Maintaining Biosecurity in Aquaculture Systems: A Constraint or a Challenge?

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ABSTRACT

Biosecurity can be defined as the protection of plants, animals (including humans and associated activities) and the wider environment from the unwanted impacts of biological agents including diseases and pests. As a discipline, biosecurity can be applied at various levels. In the context of aquatic animal disease, this can range from managing the health of individual animals, through whole commercial enterprise to national or international biosecurity. The last three decades or so have seen an increase in the farming of aquatic animals worldwide – a situation compounded from a biosecurity perspective by a quantum leap in aquaculture technologies, countries and species new to aquaculture, increased international movement of juvenile animals and broodstock; all in an environment of little knowledge of the health status of source populations and the frequent emergence of new diseases. The end-result of this change has been significant farm level production losses well documented in the scientific and lay literature. The focus on increased farm level biosecurity in recent times has been in direct response to this very real threat. All aquaculture operations rely on trade (commercial exchanges) to some extent. Trade provides stock, genetic material, inputs (such as feeds, vaccines, treatments, etc.) and takes the outputs (product). Aquaculture operations are not isolated from the realities

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of trade and the associated biosecurity risks. This paper describes the various elements that make for good farm level biosecurity and assesses the resourcing needs against net long- and short-term benefits to production. This paper also examines the role that farm biosecurity plays in overall regional or national biosecurity systems, with particular emphasis on the Australian experience. Farm level biosecurity is placed in context with inter- or intra-national disease zoning (and compartmentalisation), national quarantine control and global biosecurity initiatives such as international disease reporting and standards setting. The necessity for on-farm biosecurity as a complement to zoning and the more traditional country quarantine requirements is emphasized.

INTRODUCTION

Historically, international trade was by sea. This trade was slow and was associated with small unit volumes 'man-handled' by stevedores. Quarantine at national borders was relatively easy to maintain, and international trade in aquaculture was also very small (usually eyed ova for restocking). Now, with containers and air-freight, large volumes of agricultural commodities can be moved world-wide in a few hours or days. These commodities, be they live organisms or animal/plant products, can harbour unwanted pests and disease agents. This improved capability in commodity transportation has brought with it the greatly increased risks of spreading pests and pathogens around the world – the increased risk of the globalisation of the world's animal and plant diseases.

This historical change in commodity transportation, the last three decades or so have seen a concurrent increase in the farming of aquatic animals worldwide — a situation compounded by a quantum leap in aquaculture technologies, countries and species new to aquaculture, and increased international movement of juvenile animals and broodstock. For example, well over 200 aquatic animal and plant species were farmed around the world in 2002 (FAO, 2002). Relatively little is known of the health status of most of these species, with frequent emergence of new diseases being reported in the scientific literature (with many incidents going unreported). This is in stark contrast to the handful of familiar and well-studied terrestrial livestock and poultry species farmed around the world, where capability and capacity to manage health is by and large well established.

All aquaculture operations rely on trade to some extent. Most farms are dependent on trade for various inputs such as broodstock, post-larvae/fingerlings and feed. These inputs represent potential pathways by which new pathogens can enter farming systems. In the absence of appropriate regulation, trade (commercial exchange) in high risk commodities has continued with little or no risk management because of commercial pressures, despite the relative lack of knowledge of disease and pest risks, and often without regard to the known risks.

The end-result of this have been severe disease-associated farm level production losses — perhaps none more so than through the well documented spread of white spot disease (WSD) around the world. In 2000, WSD caused estimated global production losses in the order of 200,000 tonnes, valued at approximately US$1 billion (Rosenberry, 2001). The total white spot syndrome virus (WSSV)-associated production loss in Asia between its first emergence in 1992 and 2001 is an estimated US$4-6 billion (Lightner, 2003). The local and international spread of the causative agent, WSSV has most often been attributed to the movement of live animals, mainly broodstock and post-larval shrimp.

Another example of particular relevance to the region is epizootic ulcerative syndrome (EUS), caused by *Aphanomyces invadans*, considered to have started with the introduction of tilapias into Asia in the 1960s and now spread across Asia (including Australia) and into the USA (Roberts, 2003). The disease is thought to have been introduced into Sri Lanka with imported ornamental fish, a conclusion based primarily on Sri Lanka's island nature, the coincidence of ornamental fish imports form overseas at the time, and its occurrence around 1989 well in advance of its overland spread to India. The focus on increased farm level biosecurity across the aquaculture sector in recent times has been in direct response to this very real threat of disease spread into otherwise free areas, as demonstrated by the WSD and EUS pandemics.

These events are occurring in a global environment of increased public awareness and concerns about biodiversity, resource sustainability and food safety. The World Wildlife Fund, perhaps a moderate among detractors, identifies several environmental and social issues relating to aquaculture, including the following that relate to biosecurity:

- ⇒potential adverse effects on wild species, including disease transmission
- ⇒prophylactic use of chemicals, including antibiotics that can harm wildlife and the environment, and may lead to antibiotic resistance.

The subject of aquaculture biosecurity was the subject of a 2001 workshop in Hawaii, sponsored by the US National Oceanic and Atmospheric Administration (NOAA), 'Biosecurity in Aquaculture Production System: Exclusion of Pathogens and Other Undesirables' (Lee and O'Bryen, 2003). The workshop proceedings, published by the World Aquaculture Society (WAS), provide an excellent synopsis of biosecurity issues surrounding aquaculture.

WHAT IS BIOSECURITY?

The literal meaning of biosecurity is 'life protection'. There is no universally accepted definition of 'biosecurity'. Those definitions that do exist are based on needs of specific groups and as such there is no consistency, although there is some overlap. For example, in no particular order of importance:

Biosecurity Australia, the agency responsible for developing Australia's importation policies, does not have a formal definition as yet, but a 'working definition' can be extrapolated from Australia's Quarantine Act:

> *The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents in people, animals, plants or the environment*

New Zealand's equivalent agency, Biosecurity New Zealand, defines biosecurity as:

> *The exclusion, eradication or effective management of risks posed by pests and diseases to the economy, environment and human health. It covers terrestrial, freshwater and marine environments.*

The University of Illinois defines biosecurity as:

> *A process to protect from attack or interference due to biological organisms – that can be applied to yourself, a farm, the state, or our country. [A 'hood-of-the-truck' definition could be shortened to "keeping the bad bugs off the farm"]*

The Wikipedia web encyclopedia states:

> *A biosecurity guarantee attempts to ensure that ecologies sustaining either people or animals are maintained. This may include natural habitats as well as shelter and productive enterprise (especially agriculture) and deals with threats such as biological warfare or epidemics. This is related to the more passive concept of biosafety.*

The Saunder's Comprehensive Veterinary Dictionary defines biosecurity as:

> *Security from transmission of infectious diseases, parasites, and pests*

The US poultry industry's definition is:

> *The cumulative steps taken to keep disease from a farm and to prevent the transmission of disease within an infected farm to neighbouring farms*

In his keynote speech at the 3rd IUCN World Conservation Congress in Bangkok (November 2004), He Changchui, Assistant Director-General and Regional Representative for Asia and the Pacific defined biosecurity as:

> *Management of all biological and environmental risks associated with food and agriculture, including forestry and fisheries. It covers issues related to biosafety, food safety and plant as well as animal health such as recent outbreaks of Avian Influenza…*

The FAO in 'Towards a Food-Secure Asia and Pacific Regional Strategic Framework for Asia and the Pacific' defines biosecurity as:

> *Management of all biological and environmental risks associated with food and agriculture, including forestry and fisheries. It covers issues related to biosafety (reduction of risks associated with the use of products derived from modern biotechnology), food safety and plant as well as animal health...*

The Department of Agriculture – Western Australia in its Cattle Industry Biosecurity Plan – biosecurity is defined as:

> *A set of measures designed to protect a population from transmissible diseases, pests and weeds at national, regional and individual farm levels.*

A Review of Quarantine Systems and Biosecurity Management for the Tasmanian Department of Primary Industries, Water and Environment stated:

> *Biosecurity by its very nature is concerned with addressing risk. Biosecurity is defined as the protection of the economy, environment and health from pests, diseases and weeds.*

An Australian Government Department of Agriculture, Fisheries and Forestry document on 'Marine Biosecurity and Risk Assessment', defined biosecurity as:

> *The activities and strategies concerning protection of native biodiversity. Such activities and strategies encompass barrier control activities such as quarantine efforts, through to post-barrier activities such as monitoring, rapid response (eradication) and longer term control.*

Participants at the 2001 workshop in Hawaii defined biosecurity as:

> *An essential group of tools for the prevention, control and eradication of infectious disease and the preservation of human, animal and environmental health.*

In its broadest sense, biosecurity can be defined as the protection of plants, animals (including humans and associated activities), and the wider environment from the unwanted impacts of biological agents, including diseases and pests. As such, in addition to infectious diseases, 'biosecurity' includes pest issues, genetically modified organisms (GMOs) or other genetic issues, and food safety. It can cover intentional (including illegal) and unintentional actions — biosecurity can even be deal with protective aspects of bioterrorism – *e.g.* the Waihekie Island foot and mouth disease (FMD) hoax in New Zealand.

Given the nature of the symposium presentation on which this paper is based, "diseases in aquaculture", these latter aspects relating to ecological pests, GMOs and bioterrorism are not considered in this presentation although they are significant (perhaps even more significant) issues in their own right.

Within this narrower treatment, the definition of 'biosecurity' can be further narrowed to focus on the exclusion of unwanted pathogens (Lightner, 2003). This paper adopts this more narrow definition, focusing on pathogens and associated infectious diseases of aquatic animals, with 'biosecurity' being the exclusion or keeping out of pathogens from systems that are otherwise free of the pathogens and eradicating pathogens from specified areas once incursions occur. Aquatic animal health management on the other hand includes aspects of controlling or managing the impacts of pathogens that are effectively 'here to stay'. Biosecurity can therefore be considered a component of aquatic animal health management.

As a discipline, biosecurity can also be applied at various levels. In the context of aquatic animal disease, this can range from managing the health of individual animals, through whole commercial enterprise to national or international biosecurity.

KEY ELEMENTS OF FARM BIOSECURITY

In essence, farm biosecurity has the following three objectives:

- ⇒ minimising the likelihood of high-risk inputs introducing unwanted pathogens,
- ⇒ monitoring/surveillance to detect incursions when/if they occur, and
- ⇒ responding to disease incursions by controlling the spread and eradication of unwanted disease agents.

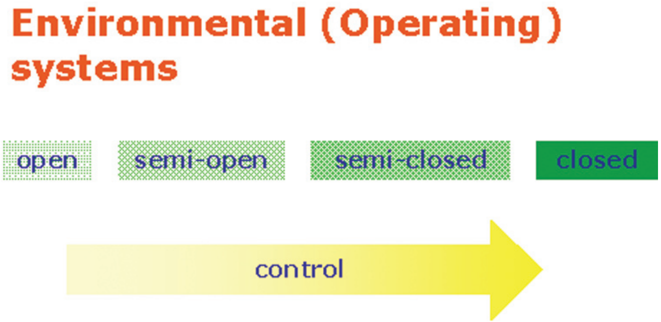
Lee (2003) identified the following key operational elements as needed to achieve these objectives (noting the broader definition of biosecurity as developed by the 2001 Hawaii workshop participants):

- ⇒ sourcing reliable stocks
- ⇒ adequate detection/diagnosis
- ⇒ disinfection and pathogen eradication
- ⇒ best management practice, and
- ⇒ practical and acceptable legislation.

Within these elements, a key factor influencing the specific biosecurity measures that could effectively be applied is the degree to which farm stock is (and can be) isolated from the environment — most importantly the level of water exchange. In Australia, national aquatic animal disease emergency response plans have been developed for several pathogens based on farm types categorised into:

- ⇒ closed, eg recirculation systems
- ⇒ semi-closed, eg prawn pond culture
- ⇒ semi-open, eg open-water cage/rope culture, and
- ⇒ open systems, eg. wild fisheries.

Clearly the level of control that can be applied to closed systems is much greater than for semi-closed and semi-open systems, as depicted below:



Managing risk of pathogen introduction

The most common high risk inputs into aquaculture systems are: (1) stock, e.g. fingerlings/post-larvae for stocking grow-out ponds, (2) feeds, (3) water, and (4) equipment such as harvest nets, aerators, etc. that may be shared between farms. Some less common inputs include vaccines and instruments such as those used for pearl seeding.

Measures can be taken to minimise the likelihood that live pathogens are present in these farm inputs. For example, stock (including broodstock) can be sourced from populations determined to be free of specific disease agents of concern (specific pathogen free - SPF or specific pathogen resistant - SPR) or populations subject to regular monitoring and known to be of good health status, or be quarantined and tested or treated to reduce the risk. For example, iodophor disinfection of fertilised ova is a standard procedure used all over the world as a precautionary measure against the transmission of many viral, bacterial and fungal diseases (see the OIE Aquatic Animal Health Code Section 5.2; Aquatic Manual Section 1.1).

Feeding of grow-out animals could be restricted to commercial pelletised feeds that are subject to a degree of pathogen inactivation through the heat created by the extrusion process and pellet drying. Fish and crustacean meals used as ingredients in aquaculture feed are also subject to a degree of heat treatment and drying during manufacture. Pelletised or processed feeds are used increasingly in feeding broodstock and all stages through hatchery development. Emerging technologies such as high hydrostatic pressure (HHP) treatment may be of future potential use in minimising feed associated biosecurity risks.

The ability of many aquatic animal pathogens to survive outside a host (sometimes for considerable periods) and to infect a variety of host species means that aquatic animal pathogens can be introduced into aquaculture systems through intake water, either in fomites (including suspended free in the water itself) or in infected/carrier organisms. Intake water may be screened and filtered to varying degrees to exclude or reduce the presence of pathogens, fomites and carrier organisms. Risks associated with water can also be reduced by treatment prior to use, such as by filtration, UV, ozone or chemical treatment (see chapter on disinfection of farms in the OIE Aquatic Animal Health Code – treatment of influent and effluent water). Where practical, underground reserves provide an excellent water source from a biosecurity perspective.

Most farm equipment such as aerators, harvest nets, footwear, and containers and vehicles used to transport live animals can be readily disinfected using chemical treatments, such as sodium hypochlorite, sodium hydroxide and iodophors.

In a summary article on farm-level biosecurity and WSD of shrimp, Mohan *et al.* (2004) provides an excellent general synopsis of measures that are commonly applied, as well as measures proposed, in term of better management practice at the farm level with respect to WSD, the principles of which can be applied in general stock health management (Mohan *et al*., 2004). These measures include pond preparation to eliminate pathogens and carriers, stocking of WSSV PCR-negative post-larvae, screening and disinfecting intake water in reservoirs, as well as reducing intake volumes (moving toward closed systems), and constructing physical barriers to prevent entry of wild crustaceans into production systems (e.g. crab fencing).

An aspect of input control is managing susceptibility of farm stock to pathogens of particular concern. This can potentially be achieved with vaccination (where commercial technology is available), through selection of culture species that are known to be resistant to the pathogen/s of concern or by maintaining good general health of stock through good management practice/husbandry.

Surveillance to detect pathogen incursions

Early detection of a pathogen incursion into a farm system allows for more effective control of the establishment or spread of a pathogen — for more effective response. Surveillance to detect incursions can be either targeted to specific pathogens or more general. For example, for pathogens of particular concern and for which there are diagnostics tests available, animals can be periodically tested, ensuring the number of animals sampled are enough to provide an acceptable level of confidence in detecting the agent were it to be present.

The health status of farm animals can also be monitored more generally through gross and microscopic examination including histology. Both targeted and general surveillance requires a degree of specialised expertise, although much can be done with minimal training. Of note, general surveillance does not need to be very expensive, especially in countries where labour is comparatively cheap.

Response to pathogen incursions

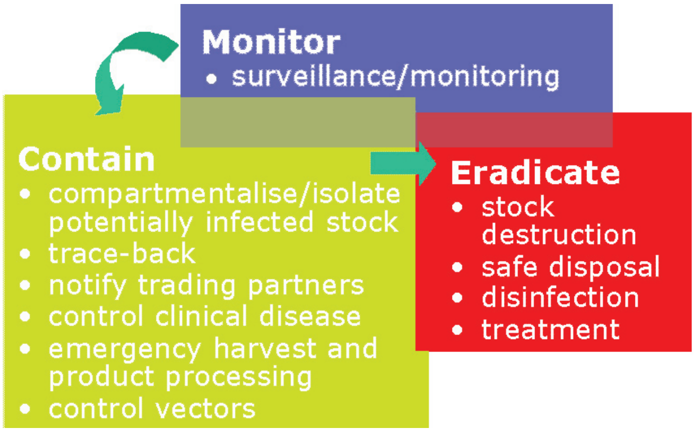
Response plans allow rapid action following detection of a disease incursion into a farm. Response plans essentially detail practical steps that should be taken in the event of an outbreak, saving time because the key decisions (and associated research needs) pertaining to various scenarios would already be made – thus allowing for early action.

Disease control issues should be taken into account in the site selection and design engineering stages of an aquaculture operation. The location and design of a farm often determine the degree to which various control measures can be applied. For example, building shrimp culture ponds that can be fully drained and dried facilitates relatively cost-effective eradication of many aquatic animal disease agents from those ponds. Equally, farm layouts can be designed in such a way that when a disease outbreak occurs, the affected animals can be readily isolated, minimising the risk of disease spreading to other parts of the farm or adjacent farms sharing the same water source. With open water cage-culture operations, allowing appropriate distance between cages or groups of cages would have a similar benefit of being able to compartmentalise culture systems.

An effective disease response plan has three key aspects:

⇒surveillance/monitoring
⇒containment
⇒eradication

Each of these is associated various activities aimed at ultimately eliminating the pathogen of concern from the farm, e.g., as shown below:

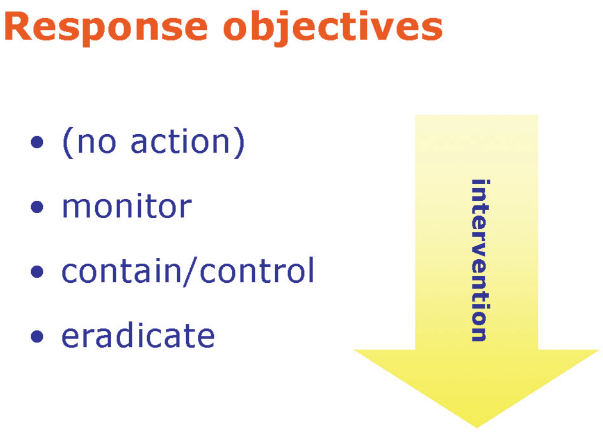


Monitor
- surveillance/monitoring

Contain
- compartmentalise/isolate potentially infected stock
- trace-back
- notify trading partners
- control clinical disease
- emergency harvest and product processing
- control vectors

Eradicate
- stock destruction
- safe disposal
- disinfection
- treatment

The level of intervention, and therefore cost, is increased for each response objective, as depicted below:



Response objectives

- (no action)
- monitor
- contain/control
- eradicate

Perhaps of most importance for successful implementation of biosecurity strategies is ensuring that farm managers and staff are aware of the potential risks and educated in the biological principles underpinning biosecurity measures, as well as their individual roles in responding to a disease event. Training programmes are important – strategies need to be developed to ensure that this awareness is not only communicated and understood, but also incorporated into policy/plans so that this capability can be maintained through ongoing training. An example of how governments can assist with such programmes is through the development of regional based resource material. An example of this at the national government level is the Disease Watch and the Field Guide[1].

Cost and Benefits

The cost of implementing biosecurity measures can be significant, particularly for marginal operations where short term profitability is essential to business success. The cost of diagnostic testing as part of surveillance activities or ensuring the absence of farm inputs such as fingerlings/post-larvae can be onerous. For example, the standard cost of a PCR test in Australia is around US$50. Similarly, the cost of filtering or treating intake water can often be prohibitive. The overall cost of biosecurity will, however, depend on the particular circumstances and needs to be looked at on a case by case basis, keeping in mind the range of available measures and that relatively low cost measures such as sourcing post-larvae from sources free of particular pathogens of concern can have tangible biosecurity benefits in most circumstances.

However, benefits are not always tangible. The New Zealand Government, for example, tries to determine threats based on risk to four core asset values (biotic, economic, social and spiritual). In Australia, import risk assessments look at the consequences of disease incursions and examine the likely economic, environmental and social impacts – globally, methodologies for sound decision making are not well established and generally inconsistent and untested. This same struggle to make level headed decisions on the net benefits of implementing biosecurity measures also occur at the farm level.

Clearly, the continued lack of attention to biosecurity by many farmers in the region shows that there is uncertainty in the value of biosecurity measures and that these benefits have not been sufficiently understood to allow a "regret-free"[2] decision. Such decisions are invariably made on relatively short-term commercial grounds (with the objective of early return on investment) and at an individual enterprise level, and in the absence of any regulatory controls.

Despite this relatively short-term view taken at an enterprise level, the significant short and longer term impacts to aquaculture resulting from several key disease problems (such as WSD, Taura Syndrome and Infectious Salmon Anaemia) over the last decade or so, have resulted in slow but increasing attention to biosecurity by industry groups (through codes

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[1] Available at: http://www.disease-watch.com/documents/CD/index/body.htm

[2] Regret Theory – where a person anticipates regret if they make a wrong choice, and take this anticipation into consideration when making decisions.

of conduct/practice), and governments (through regulation and extension/education), as well as by international organisations such as the Food and Agriculture Organization of the United Nations (FAO) and World Organisation for Animal Health (OIE), through setting standards and establishing guidelines.

A major driver in this change has been the negative publicity surrounding aquaculture and attempts by those promoting aquaculture to counter accusations of poor or irresponsible practice. This negative press has been related mainly to claims of ecosystems damage but has also included concerns relating to aquatic animal disease[3]. Of particular significance in this regard has been the potential impact of newly introduced diseases on wild aquatic animal populations (for example, see Doubleday, 2001) — it is generally acknowledged that once aquatic animal pathogens enter and establish in natural ecosystems, it is practically impossible to eradicate them.

Of equal if not greater public concern has been with respect to antibiotics (eg chloramphenicol and nitrofurans) and other chemical residues in farmed product for human consumptions (e.g. see the Statement of the Government of Thailand at AquaMarkets 2003, the Manila Conference on Market Access of Aquatic Products[4] or the Centre for Food Safety website[5]) — again driving an industry desire to avoid disease agents, rather than manage diseases chemically.

Risk assessment based resource allocation

The primary objective of commercial aquaculture at the farm level, be it small-scale, family farms or major commercial enterprises, is to make money. As such, all farmers would consider the need for and extent of implementing farm level biosecurity in the context of resources availability. Most if not all recognize the potential business risks associated with disease and allocate some resources toward managing this risk. This resource allocation is, however, rarely based on proper risk assessment. In an environment of finite resources, it is important that resource allocation to disease risk management is commensurate with the biosecurity risk. In this regard it is important not to necessarily equate the pathogen to clinical disease. This error can lead to unwarranted focus on the pathogen, when managing clinical disease may present a more cost-effective option (Hugh and Stoskopf, 1999).

Biosecurity risk in this context is a measure of the likelihood of a disease outbreak in a farm and the short- and long-term negative impacts of the outbreak. Therefore, biosecurity risk assessment at the farm level involves:

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[3] See The Aquaculture Disaster – Third World communities fight the 'Blue Revolution' by Martin Khor on the Third World Network website at: http://www.twnside.org.sg/index.htm or World Wildlife Fund website at: http://www.worldwildlife.org/cci/aquaculture.cfm

[4] AquaMarkets (2003): Available at:http://www.enaca.org/modules/wfsection/article.php?page=1&articleid=101

[5] http://www.centerforfoodsafety.org/aquacultur.cfm

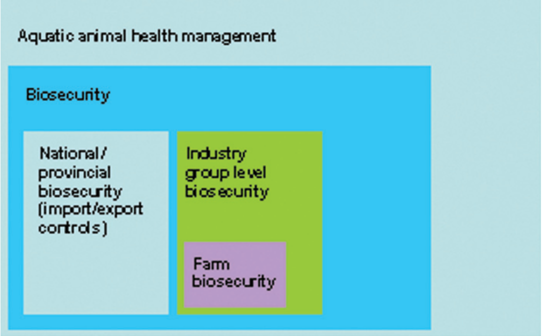
- ⇒consideration of key disease threats (diseases of concern),
- ⇒an evaluation of the likelihood that these agents would enter a farm system under existing farm conditions/operating systems — based on an examination of the 'pathways' by which disease agents can enter the farm and become exposed to susceptible host animals, and
- ⇒an estimation of the overall financial and other losses to the farm if an outbreak of disease did occur.

Based on biosecurity risk assessment, farmers can determine if the risk is such that it is unacceptable from a business perspective and if so, determine the most cost-effective risk management measures. Such a risk assessment approach to managing farm biosecurity would be appropriate to individual farmers, farming groups/cooperatives and government regulators alike.

In considering the need for farm level biosecurity, industry groups and governments in particular need to take into consideration wider and longer term negative impacts. For example, WSD has been associated with substantial losses in shrimp farms during the first few years following introduction of WSSV into systems. Production losses due to WSD are estimated at over 50% in the main shrimp producing state in India (Yap, 2001), between 70-75% in Ecuador (Hill, 2002; Yap 2001), approximately 45% (in 1996) in Bangladesh (Mazid and Banu, 2002), and approximately 80% in Peru (Yap, 2001). Other major shrimp producing countries such as Thailand and China would likely have experienced similar production losses. The significance of these losses may often be lost to individual farmers, but standards setting groups such as industry bodies and government regulators would need to take such impacts into consideration. Similarly, governments and industry groups need to consider the perceived negative impacts of aquaculture with respect to wider issues such as ecosystems damage or human health concerns on chemical residues, issues that are not generally a priority at an individual farm level.

ROLE OF FARM BIOSECURITY IN REGIONAL/NATIONAL AQUATIC ANIMAL HEALTH MANAGEMENT SYSTEMS

Farm biosecurity is a component of aquatic animal biosecurity, together with national level biosecurity associated with import and export controls, and industry group level biosecurity associated with farm cooperatives and codes of practice, as depicted below:



At all levels depicted in the diagram, the objective is to prevent the introduction of unwanted pathogens and thereby avoid associated disease impacts. Ideally, all levels of activity are complementary and together provide an effective overall level of biosecurity against unwanted pathogens.

Aquatic animal biosecurity as a whole can be defined as being a component of overall aquatic animal health management. In Australia, there is in place a national aquatic animal health management strategy (*AQUAPLAN*[6]) that attempts to bring together and coordinate the various elements of aquatic animal health management:

AQUAPLAN 1998-2003

1. International linkages
2. Quarantine
3. Surveillance, monitoring and reporting
4. Preparedness and response
5. Awareness
6. Research and development
7. Legislation, policies and jurisdiction
8. Resources and funding.

In addition to national level biosecurity, there are also international aquatic animal health programs and initiatives that try to promote and harmonise what is being done at national level. With respect to aquatic animals, these include the OIE, the FAO and the Network of Aquaculture Centres in Asia-Pacific (NACA). For example, the OIE sets standards (recognised by the World Trade Organization) for translocation of aquatic animal products, risk analysis and evaluation/recognition of competent authorities, as well as identifying globally significant (notifiable) animal diseases and coordinating the collation and reporting the health status of member countries with respect to these notifiable diseases.

The biological principles underpinning what can be achieved at international, national/provincial and farm levels are the same. As such, all the key elements of farm level biosecurity are mirrored in national and international biosecurity initiatives. The complementarity of international, national and local/farm level biosecurity needs to be stressed. Unilateral national border control on imported aquatic animal commodities for example can only do so much, especially for countries that share water basins or coast lines with neighbouring countries.

WHO HAS RESPONSIBILITY?

In the final analysis, all partners involved in aquaculture have some responsibility with respect to biosecurity; these include:

- ⇒Farmers — can apply good biosecurity practice as part of their normal operations
- ⇒Industry organisations/cooperatives — can develop biosecurity codes of practice/conduct and facilitate information exchange between farmers, encouraging a

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[6] Available at: http://www.daff.gov.au/aquaplan

AQUAPLAN 2005-2010

1. Enhanced integration and scope of aquatic animal health surveillance in Australia

- To identify needs and gaps with respect to surveillance requirements for specific industry sectors.
- To develop cost-effective surveillance systems tailored to address the identified gaps and needs.
- To have a surveillance information system that addresses the deficiencies found in Objectives 1 and 2, which is organised and readily accessible at a national level.
- To improve investigation and reporting of major (wild) fish kills.
- To create a consistent system of aquatic animal disease laboratory diagnosis and reporting across Australia.

2. Harmonisation of approaches to aquatic animal health in Australia

- To harmonise the framework for aquatic animal emergency disease management in Australia.
- To implement a common approach to zoning for disease control and market access.
- To implement a common approach for managing pathogens associated with the translocation of live aquatic animals across Australia.
- To harmonise any new legislative, code of practice or quality assurance approaches as they are initiated in aquaculture.

3. Enhancement of aquatic animal emergency disease preparedness and response framework

- To agree on an approach to the establishment of an aquatic emergency animal disease response agreement for Australian aquaculture industries.
- To ensure the scientific and technical accuracy of *Aquavetplan*.

4. Education and training in the aquatic animal health sector

- To clearly define the current and future needs for aquatic animal health support among Australia's aquaculture industries (established and emerging).
- If required, to modify the current education and training structures to ensure the needs of Objective 1 are met.
- To develop an accreditation and competency scheme for aquatic animal health service providers.
- To provide training in the framework and operational aspects of aquatic animal disease emergency management.

5. Welfare standards for aquaculture

- To develop a scientifically-based and harmonised approach to aquatic animal welfare policies across Australia.
- To increase awareness of aquatic animal welfare issues within industry.
- To assist international standard setting bodies in developing welfare guidelines and standards that are scientifically based.

6. Appropriate use of therapeutics for aquatic animal health management

- To ensure the availability and safe use of therapeutics for cultured aquatic animals in Australia.

7. Aquatic animal health management as part of ecologically sustainable development

- To ensure that market opportunities are not lost due to the use of suboptimal health management practices in aquaculture.
- To raise awareness about disease issues associated with imported live aquatic animals.

corporate view and discouraging secrecy on matters of broader disease concern. (Financiers may also paly a role by requiring farmers to include biosecurity measures into farm operations).

⇒Local/national governments — can increase awareness through extension, require minimal biosecurity standards at the farm level (e.g. as a part of licensing agreements) and through control of the translocation of high risk commodities within their jurisdictions and from other countries. International organisations — can increase awareness of biosecurity (particularly at the national/provincial government level) and set standards for best biosecurity practice at all levels.

CONSTRAINT OR CHALLENGE

A 'constraint' is a hurdle to achieving an objective. From a farm perspective, the primary objective is profitability – ideally, sustainable profitability. Put in the context of this paper, biosecurity would be a constraint if the cost of implementation on the farm's bottom line was prohibitive. A 'challenge' implies a hurdle that needs to be overcome – the emphasis being on necessity. That is to say, biosecurity rather than being an option, is essential to profitability.

Based on the above definitions, whether biosecurity is a constraint or a challenge is a determination that has to be made on a farm by farm basis, based on the individual circumstances. However, generalisations can be made taking into account what has happened historically and those expected future threats to the industry that are already making significant headlines.

⇒Is farm biosecurity a 'constraint'? — yes to some, it will cost and marginal operations may well go under.

⇒Is it a 'challenge'? — yes, it is necessary to the long term financial viability of the aquaculture sector as a whole. Importantly, the long-term down side of not giving serious attention to biosecurity could worsen the already poor public/consumer perceptions of aquaculture, which could result in an even greater (and potentially irreversible) impact on the bottom line of individual farms.

WHAT CAN BE ACHIEVED – A VISION

A common understanding of what biosecurity means, well defined and put in the context of other aspects of aquatic animal/plant health management.

All parties taking collective responsibility in maintaining/improving aquaculture's image in the eyes of consumers and other stakeholders, who are increasingly aware of, and have growing concerns regarding, ecological impacts of aquaculture operations and food safety of farmed product.

Farmers/financiers/industry groups/government extension/academia

> *Biosecurity established in the psyche of all farmers and becoming a basic cost of doing business, like feed management, stock supply and other routine tracking/traceability operations — in the context of this paper, farm operators who are aware of the potential risks, recognise the limitations of national and international regulatory capability and take greater responsibility for biosecurity at the farm level.*

Industry groups

> *Consistent application biosecurity across industry groups — corporate citizenship.*

International organisations

> *Set of internationally agreed "templates" for achieving biosecure aquaculture facilities/farms. These would cover the engineering factors, husbandry factors, quality assurance programs, the surveillance requirements and the certification for incoming and outgoing stock.*

Governments/international organisations

> *Government regulation at the local level to ensure compliance – and consistent application globally. A system where live animals could be sent with confidence from one biosecure facility to a similar (or lower) standard facility anywhere in the world (where the pathogens that may be present are known) — this is already happening in the areas of food hygiene, shellfish sanitation, and export fish-packing houses; why not for aquaculture?*

Biosecurity is a team effort — a shared responsibility. What should be strived for is consistency across the board and cooperation among relevant groups that have clearly defined jurisdictions. But we must have realistic expectations. However, left to itself, it is highly unlikely that industry groups/farmers will or can adhere to a minimum biosecurity standard — it only takes a small portion of a sieve to have a hole for the whole sieve to be useless! In the final analysis, government jurisdiction, be they at national or local level, have a public duty of care to ensure that all farmers comply with a minimum biosecurity standard.

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