Biosecurity: A New Word for an Old Concept

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ABSTRACT

Biosecurity is a fashionable word that is being used in a number of different circumstances, these are explored. The concept of biosecurity is used to cover the management of risks arising from biological organisms and agents that may cause harm to living organisms and other aspects of the environment. Following the spread of diseases such as whitespot syndrome virus and Taura syndrome virus in prawns, Akoya disease in pearl oysters and epizootic ulcerative syndrome in fish, the need for improvement in aquatic animal biosecurity has been recognised. The principles underpinning the development of a biosecurity program are identified. Biosecurity programs should have a strong scientific basis and use risk assessment to evaluate risk management approaches so as to ensure that the adopted measures provide appropriate protection without unduly hindering business opportunities.

INTRODUCTION

Biosecurity is a major theme of the Fifth Symposium on Diseases in Asian Aquaculture. This acknowledges the importance of biosecurity to the successful production and harvesting of aquatic animals and some of the recent problems that have resulted from the spread of diseases.

As a nation that exports about 70% of its primary production, Australia regards biosecurity as very important. Increasing numbers of live aquatic animals and their products, many of which are not highly processed, are being exported from Australia. Access to many of Australia's export markets, particularly for terrestrial animals and plants, is dependent on the maintenance of a high health status. The introduction to Australia of internationally significant pests and diseases would have a severe impact on access to those export markets.

In common with the rest of the world, aquaculture is of increasing significance in Australia. Although the Australian aquaculture industry is not large on a global scale, aquaculture is the fastest growing primary industry in Australia. As in other parts of the world, there is increasing concern about protecting aquaculture, wild fisheries and the aquatic environment in general, from introduced pests and diseases. Historically in Australia pests and diseases of aquatic animals did not command much attention and few biosecurity measures for aquatic animals existed prior to the 1970s, but there is now a call for improved aquatic animal biosecurity policies.

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In 1999, this growing concern culminated in the development of a nationally agreed strategic plan for aquatic animal health called AQUAPLAN (AFFA, 1999). It has eight component projects:

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

AQUAPLAN is in essence a national level biosecurity plan. It contains objectives, a communication and information sharing strategy, community awareness programs, surveillance and monitoring programs to detect disease problems, response mechanisms, uses scientific and technical information as a basis for the plan, an administrative framework and identified resources for implementation. As is essential with all biosecurity plans, AQUAPLAN is subject to regular review and revision to ensure that it meets contemporary needs.

Similar driving forces are at work internationally. Aquaculture has been growing rapidly to fill the widening gap between fisheries production and the demand for fisheries product, but knowledge gaps and the failure to implement adequate biosecurity measures have led to significant production losses. The need for more effective aquatic animal biosecurity is being recognised and discussed in many international fora.

This paper explores what biosecurity is, why the approach to biosecurity for aquatic animals is changing, the principles that underlie a good biosecurity program and future directions for aquatic animal biosecurity.

WHAT IS BIOSECURITY?

Literally biosecurity means ‘life protecting’, but its use appears to be restricted to issues related to preventing the introduction, establishment or spread of unwanted biological organisms or agents.

Biosecurity is a word that has become fashionable in recent times and is being used regularly in a range of circumstances. The word biosecurity is unlikely to be found in a dictionary, however it is accepted and used by many people as it serves their purpose. Its meaning is readily understood, most probably because it is a new term used to describe what has been practised for a long time in a number of different guises.

New Zealand’s Biosecurity Act of 1993 is one of the first official uses of the word (anon., 1993). Biosecurity is not defined by this Act, but its meaning is clear from the context. New Zealand’s Biosecurity Council has defined biosecurity as “the protection of New Zealand’s economy, environment and people’s health from pests and diseases. It includes trying to prevent new pests and diseases arriving, and eradicating or controlling those already present.”

Biosecurity has also been debated in the United Kingdom Parliament during a recent amendment of the Animal Health Act subsequent to the foot-and-mouth disease outbreak (anon., 2002). Although biosecurity was not defined, its meaning can be gathered from its use - "Biosecurity measures are measures taken to prevent the spread of causative agents of disease. Causative agent includes any virus, bacterium and any other organism or infectious substance which may cause or transmit disease."

Australia has established the agency Biosecurity Australia. One of its roles is to "permit safe trade while protecting Australia's plant, animal (including aquatic animal) and human health, and the environment through scientifically based biosecurity policy." The other important change in this regard is that Australia now refers to biosecurity instead of what had historically been termed 'quarantine' under the relevant national (federal) legislation, the Quarantine Act. The use of the word 'quarantine' in this way has caused confusion internationally as in most other countries quarantine is used to refer to the (mandatory) isolation of people, animals, plants or goods for a period during which their health status is determined or they are rendered 'safe'. Biosecurity is a more appropriate word which more accurately covers the range of issues dealt with by the Australian Quarantine Act.

The word biosecurity has become more widely used since the attack on the World Trade Centre last year and it is frequently used in association with terms such as food security and bioterrorism. In the latter case it refers to protection against the use of pathogens, such as anthrax, to infect the civilian population or to infect animal and plant populations to disrupt production and trade. Biosecurity is also used with regard to xenotransplantation and the threat of the transmission of agents between species.

The common theme running through all these situations, is the concept of taking appropriate measures or putting procedures in place to manage the probability of a biological organism or agent spreading to an individual, population or ecosystem and the harm that may result.

The biological organism or agent in these circumstances encompasses:

1. a recognised disease agent of humans, animals or plants (eg viruses, bacteria, fungi, prions, parasites);
2. a new or novel disease agent of humans, animals or plants;
3. a recognised pest species that causes economic damage; or
4. a species that would cause ecological degradation, reduce biodiversity, or other adverse environmental effects.

The population at-risk of harm caused by the unwanted biological organism or agent (usually pests and disease agents) are humans, plants or animals or some combination of these, though in some circumstances it could conceptually extend to the causing of harm to the physical environment alone. The geographic spread of the at-risk population could be the entire planet, a group of countries (e.g., European Union), a region involving parts of several countries (e.g., Mekong River basin), a single country, a sub-national region, a farming enterprise or establishment, a production unit (e.g., a pond) or an individual plant or animal. Biosecurity can be applied at all of these levels and appropriate programs should be developed as necessary for each level.

AQUATIC ANIMAL BIOSECURITY

An improvement in biosecurity practices is an increasingly pressing issue for fisheries and aquaculture managers, particularly as the value of aquatic animal production grows. Resource protection, food security, trade, production/profitability and investment/development issues are driving this change.

A stock-take of biosecurity outcomes for aquatic animals worldwide would show that some systems perform poorly, while other systems are successful.

Recent examples of major losses suffered by aquatic animals from pest or disease spread include the carp mortalities in Java, the infectious salmon anaemia outbreaks (and subsequent disease control programs) in Norway, the United Kingdom and North America, the whitespot syndrome virus and Taura syndrome virus epidemics in prawn aquaculture, the spread of epizootic ulcerative syndrome (EUS) in Asia and Akoya disease in Japanese pearl oysters. There are many other less spectacular examples of disease loss, which are important at a local level as they result in loss of production, perhaps resulting in unemployment or food shortages, loss of market access or market share, leading to bankruptcy or industry failure, reduction in industry development and investment, or environmental degradation. The flow-on effects to downstream processors and local communities can be severe.

Biosecurity practices are well developed in the intensive terrestrial animal industries, particularly the pig (swine) and poultry industries. Disease associated mortalities in the past, made more acute by increasingly intensive husbandry practices, have demonstrated the negative impacts of poor biosecurity practices. Even for diseases that do not result in high mortality levels, small percentage decreases in production, for example in feed conversion efficiency, can significantly impinge on an enterprise's profitability when large numbers of animals are involved. The situation in aquaculture is no different.

Worldwide, communities are demanding protection of the natural environment including the conservation of biodiversity and fisheries stocks. Many see aquaculture as a threatening process to wild stocks because of the movement of pests and diseases and changes in the prevalence of diseases brought about by aquaculture. As wild fishery resources are exploited at their maximal sustainable levels, or beyond, those with access want to see 'their resource' protected from threats, including from the spread of pests and diseases.

International trade rules have altered with the introduction of the World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Measures (WTO SPS Agreement) (WTO, 1994). New rights and obligations affect the way member governments develop and implement biosecurity measures. In developing countries the aquaculture production of species such as shrimp is often for export and has become an important source of foreign exchange. Sudden loss of export markets can have a devastating effect on communities and economies. On the other hand fishers, farmers and investors in the importing country, demand government action to protect against the introduction of foreign pests and diseases which threaten local production.

Biosecurity concerns for aquatic animals are heightened by the recognition of new pest and disease threats and the serious losses that have resulted, the so-called 'dread factor'. The expansion of aquaculture into new species and locations, coupled with intensification, has

created new problems. 'New age, real time communication' has allowed the rapid dissemination of information, often incomplete stories that are sensationally presented. Reports in the industry and scientific press, while tending to focus on severe examples, may provide a fuller picture, but their publication and critical assessment can be delayed. The seriousness of the situation can be overstated to raise the profile of the problem, often to gain an advantage in the search for further financial support. The rapid transmission of a distorted description can elicit a fear response by producers in other countries not familiar with the issues. This in turn can lead to demands for increased government protection and consumers switching to other commodities, even when there is no direct threat to their health.

PRINCIPLES OF A GOOD BIOSECURITY PROGRAM

The basic premise that underpins a biosecurity program is not complex; it is, in essence, the practical application of information to the management of identified risks. A biosecurity program is developed through the scientific analysis of information with the aim of adopting procedures to manage risks to an acceptably low level, ie through a risk assessment approach. The use of sound epidemiological principles and a logical, structured approach will result in a more accurate outcome. The management of biosecurity risk has a cost, including the direct cost of applying the measures, the indirect cost of loss of access to materials, changes in product quality and the diversion of resources from other useful functions. A risk assessment approach to the development of biosecurity programs allows for the identification of the most cost effective way to manage risks.

A biosecurity program that does not take into account the potential pest or disease impact, the expected benefits of the program, the cost of implementing the program, and its likely effectiveness could be wasting resources. Such an assessment should factor in future benefits that may accrue. There is little point in spending more in managing the risk of a pest or disease incursion, if its establishment would result in lower losses than the exclusion program costs to run.

The key elements in developing a biosecurity program should include:

- identification of the at-risk population that is to be protected by the program;
- identification of the threats/hazards;
- identification of the pathways by which the hazards could be introduced, establish or spread in the at-risk population;
- assessment of the likelihood of the hazards being introduced, establishing or spreading in the at-risk population;
- assessment of the level of harm that would result;
- if the risk is unacceptable, assessment of the effectiveness of the risk management measures that could be used to mitigate the risk;
- documentation of the program, its performance and auditing of the program;
- regular critical review of the program to ensure that the objectives are current and the measures are still the most appropriate;
- preparation of contingency plans;
- involvement of the program's participants in its development and operation; and
- provision of adequate resources to implement the program.

The same basic principles apply to developing a biosecurity program whether the program is for an entire country or a single tank of animals.

In the case of commercial enterprises, the biosecurity program should be part of a broader business risk management program for the enterprise covering other risks such as cash-flow problems, physical damage (e.g. cyclones, floods) and marketing problems. For governments, a biosecurity program may be part of a wider industry development program.

As an initial step, the objectives of the biosecurity program need to be identified to ensure that the program is well targeted. This includes a description of the population at-risk, the potential threats and identification of the pathways by which pests and diseases could be introduced.

Technical information needed for risk assessment

Accurate information is looked-for in undertaking biosecurity assessments; the better the information, the more accurate the assessment and appropriate the risk management measures. Biosecurity programs can only be as effective as the information on which they are based. In essence, scientific information can help refine risk management measures by allowing better targeting of the risks. For example, expert knowledge of the life cycle of the pest or disease agent, its interaction with the host and environment can frequently identify places where its life cycle can be easily broken, with greater certainty and more cost effectively. It can also provide alternative approaches to managing the pest or disease agent without the cost and inconvenience of isolating the host, such as breeding for genetic resistance or using host species or varieties that are resistant to disease, the use of strategic vaccination, and altering the environment to break the pest lifecycle.

Scientific information can be drawn from many sources including the peer-reviewed literature, from practical observation and experience, good practices used by other industries, demonstration farms, or from specific studies. Before use, all information should be critically evaluated for relevance and experimental design limitations. The risk assessment process can be used to identify gaps in the available data and their significance, thus providing future research direction and priorities.

Gaps in the scientific information are something with which aquatic animal biosecurity risk assessors are very familiar. For many aquatic species, knowledge of their pests and diseases is at best rudimentary. There is an increasing list of new pests and disease agents and new hosts for well-known pathogens. This trend can only be expected to continue. Research is necessary to gather baseline information, which can be used to help interpret new disease events and findings, and assist in determining if revised biosecurity risk management measures are needed.

Risk management

Decisions still need to be made irrespective of whether the scientific information is sufficient or not – it is not an option to delay taking action to protect the at-risk population. In such circumstances the best available information and expert opinion should be used as the basis of the biosecurity program. In situations where the available information about the pests and disease agents of an aquatic animal species is substantially deficient, general operating

practices and principles can be adopted to address the theoretical biosecurity risks. The principles used to manage known risks can often be effectively applied to emerging disease agents while further specific information is obtained. Frequently, epidemiological information about related pests and disease agents can provide guidance to measures that may be effective. In such circumstances, pending better data becoming available, it is usual to take a precautionary approach because of the uncertainty surrounding the effectiveness of the measure. Similarly, measures used to manage risk from one pest or disease agent may be effective in controlling the spread of other pests and disease agents.

A biosecurity program should only use necessary measures to manage the risks and not impose unnecessary impediments. There is a balance between the benefits of maintaining/improving the current pest and disease status and costs of implementing the measures. In determining which measures to apply, consideration should also turn to the feasibility of successfully implementing the measures, including the availability of technology and reliability of the infrastructure. If the measures are unpopular or provide incentives to break them, such as a financial benefit, trade may be driven underground and result in lesser levels of biosecurity protection than could otherwise be achieved by less stringent measures. Biosecurity risk managers should choose risk management measures for which compliance is easy to confirm or police.

In practice, there are many ways to manage biosecurity risk. Common approaches include the exclusion of genetic material or isolation of the population at-risk; testing to confirm disease status; vaccination; altering the environment to make it unsuitable for the pest or disease agent; treating the animal/product to kill the pest or disease agent; use of disease free zones or other restrictions on source; controlling the use of product to minimise exposure; and using reproductive materials instead of live animals. Risk assessment is the most appropriate way of determining which measure or combination of measures is the most effective at achieving the program's objectives.

Documentation

The biosecurity plan should be written down. This will provide continuity when there are staff changes and a basis for evaluation and review of effectiveness over time. Biosecurity programs should be regularly reviewed to ensure they remain current and meet new or altered risks. Record keeping of the program's performance provides a source of information for reviews and a basis for retrospective studies if the system fails. A system designed to provide measurable outputs for audit purposes will assist in this regard.

The role of the participants in the biosecurity program and specific actions they need to take should also be documented. The provision of standard definitions for important terms ensures a common understanding by the participants. Confusion is likely to lead to inappropriate actions, error and increased biosecurity risks.

Emergency response

There is always a chance of failure with biosecurity programs. Often this is a result of insufficient information for an accurate assessment of risk or human error. Biosecurity programs usually only seek to manage risk, not to eliminate it. It is usually not economically

feasible to eliminate risk. To reduce the impact of biosecurity failure, a sound epidemiological approach needs to be taken to the investigation of disease outbreaks to ensure rapid identification of the agent concerned. For the eventuality that pests and diseases enter, response plans should be prepared to minimise impact and isolate and eliminate the pest or disease agent rapidly. In preparing a response plan consideration should be given to damage that may eventuate and whether the response plan could cause more harm through restrictions on trade. The rapid dissemination of authoritative information can facilitate prompt responses and minimise impacts.

Communication

Communication, education and awareness are critical to a successful biosecurity program. The participants in a biosecurity program, whether beneficiaries or employees, need to understand their role and have sufficient training and resources available to effectively accomplish their role in the program. Their views and practical experiences should be captured and used in the design of the biosecurity program. Other community members who may benefit from, or who may adversely affect the functioning of, a biosecurity program need to be aware of the program so that they can contribute responsibly. A targeted communication strategy is required; modern communication technologies can assist in disseminating information quickly to a wide audience.

Biosecurity programs can and should be adopted by all enterprises holding aquatic animals. In the majority of situations enterprises, particularly commercial production units, can not operate their biosecurity programs in isolation. For example, neighbouring aquaculture establishments and other users of the water resources may contaminate the water supply or increase the load of disease agents in the local environment. Governments often do not have the resources to fully enforce all the biosecurity measures which it may have put in place. Industry needs to cooperate with government to ensure effective operation of biosecurity measures. Individual farmers should also work together to identify and address common risks.

Resources

For a biosecurity program to operate effectively and achieve its goals, adequate resources to implement the program and maintain its operation are essential. If resources are inadequate it is better to review and revise the program to ensure that the most cost effective measures, with the greatest chance of success, are put in place.
A biosecurity program can also be developed from the perspective of using it as a selling point to gain a market advantage and differentiate product in the marketplace. In these circumstances, market research can be performed to understand how the market would react and whether there is a sufficient price differential to justify the costs of the program.

These same principles apply no matter the size of the population at risk. Aquaculture establishments should not rely on Government controls being totally effective. These may break down from time to time for any number of reasons. Biosecurity risk management measures at the local level may provide sufficient barrier to prevent infection in the short term until the emergency response plan is activated.

Aquatic animal industries can build on the models developed by the other intensive animal farming industries. Intensification has meant that they too have had to develop systems to deal with biosecurity issues ñ the same principles apply although there may be added complications arising from the number of aquatic animal species, sharing of water supplies, knowledge gaps, etc.

THE SPS AGREEMENT

Trade is an increasingly important driving force for aquatic animal biosecurity. The SPS Agreement provides an internationally enforceable set of rights and obligations on the use of biosecurity measures by governments. Member countries of the WTO have a basic right to take necessary, scientifically justified measures to protect human, animal and plant life or health or their territory from damage by a pest, but these measures must be no more trade restrictive than necessary. Trading partners (or exporting countries) can demand that measures are justified and that alternative ways of managing risk are considered.

Sufficient scientific information is required to justify the imposition of measures by governments or to argue that alternative measures provide sufficient safeguard. The existence of effective official monitoring and surveillance programs is important in this regard. Such programs must use appropriate methodologies for sampling and testing, be backed by suitable transport and laboratory infrastructures, and have systems for collating and reporting the results.

There is one difference between the measures that non-governmental enterprises may use and the mandatory government controls at national and sub-national levels. This difference results from the international obligations that arise for WTO member countries from the SPS Agreement. For governments, the objective in managing biosecurity risk must be determined across the whole range of biosecurity activities. Governments must seek consistency in the level of protection they achieve (the so called appropriate level of protection or ALOP). Other than in the setting of their general objective (ALOP) for the entire biosecurity program, i.e., for aquatic animal biosecurity as a whole, Governments are limited in the consideration they can give to benefits in their decision-making. Non-governmental enterprises on the other hand are not limited in what they take into account; nor do they have to ensure that they approach the management of risks in a consistent manner. They can undertake a cost benefit analysis for each measure and vary their approach to risk management as it suits them. For example, a farmer can choose to accept a higher level of risk in particular circumstances where the expected benefits are seen as to be worth the risk (such as bringing in new genetic material).

DEVELOPING COUNTRIES

Developing countries can commence their biosecurity programs at a level which can be more easily and effectively implemented in their circumstances. An important initial step is to educate farmers about the risks, good risk management practices and how to reduce the risk of disease spreading between neighbours. The establishment of local networks can help raise awareness and foster a cooperative approach to problems.

Biosecurity programs should be developed with achievable objectives, commensurate with the available resources and technologies, and with regard to the robustness and reliability of the system. Programs should take into account the impact of the measures on the farmers and ensure there are clear benefits to the farmers, so that they will be willing to participate. The program should be regularly reviewed to ensure it is still appropriately structured, is meeting the needs of participants, is using appropriate technologies, remains cost effective and is addressing the current threats.

THE FUTURE

The level of biosecurity protection provided to the natural and built aquatic environment will increase because of the investment at risk and the property value given to the wild fishery and environmental values. The movement towards science-based risk assessment to develop biosecurity measures will gather pace because of the need to justify the measures to trading partners, investors, resource managers and the community more generally.

Consumer demand for high quality, healthy product will be another driving factor towards improved biosecurity. Rapid communications will mean that industry and governments will have to work closely together and be more responsive to consumer requirements.

The interdependence of aquaculture establishments sharing a common water resource, and therefore common biosecurity threats, will lead to greater levels of local and regional co-operation in managing associated risks.

More emphasis in aquatic animal health research will be placed on generating information to support biosecurity assessments to improve their accuracy and better-targeted risk management measures.

There will be a movement back to basic investigatory studies. Although more sophisticated methodologies are very useful, provide specific information and are cost effective, their specificity doesn't allow for the collection of more general observational information, especially in poorly studied aquatic animal species. With aquatic animal species much basic information is still needed to allow accurate biosecurity risk assessment and risk management.

CONCLUSIONS

Farmers have always cared for their stock, providing feed, shelter, water and health care. As scientific knowledge increases and the world becomes smaller, these basic husbandry skills must be expanded to include elements of prevention and harm minimisation. Improved approaches will be based on scientific assessment, including consideration of the costs and benefits; competitive pressures for continual improvement; and societal expectations.

Appropriate biosecurity management could have prevented many of the serious losses experienced in aquaculture in recent years. Biosecurity risks are increasing every year as aquaculture develops, new species are cultured and new host-pathogen-environment interactions are tested.

Biosecurity makes good use of science, makes good sense and is good practice when used appropriately. It can be a cost effective way of managing pest and disease risks.

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