asia are those that fit the latter category, while much of the Americas and Europe have implemented biosecurity measures based principally on import controls, export certification, and surveillance-based zonation/compartmentalization mapping disease presence/absence to support import/export requirements.

The variability of biosecurity programmes across aquaculture-dependent countries means that any measures taken can be subject to risk from unmanaged sectors within the production framework, or within shared production waters (coastal and freshwater). Overlaying this is the growing recognition of, and impact from, climate change to the production environment. This requires adaptability for both production systems and their health management.

The ongoing emergence of new disease challenges, especially in regions with developing or intense local production systems is evidence of ongoing risks associated with aquaculture.

The discussion highlighted policies, guidelines and training processes that are already available; but also recognized the failure of these to prevent the emergence of new diseases that can defy recognition and diagnosis for years, as well as the re-emergence of known diseases. Lack of buy-in for top-down or academic-driven procedures, as well as clear cost-benefits to producers investing in biosecurity measures were seen as the main impediments to effective and proactive disease avoidance. Most resources are deployed after a disease emergency, rather than for investment to prevent its occurrence. Likewise, such investments can be transient – successful disease control meaning a return to the *status quo* before the disease outbreak. This is not unique to aquaculture, as it is also seen in both agriculture and human health management. However, it has serious food production consequences, since global aquaculture is serving to provide the protein and economies needed for a growing human population, especially in developing countries.

Another factor discussed was trade, where the OIE is the standard-setting body for animal health matters under the WTO's Agreement on Sanitary and Phytosanitary Measures (the SPS Agreement). The OIE has a tool for Evaluation of the Performance of Veterinary Services (PVS) that underpins OIE Member Country's agriculture health management and certification for animal/animal product trade. The PVS tool is a voluntary evaluation but has been taken up by many countries to identify weaknesses and strengths that countries can address and build upon to move them towards a position of robust international recognition. A similar tool is available for aquaculture (OIE PVS: Aquatic, 2013). The PMP was seen as a key foundation piece for any country wanting to work towards a PVS evaluation for aquaculture, rather than a duplicative process. This complementarity point was underscored by the fact that many countries currently manage aquaculture under non-veterinary service departments.

The PMP works from the farm level in a progressive pathway of development to whatever goal the industry and/or country needs for appropriate disease risk controls for their aquaculture industry. It may progress to a national or regional level for aquaculture networks, or towards a PVS or trade-partner evaluation for biosecurity measures, i.e. importer investment in proof of disease freedom (surveillance) and health certification for international market access.

Participants saw this as a potentially useful tool for aquaculture that could be developed on several levels:

- It provides opportunity for everyone, regardless of biosecurity infrastructure (zero to advanced) to develop a biosecurity programme that meets their needs.
- There are processes in place that can be built upon (e.g. FAO self-assessment survey on performance and needs on biosecurity and aquatic animal health management, national strategies on aquatic animal health, OIE standards on aquatic animal health, voluntary guidelines, codes of practice).
- It is flexible and voluntary.
- It addresses exotic, enzootic and emerging diseases.
- It respects a need for national and industry investment via input and buy-in for the approach.
- It also includes non-industry stakeholder input, notably environmental and shared water-resource users, who can have a significant impact on economic development, based on biosecurity and sustainability concerns.
- Enhanced disease prevention reduces the need for chemotherapeutants and pesticides (i.e. it is a responsive approach to disease and pest challenges) and encourages research on prophylactic measures (i.e. preventative measures, such as vaccines and SPF stocks).

9. THE WAY FORWARD

The next steps required to move the development and implementation of the PMP/AB forward are (current target dates are given in parentheses):

- Finalization of this report and supporting documentation for presentation to participants to share with industry associations and government authorities for information prior to tabling to the COFI Sub-Committee on Aquaculture.
- Explore possibility of presentation of PMP/AB to FAO COFI Sub-Committee on Aquaculture 10th Session for endorsement scheduled in August 2019
- Explore possibility of raising awareness on PMP/AB during the next OIE General Assembly
- Development of a self-assessment tool for countries to assess where they are on the biosecurity development pathway. This is voluntary and has no market access applicability.
- Initiation of "prototype" trials with the PMP approach for projects that are already underway with FAO, WB, NORAD, MSU and others, in support of aquaculture development.
- FAO/WB/MSU will look at a potential second workshop in late 2018 (January 2019) to assess progress with a draft business case, a craft country self-assessment checklist/tool, and any results from "prototype" testing in countries that have aquaculture development projects underway with Norway, FAO or other organizations with an interest in volunteering "field-testing" opportunities in 2019.
- FAO to consider making a presentation at the next World Aquaculture Society, AQUA 2018, to be held in Montpellier, France, August 25–29 (already completed).
- The linking of government laboratory expertise to academic expertise (e.g. University of Exeter, Sustainable Aquaculture Program), as with extension services linking academia to industry, would be a "good news" story; as per the PMP approach. A short, 1 500 word piece for the front of *Science* (Policy Forum page) could also be a useful launch pad for this initiative.
- FAO will work with funding agencies for support to engage the expertise needed to build as comprehensive a cost-benefit analysis as possible for the PMP/AB.
- The core coordination team, led by FAO, WB and MSU will keep the workshop participants updated on progress as the above strategy rolls out over the summer and fall of 2019.

10. CLOSING REMARKS

Delegates expressed their deep appreciation to the organizers of the consultation.

Remarks closing the PMP/AB Consultation were given by Dr Xavier Vincent on behalf of the World Bank, Dr Mark Lawrence on behalf of Mississippi State University, and by Dr Vimlendra Sharan on behalf of the FAO.

- Dr Xavier Vincent stated that the World Bank is pleased to see the interest in developing a business case/marketing strategy for the PMP/AB approach, since this provides something tangible for investors, partnerships and networks. As with FAO and OIE, WB will need endorsement from both governments and private-sector stakeholders and interests. The WB can provide a valuable partnership and expertise to develop a strategy easily understandable by national Ministers of Finance.

- Dr Mark Lawrence extended his thanks to FAO and WB and expressed keen interest in helping with any future meetings for this initiative. Also, he noted that the opportunity to brief the United States Congress following this-high profile expertise workshop cannot be underestimated in the context of educating government decision-makers on the importance of the aquaculture industry, on biosecurity management and on why both are crucial to the economy of the United States of America and to international market access.

- In his closing remarks, Vimlendra Sharan, Director of FAOLOW thanked all the participants and partners for this timely endeavour and noted that the uncertainties identified will help further shape the PMP and as with any new tool, guidance documents and resources for advocacy and training will be needed that will facilitate adoption at the national level.

Annex 1. Draft working document

Development of a Progressive Management Pathway to assist national and international improvement of biosecurity in aquaculture production[1]

Summary

The great potential of aquaculture to contribute to food and nutrition security and poverty alleviation has been significantly hampered in many instances by biosecurity and animal disease challenges. During the last three decades, the sector has faced a number of re-emerging and/or newly emerging disease challenges approximately every three to five years. While measures to prevent and reduce the impacts of diseases affecting aquaculture have been launched by affected stakeholders (government, producers, academe), it seems that such efforts have not efficiently addressed the disease problems challenging the sustainability of this fastest growing food producing sector. The required human and infrastructure capacity to address disease challenges did not match the rapid development of the sector. One of the reasons for this mismatch is the great diversity of the aquaculture sector, with more than 500 species farmed in all types of environments (freshwater, brackishwater, marine), systems (pond, cages, recirculating systems, integrated multitrophic aquaculture, polyculture; nursery, grow-out, hatchery, etc.), management strategy (extensive, intensive), and size of the operation (ranging from backyard and subsistence to small-, medium-, and large-scale operations). The stakeholders and enterprises involved in the supply/value chain are also very important, and each segment is a source of risk.

A progressive management pathway (PMP) is proposed as a tool to assist countries to put into place appropriate and sustainable levels of risk management in aquaculture production systems. The PMP for Aquaculture Biosecurity (PMP-AB) is an extension of the “”Progressive Control Pathways”” (PCP) approach which has been internationally adopted to assist countries as systematic frameworks for planning and monitoring risk reduction strategies for control of major livestock and zoonotic diseases. Most PCPs relate to control of single diseases or disease complexes; in contrast, the PMP focuses on building management capacity through a bottom-up approach with strong stakeholder involvement to promote application of risk management at producer level as part of the national approach.

The initial PMP stages focuses on establishment of national co-ordination structures that ensure producers and other stakeholders are engaged in the development of strategies (Stage 1), with the application of the strategy at producer level a key expectation in Stage 2. Sufficient levels of producer application of biosecurity action plans (BAP) should then enable, in Stage 3, the attainment of national levels of reduction of specific diseases to give confidence that an effective national biosecurity system is in place. In this stage the

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[1] This working document was prepared by Keith Sumption (FAO), Melba Reantaso (FAO), Mark Lawrence (MSU), Franck Berthe (WB), and Rohana Subasinghe (ex-FAO) (10 March 2018) intended to be presented during the Stakeholder Consultation on PMP for Improving Aquaculture Biosecurity, 10-12 April 2018, Washington DC, USA

capacity to defend against incursions of a range of diseases should be developed, and in Stage 4 the full range of management competences should be in operation that give national and international confidence to statements of national aquaculture and ecosystem health, and which are able to reducing emergence of new diseases, to prevent, detect and responding to threats. This last stage would enable attaining "”one Health’” principles of health protection of the ecosystem as well as animal health and human health, including food security and through sustainable, resilient livelihoods through aquaculture.

Introduction

This initial draft of a Concept Note on Progressive Management Pathway (PMP) assist national and international improvement of biosecurity in aquaculture production is being developed to serve as a working reference document during the FAO/MSU/WB Stakeholder Consultation on Progressive Management Pathway (PMP) to Improve Aquaculture Biosecurity that will be held at the World Bank Headquarters, Washington, D.C. 10-12 April 2018.

Why develop a Progressive Management Pathway for aquaculture biosecurity?

The FAO State of World Fisheries and Aquaculture[2] reported that fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world. Production from aquaculture in 2014 amounted to 73.8 million tonnes, with an estimated value of US$160.2 billion. World *per capita* fish supply reached a new record high of 20 kg in 2014. There is thus a tremendous potential for oceans and inland waters now, and even more so in the future, to contribute significantly to food security and adequate nutrition for a global population that is expected to reach 9.7 billion by 2050. The OECD/FAO Agricultural Outlook 2016[3] forecasted that aquaculture will overtake capture fisheries in 2021 and may reach 52% of total fish production in 2025. The outlook also identified diseases as one of the major uncertainties that will affect productivity gains.

Transboundary aquatic animal diseases **(**TAADs) are highly contagious/transmissible agents with potential for very rapid spread irrespective of national borders and may cause serious socio-economic and possibly health consequences. Three categories of infectious diseases affecting aquaculture include: (1) exotic diseases that are important to trade (i.e. OIE list of diseases) that are governed by international standards; a set of criteria needs to be met to be included in the list; pathogens/diseases of important traded species (e.g. finfish, crustaceans, molluscs, amphibians); reporting/notification to OIE is recommended during an outbreak; (2) endemic diseases that consistently affect aquaculture production at hatchery, nursery, and grow-out facilities (e.g. bacteria, parasites, fungal, virus); and (3) newly emerging diseases (which includes diseases of known aetiology that are introduced to new geographical areas or new species and unknown aetiology).

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[2] FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp. (http://www.fao.org/3/a-i5778e.pdf)

[3] OECD/FAO. 2016. OECD-FAO Agricultural Outlook 2016-2025, OECD Publishing, Paris. http://dx.doi.org/10.1787/agr_outlook-2016-en

The great potential of aquaculture to contribute to food and nutrition security and poverty alleviation has been hampered by significant biosecurity and animal disease (exotic, endemic and emerging) challenges. During the last three decades, the sector has faced a number of re-emerging and newly emerging diseases approximately every three to five years. Too often, there is a long-time lapse from the time that an emergent disease was observed in the field to the time when the disease was reported, a diagnostic method was developed, an etiologic agent was identified, and finally appropriate disease management or risk management measures were determined and implemented, which can then enable achievement of disease recovery or disease freedom. Thee time lapses have led to significant production losses and loss revenue in aquaculture, in many occasions seriously collapsing the industry at local and national levels. In a largely non-compensatory commodity production system like aquaculture, such production losses are detrimental to the sustainability of the industry and its future. Aquaculture is the fastest-growing food producing sector, and the biosecurity and aquatic animal health management strategies/actions/responses have not kept pace with such rapid development.

Managing the risks driving emergence and impact of aquatic animal diseases

The recent increase in the emergence and spread of aquatic animal diseases in aquaculture systems, along with their significant impacts, call for a new approach to management that will brings together the required range of stakeholders to develop action plans that are applicable and beneficial both in short and longer term timeframes, to address the specific attributes/factors (drivers and pathways) contributing to the risk situation.

Fish is also the most traded of all food commodities, and indiscriminate trading has contributed to the introduction and spread of pathogens along with host movement. While international standards are meant to assist countries in reducing the risks of TAAD introduction and spread, they are in constant change for many reasons including: 1) emergence of unknown diseases; 2) better understanding on dynamics and epidemiology of disease; 3) improved diagnostic and detection methods; 4) emergence of unknown diseases, and 5) changing trade patterns (political, social, industrial and economic environments). Such standards are also more widely applied by developed countries; developing countries generally face difficulties in its implementation (and interpretation).

Some of the main management challenges, from enterprise to international level, relates to the problems associated with:

- intensification of aquaculture, with farms getting bigger and more concentrated;
- increased movement of broodstock, post-larvae, fingerlings, and fry for regional and inter-regional trade
- introduction of new species for aquaculture; species diversity, with each species having different risk profiles
- development and expansion of the ornamental fish trade;

- use of non-native feed stocks and feeding practices such as live, fresh or frozen materials as well as trash fish (representing the silent sleeper of aquaculture-related invasions)
- enhancement of marine and coastal areas through stocking of aquatic animals reared in hatcheries;
- climate change

A number of these can be addressed through management, with opportunities including:

- better understanding and use of specific pathogen free (SPF) stocks, and addressing the lack of SPF stocks for most cultured species;
- increasing the awareness of emerging diseases and engaging stakeholders in mitigating these risks
- greater use of understanding of the immune response of many of the aquaculture species and pathogenesis of many diseases;
- greater use of biosecurity measures based on stakeholders /producers understanding of hazards (pathogens), transmission routes, susceptibility to disinfectants and potential carriers;
- Innovative measures and technologies for reducing biosecurity risks at all levels, especially targeting the small-scale producers

At national level, for progress to be made, management actions may also require to address:

- the need for national surveillance programs that would define and communicate current risks for the industry
- public and private sector co-operation to ensure biosecurity measures and public responses are capable of responding effectively to disease emergencies;
- the need for prudent advice, guidance and policy relating to non-native food stocks
- irresponsible and misuse of veterinary medicines that contributes to the development of antimicrobial resistance (AMR) and concerns on residues;

Internationally, supporting management will also need acceleration in development of effective new tools, particularly to increase the availability of vaccines which are currently limited to a few fish species/diseases, and evidence based practices that provide an alternative to antimicrobials.

PMP for Aquaculture Biosecurity (PMP-AB)

Addressing biosecurity challenges in aquaculture requires a holistic approach that takes into consideration all essential elements (governance, technical, communication, infrastructure, operations, etc.) of an aquaculture biosecurity programme. All of these elements cannot stand-alone, they are interrelated and interconnected. These elements are elaborated in Annex A.

The PMP-AB builds on many decades of research and experience in FAO and its partners, regional and international organisations, national governments, as well as those from producers and academic sectors on the challenges of managing the risks to aquatic animal health. The sheer numbers of cultured species (more than 500 species), stakeholders and enterprises involved in the supply/value chain, the diversity of the aquaculture containment and systems (earthen ponds, tanks, cages; recirculating systems, multitrophic, integrated, polyculture, grow-out hatchery), environments (brackishwater, freshwater, marine), size of farming operation (backyard to subsistence to small-, medium- and large-scale commercial operations) and management (extensive, intensive), the pathogens themselves (single and multi-infection) and the emergence and rapid spread of infections, the multiplicity of pathways for spread, all combine to present an enormous challenge for management, at all levels. These challenges are recognized in the approach proposed, by the focus on establishment of national biosecurity management systems that are built through active engagement of the stakeholders with the relevant national agencies. The implementation is expected to be through both the stakeholders investment and effort, and that of national agencies that safeguard the health of the sector and the production environment.

Biosecurity actions plans (BAPs) implemented at entrepreneur/producer level are seen as significant ways to advance management competence and ownership of risk management responsibility at stakeholder level. Beyond providing immediate benefits to health and productivity, BAPs should open up greater possibility of recognition of biosecurity compartments for promotion of international trade. The national responsibilities, and management capacity required, differs at each stage, and the initial stages of the PMP do not make heavy demands on national agencies. The strategies developed in Stage 1 should identify the roles of public and private partners in development of the "national pathway" its likely time course, and its milestones and indicators.

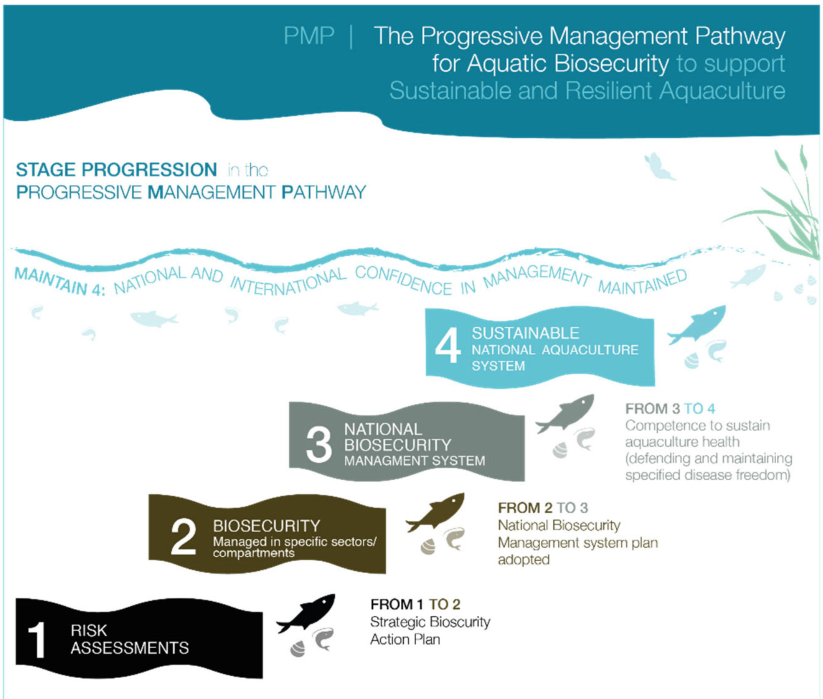
The role of national agencies in safeguarding progress is more critical at later stages when policy and capacity will be important for managing the risks of emerging diseases and international incursions where co-ordination of surveillance and response is critical. At the last stage, it is expected that the challenges of pathogen emergence, protection of ecosystem health, and public safety (including risk of anti-microbial resistance (AMR)), will require an ever evolving management that has public and private stakeholders working in mature and sustainable partnerships with clear commitment to sustaining the system.

The PMP-AB should be useful as a tool to promote and safeguard investment by both public and private stakeholders. The use of indicators and milestones, at producer as well as national level, should assist in development of national plans and in setting measurable and smart indicators for progress. Internationally, the approach allows peer-to-peer comparisons, and management capacity developed in one country may provide powerful advocacy and example to support other countries with a similar starting point. The PMP-AB is not a set of new international standards, but a tool to improve management and its ability to meet principally the needs of national stakeholders. In doing so, the capacity to both generate early warning information and benefit from this system should also rise, with evidence from monitoring and surveillance contributing to the world animal health information system (WAHIS) of the OIE.

Stages in the PMP for Aquaculture Biosecurity

The PMP-AB includes 4 stages (Figure 1).

Figure 1. Description of PMP Stages



A regular step-wise progression is the rule, from Stage N to Stage N+1, but a fast-track system is under consideration, by which countries would be expected to provide the evidence for meeting the critical entry requirements for having fulfilled the lower stages and directly be recognized as being in Stage 3 (for example). To move from one stage to another a set of minimum requirements must be met, and a detailed plan for implementation in the following stage must be prepared. These "gateway passes"" are usually in the form of Specific National Plans, as indicated in Figure 1.

Laying the foundations: Stage 1 of the Pathway
In Stage 1 the focus is upon creating the necessary environment for creating a national strategy that has the confidence and support of the key stakeholders in private as well as public sectors, and which addresses the principal hazards and risks that affect aquaculture

health and production. The priorities of stakeholders will be diverse, and it may take some time to develop the common understanding and commitment needed to move forward with practicable biosecurity plans that can be adopted, with clear benefit, by the principal actors and stakeholders. The focus of attention may be upon aquaculture production and food security, or may be upon specific sectors; each country will differ in this. What should be common is the agreement on the longer term vision, and what needs to change over time to achieve this. Each country will differ in the time it needs to complete its **Strategic Biosecurity Action Plan**, the “Gateway pass” for entry into Stage 2.

Building biosecurity at every level: Stage 2 of the Pathway

The focus of Stage 2 is upon implementation of the national biosecurity plans at the producer (or sector) level for the priorities agreed in the national strategic plan. The co-management of the plan, between public and private stakeholders, is expected to be continued and strengthened by the processes of reviewing evidence on implementation and evaluating improvements to adoption and application. During this stage, if the strategy is to move higher in the PMP, it should develop the allied capacities needed to ensure the progress is safeguarded, which includes the ability to assess internal and external threats to progress, and establish the capacity (which may include additional efforts on biosecurity at ports and borders) to mitigate risks. To move to Stage 3, evidence of sufficient implementation of the BAPs at producer level is expected, together with the commitment, evidenced through an adopted plan, for a “National Biosecurity Management System”.

National safeguarding and sustaining progress: Stage 3

In Stage 3, the management capacity should be sufficient to safeguard the level of investment made by private and public entities and enable confidence that specific agents, diseases, or risks can be managed by the combination of public efforts, policies, legislation, and producer interest and engagement. In this stage, confidence should be built through monitoring and surveillance systems, and by producer support, that specific diseases are under levels of control within the country. Sufficient attention and action should be demonstrable for management of diseases that pose the greatest threats. It should be evident that producer level biosecurity, national certification, and surveillance systems are trade enabling, and that the system allows for awareness and changes in action as threats are recognized.

Sustainable, healthy and resilient aquaculture systems

For entry into Stage 4, a body of evidence from Stage 3 (maturity of the system for monitoring aquaculture health, including specific diseases, and evidence of stakeholder support and participation in achieving progress) is required, as well as an **adopted plan** with national commitment of all relevant agencies to safeguard the **national aquaculture system. The plan here refers to the overarching national policy and plans for aquaculture, which considers its role and responsibilities in safeguarding the environment.** There must be evidence of the capacity and commitment to prevent, detect, and respond to new threats to the system, in both cultured species and in the wider environment. Maintenance of the “” final stage””, with its range of co-ordinated activities and processes, may be vulnerable to changing political and economic factors, and if substantial loss of management capacity occurs, “”downgrading”” of the PMP status may result.

Ownership and Outcomes of each stage

Risk ownership is an important principle as described in the ISO Standard 31000 on “”risk management frameworks””. The PMP is broadly in line with ISO 31000 and has a set of principles to establish the Risk Management Framework at national level. It establishes risk ownership and promotes the “plan-do-check-act” cycle of quality management to emphasise the central role for monitoring and evaluating that will enable problems or progress to be considered and actions taken. The main changes in risk ownership are illustrated in Figure 2 and Table 1.

Figure 2. Main changes in risk ownership at the different stages

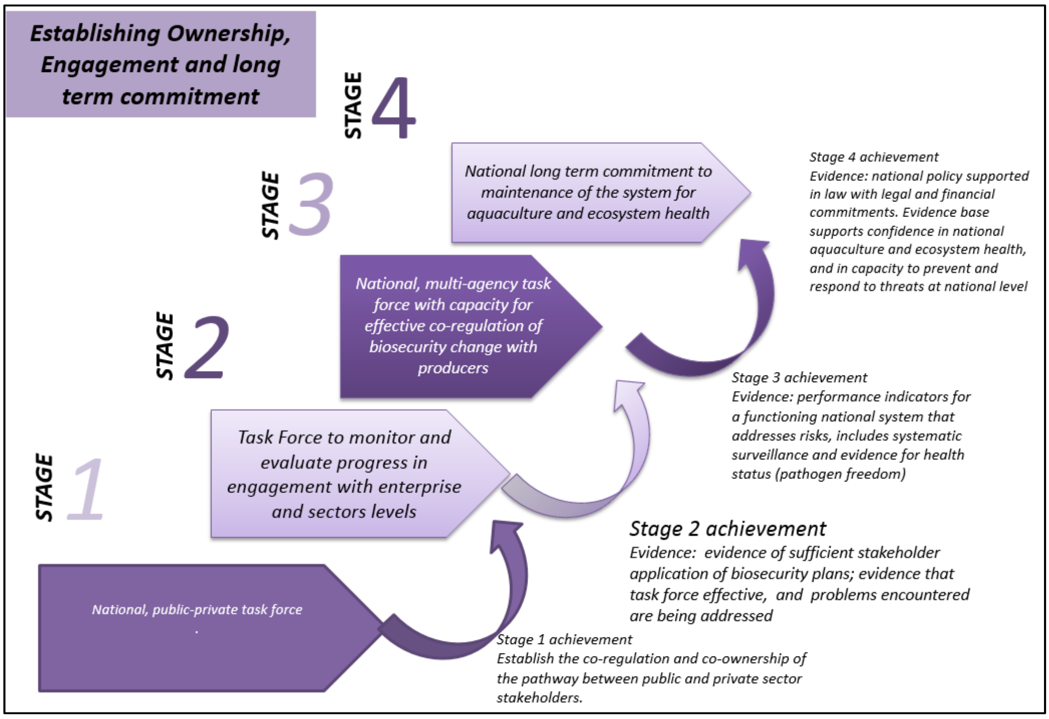


Table 1.Risk ownership level and evidence of achievement.

Stage	Risk ownership level	Evidence of achievement
4	National system for long term commitment to maintain aquaculture and ecosystem health	National policy supported in law with legal and financial commitments. Evidence base supports confidence in national aquaculture and ecosystem health. Proven Capacity to prevent and respond to threats at national level.
3	National, multi-agency task force with capacity for effective co-regulation of biosecurity change with producers	Evidence of meeting performance indicators for a functioning national system that addresses risk, including systematic surveillance and evidence for claims regarding health status
2	Task Force with mandate to to monitor and evaluate progress in engagement with enterprise and sector levels	Evidence for sufficient stakeholder application of biosecurity plans; Evidence that task force is effective in addressing the engagement and implementation challenges
1	National, public-private task force	Establishment of the task force for co-regulation/co-ownership of the pathway; principles, procedures, and practises for public and private stakeholder engagement agreed and practised

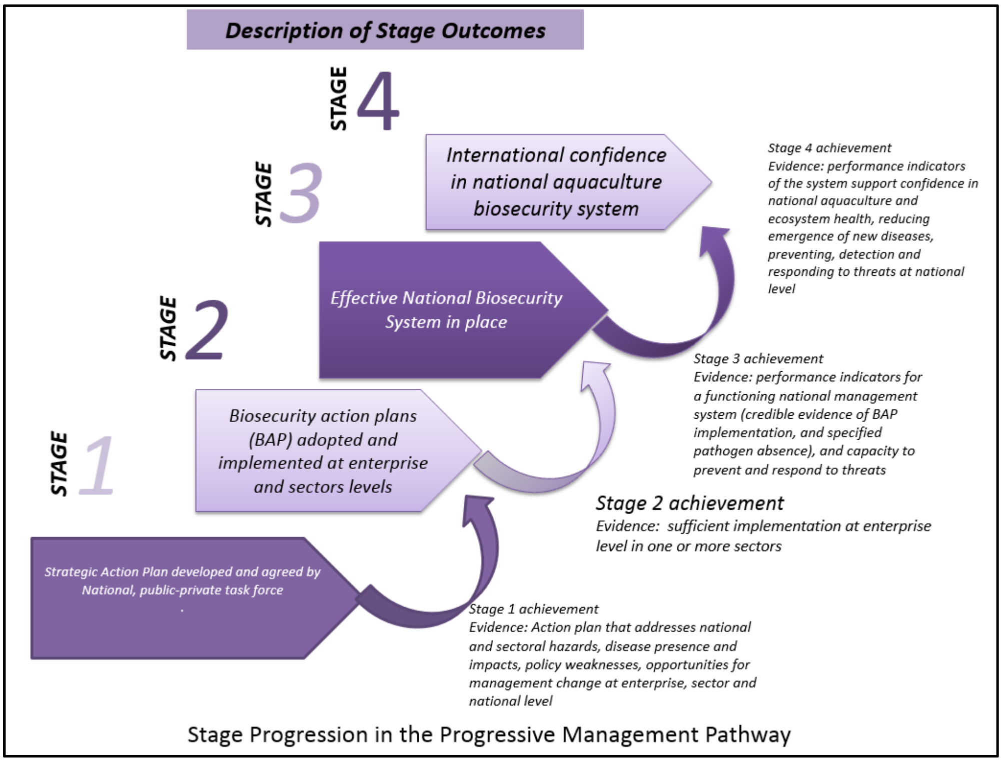
A "Stage" should be considered a development step; on entry, the management capacity will need to develop depth and competence through application to achieve the intended OUTCOME of a stage. PMP support projects may therefore be described as assisting countries to implement a Stage and measured by the achievement of the outcome – as well as the various performance indicators (not described here).

These outcomes are therefore NOT in place at the start of a stage, but should evident at the end, and are described in Table 2 and Figure 3 below.

Table 2. Stage outcomes and evidence of achievement

Stage	Stage OUTCOME level	Evidence of achievement
4	International confidence in national aquaculture biosecurity system	Performance indicators of the system support confidence in national aquaculture and ecosystem health Evidence base for systematic capacity to prevent, detect and respond to threats at national level, and to reduce risk of disease emergence.
3	Effective national biosecurity system in place	Evidence of meeting performance indicators for a functioning national biosecurity system, Credible evidence of meeting **biosecurity action plan** (BAP) targets for implementation at producer level; Evidence of absence of specific pathogens, supported by evidence for capacity to prevent and respond
2	**Biosecurity Action Plan**s (BAP) adopted and implemented at enterprise and sector level	Evidence for sufficient stakeholder application of BAPs at enterprise level in one or more sectors
1	Strategic Action Plan developed and agreed by national, public-private task force	Action Plan that addresses • national and sectoral hazards, disease presence and impacts; • policy and governance weaknesses, • short term and long term opportunities for improvement in management enterprise at sector and national level • priorities and tactics for engaging enterprises in biosecurity management (biosecurity action plans)

Figure 3. Description of stage outcomes



Benefits of the PMP approach

At the national level, the PMP approach should address a lack of clear national plans by enabling a focus on national strategy development processes, mid -to -long term, and by promoting the co-management approach. The greater use of planning processes that bring stakeholders together should have a variety of benefits in itself, and it should build the basis for national public and private co-management of biosecurity.

From Stage 2, sufficient adoption of appropriate biosecurity action plans at the producer level in participating countries should begin to reduce the incidence and impact of those disease targeted as priorities in the countries, and it should build a much greater awareness among stakeholders of the role biosecurity can play. From Stage 2, compartments operating at higher biosecurity levels may enjoy benefits of negotiating trade arrangements based on the recognition of their management competences.

From Stage 3, greater benefits at the national level should be realized through the evidence from monitoring and from the national biosecurity system performance indicators, both of which support greater confidence in health status of traded aquaculture commodities.

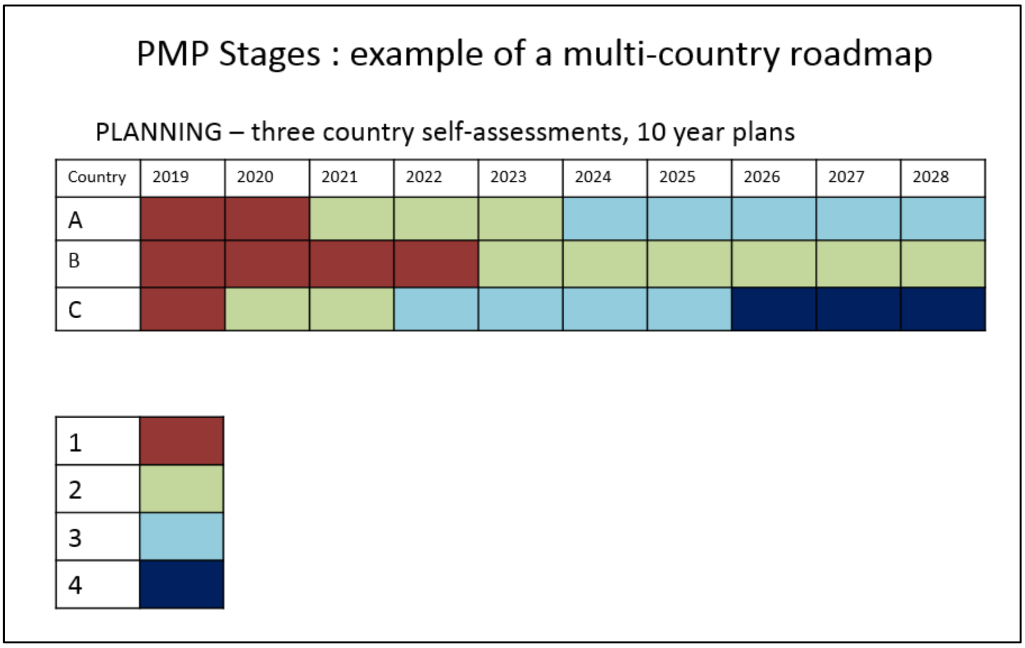
In Stage 4, societal and international confidence in the aquaculture system should provide benefits not only for trade but for national recognition of achievement and of the safeguards for the environment and public health.

Each stage should therefore provide a tangible benefit to stakeholders, and it will be part of the work within each stage to demonstrate, communicate, and advocate for activities and solve the challenges inherent in retaining commitment. Co- management principles at each stage should ensure the problems are well recognized and management solutions are identified.

How will the PMP approach be rolled-out to the national level? The Global Plan of Action

The approach taken by other pathways (*e.g.*, PCP-FMD) is to promote national uptake, often through regional meetings, at which a "”Regional Roadmap’" is developed. Countries assess their likely rate of change over a 15-20 year period. For example, *The Global Strategy for FMD* foresaw that countries would progress 2 stages over a 15 year period, ensuring that after 15 years, all countries would be <u>at least</u> in stage 3, which would be a significant increase in level of control.
An example of PMP-AB application to a region, or a multi-country roadmap, is shown in Figure 4. In this illustration, country B estimated its problems to complete Stage 1 as being significant and did not expect Stage 2 to be completed within 10 years. Greater international support to countries in Stage 1 might accelerate the process; however, because this is a key strategy development phase, time must be given to allow for national processes of consultation and adoption by those who will be implementing the plan.

Figure 4. Example of application of PMP-AB to countries A, B, C.



For roll-out of the PMP, a "Global Plan of Action" is proposed in which the PMP-AB is the principle tool for application at the national level, and partners in the regional and global aquaculture health community would promote and support the country efforts.

Not every country will feel it needs to participate, and the adoption of the PMP approach could be purely voluntary. This is not a fundamental issue; the PMP approach may still provide a useful means to promote management under donor funded initiatives, making use of the tools for measuring performance and achievement.

Table 4. PMP stages and their relationship to the different elements in Annex A.

PMP Stages : relationship to programme elements/components (PC)

	Components essential to stage achievement or maintenance											Components enabling and sustaining change			
PMP Stage	PC8 Risk	PC2 Pathogen list	PC1 Policy	PC11 Communication	PC3 Farm level Biosec.	PC4 Diagnostic system	PC5 Surveillance	PC7 Borders	PC6 Zoning	PC9 Emergency		PC12 R&D	PC13 HR Dev.	PC14 Instit. Dev	PC15 Int. Co-operation
4	+++	++	+	+++	+	+++	+++	+++	+++	KEY		Support stage progress and create new options			+++
3	++	++	+	+++	+	++	Key: surveillance	KEY	++	+		Support stage progress and create new options			+++
2	++	+	+	+++	KEY	+	Key: Monitor	+				Support stage progress and create new options			Share, compare
1	KEY	+	KEY	+								Support stage progress and create new options			Support

How will stage progression be evaluated?

The assessment system by which a country is accepted as being in a PMP stage will be discussed at the April 2018 Workshop (Washington, DC). In other Progressive Control Pathways, **self-assessment** is an essential part of the process of national ownership of the principles, responsibilities, and co-ordination with other activities required for management. Therefore, the PMP-AB is likely to focus on self-assessment processes. International acceptance in other PCPs usually involves a standard process of assessing evidence, which is mediated with the technical support of the FAO and OIE (under the GF-TADS Framework). The potential for **Joint Evaluation (JE),** undertaken through a mission or consultation process between international experts (trained and accredited) and the national responsible PMP-team, needs to be explored. This approach has become the accepted norm for uptake and application of the global health security agenda (GHSA) at the national level, and it has advantages of bringing attention to areas of weakness and strength that assist commitment of national authorities.

Supporting tools and guidance for the PMP/AB

For adoption at the national level, guidance documents and resources for advocacy and training at the national level will be needed. These will be developed following the April 2018 Workshop if the approach is widely supported.

Guidance to national authorities, and assistance in the initial steps of the PMP process, will be assisted by having a cadre of experts with expertise in aquaculture and in risk management. Familiarity with institutional change processes enables them to guide countries and help design projects to assist. International partners should be able to identify these experts and certify/train them for this role, subject to funding availability.

For Stage self-assessment, check-lists and guidance will be provided.

Online forum and training for PMP-practitioners are a cost effective means to train people in the approach and share experience and tactics to achieve better engagement. It also enables gaining online support. This system works well with other PCP/PMP.

Global Governance of the PMP/AB and its application in the Global Plan of Action

As with any new tool, the PMP/AB and its associated guidance and training materials will require a period of testing through national application, and adaptation will be made as a result. The April 2018 workshop should help identify the level of global interest in the tool and develop a plan of action. It will also identify the appropriate governance mechanisms to ensure the development of both the tool and the support system.

The strengths of different partners will be important to support the system, including experts for national training and (joint) evaluations (if adopted) and leading international scientific laboratories and research centers for technical support.

Annex A. Elements (or components) of Aquaculture Biosecurity

Element 1. Policy, legislation, and enforcement.

Policy refers to a national long-term 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 NAAHS 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 regional and national aquatic biosecurity strategies and acting on the respective programme activities needed to implement them. To have an effective national policy for aquatic animal health and biosecurity, identification of the Competent Authority on aquaculture and aquatic animal health is essential. The advantages of harmonizing aquatic animal health policy among countries belonging to the same region or subregion are many and include facilitated trade in live aquatic animals and their products and increased aquatic biosecurity for all countries. To address aquatic biosecurity adequately and to support improved national aquatic animal 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 animal health and aquatic biosecurity.

Element 2. National list of pathogens.

National pathogen lists (NPLs) 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 diseases (based on internationally accepted methods) should be established. OIE-listed diseases that are relevant to national conditions form a good starting point; however, the OIE-listed diseases are those of internationally traded commodities, while NPLs must also consider other serious diseases of national concern. NPLs 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/pathogen surveys, adequate disease record keeping and reporting, and a national disease database.

Element 3: Farm-level biosecurity plan

Farm-level biosecurity and health management plans are essential to sustain any aquaculture endeavour. A biosecurity plan should: (1) apply to a defined epidemiological unit or area (compartment) or geographical zone; (2) identify specific disease hazards (infectious pathogens); (3) evaluate the risk of these hazards to the unit; (4) evaluate critical points where diseases can enter or leave the unit; (5) evaluate and monitor disease status of the unit; (6) have contingency plans in place if disease does break out; (7) have written records for third-party auditing and certifying, particularly where markets require live animals or their products to be certified as free of disease or specific pathogens; and (8) be transparent and credible. The plan should include such aspects as farm registration programmes, development of standard operating procedures (SOPs) and best 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.

Element 4. Diagnostics

Adequate disease diagnostic capability 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 animals 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 animals. The second equally important role of diagnostics is to determine the cause of unfavourable health or other abnormalities and to recommend measures appropriate to a particular situation. The accurate and rapid diagnosis of an outbreak of disease in a cultured or wild population is essential to preventing further losses through correct treatment. It is also critical for 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.

Element 5: Surveillance, monitoring and reporting

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 zonation. Surveillance also provides the building blocks of information necessary to have an accurate picture of the distribution and occurrence of diseases relevant to biosecurity and international movement of aquatic animals 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. 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 analyze data and to report findings), legal support structures, and transport and communication networks. In addition, they must be linked to national and international (OIE) disease reporting systems (e.g. pathogen list 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 OIE *Aquatic Animal Health Code, 2016*.

Element 6: Zoning and compartmentalization

Zoning and compartmentalization are mechanisms that allow a particular geographical unit (e.g. sub-region, drainage basin, coastal area, cluster of aquaculture establishments, or even a single establishment) to establish and maintain officially recognized freedom from a specified disease or diseases, even though surrounding units may be infected. A *zone* is a portion of one or more countries comprising either: 1) an entire water catchment from the source of a waterway to the estuary or lake, 2) more than one water catchment or part of a water catchment from the source of a waterway to a barrier that prevents the introduction of a specific disease or diseases, or 3) part of a coastal area with a precise geographical delimitation or an estuary with a precise geographical delimitation that consists of a contiguous hydrological system with a distinct health status with respect to a specific disease or diseases. 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 OIE Aquatic Animal Health Code, 2016). In addition to contributing to the safety of international trade, zoning and compartmentalization may assist disease control or eradication.

Element 7. Border inspection and quarantine

Border inspection includes all those activities regulating the importation and exportation of live aquatic animals and their products that are conducted by the national Competent Authority and national customs officers at international airports, land border posts and sea ports of international entry. *Quarantine* is the holding of aquatic animals under conditions that prevent their escape, and the escape of any pathogens or "fellow travellers" they may be carrying, into the surrounding environment. Quarantine may be conducted pre-border (in the exporting country), border (at the border post of the importing country) or post-border (at a quarantine facility operated directly by the Competent Authority or by the private sector, under the standards and supervision of the Competent Authority). Quarantine is one of a number risk mitigation measures that may be applied to shipments of live aquatic animals to reduce the risk of introducing serious pathogens and pests.

Element 8. 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. Risk analysis at the farm facility level is important to minimize risk of disease to producers. Import risk analysis (IRA) is an internationally accepted method for deciding whether trade in a particular commodity (a live aquatic animal 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 animals should have a minimum level of capacity to assess possible risks due to pests (invasive aquatic alien species) and pathogens.

Element 9. Emergency preparedness and response capacity and contingency plans

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 animals, 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.

Element 10: Use of veterinary drugs and avoidance of antimicrobial resistance (AMR)

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 presence 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, standard operating procedures) to ensure the safe use of veterinary drugs, along with testing and monitoring programmes to assure 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. AMR can result from inappropriately used in aquaculture and other farming systems, or it can result from inappropriate use in humans. AMR is a growing problem because the development of "superbugs" resistant to multiple antibiotics can reduce the effectiveness of some essential antibiotics in treating human infections.

Element 11: Information, education and communication and aquatic animal health information system (AAHIS)

Communication includes activities that increase the flow of information between and among national policy-makers, producers, 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 animal health situation. It is especially important to an effective national aquatic animal biosecurity programme to establish and promote good communication and linkages between national veterinary services and national fisheries authorities. Communication may include development of national and regional aquatic animal health information systems and networks.

Element 12. Research and development, extension and other studies

Research capacity in aquatic animal 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 animal 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 animal 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 animal health centre. 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 animal diseases (TAADs) under local conditions is vital for the sustainable development of national aquaculture production and the maintenance of aquatic biodiversity.

Element 13. Human resources and institutional capacity development

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 NAAHS. This requires the hiring and/or training of scientists, veterinarians and other staff possessing critical expertise and training in the key areas of aquatic animal health (often at the PhD, MSc and DVM with specialized training in aquatic pathology). Examples of important expertise include 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.

Element 14. Institutional structure (including infrastructure)

Infrastructure for aquatic animal 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 and other relevant governmental agencies. In some instances national organizational structures, hierarchies, and lines of reporting and communication may need to be restructured to achieve efficient and effective national biosecurity.

Element 15. 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 OIE and with foreign universities and experts. There is great potential for regional cooperation and networking in almost all areas of aquatic animal health at national, regional and international levels.

Annex 2. Programme

FAO/MSU/WB Stakeholder Consultation on Progressive Management Pathway (PMP) to Improve Aquaculture Biosecurity World Bank Headquarters, Washington, D.C. 10–12 April 2018

Date and time	Activity
DAY 1: 10 April 2018 Tuesday	
08:15–08:45	Registration
Session 1	**Opening**
08:45–09:15	Welcome Remarks • FAO (Arni Mathiesen) • MSU (Mark Lawrence) • WB (Xavier Vincent)
09:15–09:20	Introduction to objectives, mechanics and expectations (Melba Reantaso)
09:20–10:00	Self–introduction and group photo
10:00–10:20	Coffee break
Session 2	**Thematic presentations and Plenary discussion**
10:20–10:40	Presentation 1: Drivers and pathways of aquatic animal disease emergence (Melba Reantaso, Sharon McGladdery and Grant Stentiford)
10:40–11:00	Presentation 2: Health management in small-scale aquaculture: opportunities for the progressive management pathway (PMP) approach (Rohana P. Subasinghe)
11:00–11:20	Presentation 3: Effective extension services to support biosecurity systems (Larry Hanson)
11:00–11:20	Plenary discussions
	Country presentations
11:20–11:40	Presentation 4: Chile (Jose Burgos and Alicia Gallardo)
11:40–12:00	Presentation 5: Norway (Yngve Torgensen)
12:00–12:20	Presentation 6: Philippines (Leobert de la Pena and Joselito Somga)
12:20–12:40	Presentation 7: South Africa (Kevin Christison)
12:40–13:40	Lunch
13:40–14:00	Plenary discussions
14:00–14:40	Presentation 8: Introduction to progressive management pathway (PMP) to improve aquatic biosecurity (AB) (Keith Sumption)
14:40–15:00	Plenary discussions on PMP
15:00–15:20	Coffee break
Session 3.1	**Working Groups**

15:20–15:40	Working group guidelines and ToR (Keith Sumption)		
15:40–17:00	WG1	WG2	WG3
17:30	Welcome reception		
Day 2: 11 April 2018 Wednesday			
Session 2 continued			
08:20–08:30	Tasks for Day 2		
08:30–09:00	Presentation 10: Socio-economic impacts of aquatic diseases and economic drivers (Franck Asche)		
Session 4	**Private-sector perspectives on biosecurity**		
09:00–09:15	Presentation 11: ABCC/Brazil (Itamar Rocha)		
09:15–09:30	Presentation 12: Merck/USA (Tim Kniffen)		
09:30–09:45	Presentation 13: NAQUA/KSA (Victoria Alday)		
09:45–10:00	Presentation 14: ShrimpVet/Viet Nam (Loc Tran)		
10:00–10:20	Coffee		
10:20–10:40	Plenary discussion		
Session 4			
10:40–11:00	Working group guidelines		
11:00–12:30	Working groups (continued)		
12:30–13:30	Lunch		
Session 4 continued			
13:00–15:30	Working groups (continued)		
15:30–16:00	Coffee		
16:00–17:00	Working group 1 reporting		
17:00–17:30	Wrap-up and Tasks for Day 3		
Day 3: 11 April 2018 Thursday			
08:30–09:30	Working group 2 reporting		
09:30–10:30	Plenary discussions		
10:30–11:00	Coffee		
Session 5: The Way Forward and Closing			
11:00–12:30	Presentation on the way forward and plenary discussion		
12:30–13:00	Closing		
13:00–14:00	Lunch		
14:00	Departure of participants		

Annex 3. List of participants

FAO/MSU/WB Stakeholder Consultation on Progressive Management Pathway (PMP) to Improve Aquaculture Biosecurity
World Bank Headquarters, Washington, D.C., 10–12 April, 2018

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Annex 4. Group photograph

The FAO/MSU/WB First Multi-Stakeholder Consultation on a Progressive Management Pathway to Improve Aquaculture Biosecurity (PMP/AB) was held at the World Bank Headquarters, Washington, D.C., United States of America from 10 to 12 April 2018. The PMP/AB has the potential to integrate appropriate and sustainable levels of risk management into aquaculture production systems and follows the principles of being risk-based, collaborative and progressive. The sheer numbers of cultured species (more than 500), stakeholders and enterprises in the supply and value chain; the diversity of aquaculture systems, environments, and types of farming operation and management; and the many diseases impacting aquaculture development, including the emergence of new pathogens and their rapid spread globally, all combine to present an enormous challenge for aquaculture development and sustainability at all levels.

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