INTERNATIONAL AQUACULTURE BIOSECURITY CONFERENCE

Practical Approaches for the Prevention, Control, and Eradication of Disease

PROCEEDINGS

August 17-18 2009

INTERNATIONAL AQUACULTURE BIOSECURITY CONFERENCE

Practical Approaches for the Prevention, Control, and Eradication of Disease

INTERNATIONAL AQUACULTURE BIOSECURITY CONFERENCE

Welcome to the International Aquaculture Biosecurity Conference

Aquaculture is a new and rapidly growing industry in many parts of the world. The rapidly increasing human population will require that intensive production of aquatic animals will be more and more important as part of the food supply.

A healthy population is fundamental for success in any sustainable food-producing industry. Low incidence and prevalence of disease with negligible use of antibiotics and other chemical compounds is the goal. However, any intensive bio-production – whether on land or in water – will have a risk for outbreak of disease. The same general principles and mechanisms for development of disease apply to both land-based and water-based animal production. However, fish farming differs from bio-production on land as infections which occur in a wild fish population as a sporadic event, may cause large mortality in fish ponds or net-pens.

The International Aquaculture Biosecurity Conference is a forum for information about practical approaches for the prevention, control and eradication of diseases in fish farming. Biosecurity contributes to further development of a sustainable food production in water, and it will be important for international trade as well as for food safety. The conference should also have a positive effect on the economic success of fish farmers and even reduce the suffering of diseased fish, thus having a fish welfare effect as well.

The speakers are internationally recognized experts in their field coming from different countries and continents. It is our intention that their presentations will help in establishing a framework for the development and implementation of science-based biosecurity plans and provide practical and effective tools to assist in the prevention, control and eradication of serious diseases in aquatic animals.

Biosecurity in aquamedicine is a science still in its infancy. The participants of this conference representing aquaculture producers and industry organizations, governmental and academic institutions are the pioneers of this science. It is our hope that the International Aquaculture Biosecurity Conference will generate knowledge which will contribute to a sustainable aquaculture industry world wide.

With best regards,

James A. Roth DVM, PhD, DACVM
Distinguished Professor and Director
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Co-Chairs, IABC Executive Committee

International Aquaculture Biosecurity Conference

Practical Approaches for the Prevention, Control and Eradication of Disease

Conference Objectives

Presentations by invited subject-matter experts will outline, elaborate on, and show the vital elements that are necessary to construct practical, effective and economical aquaculture biosecurity plans and programs. Pulling from existing, developing or conceptual biosecurity plans and programs throughout the world, in aquaculture and other animal production systems, the conference will address critical issues and establish a framework for preventing, controlling and eradicating aquatic animal diseases in aquaculture — from the farm to the nation.

Monday, August 17, 2009

08:30 - 09:00	**Introductions/ Welcome to IABC & Norway** *Representative of Norwegian Ministry of Fisheries*
09:00 - 09:30	**OIE and Biosecurity Programs** *Barry Hill – OIE*
09:30 - 10:00	**Aquatic Animal Biosecurity: FAO'S Mission, Vision and Activities** *Rohana Subasinghe – FAO*
10:00 - 10:30	**Coffee/Tea Break**
10:30 - 11:15	**Economic Impact of Disease and Biosecurity Measures** *Edgar Brun – Norway*
11:15 - 12:00	**Components of Ideal Biosecurity Plans and Programs** *David Scarfe – United States*
12:00 - 13:30	**Lunch**
13:30 - 14:15	**Minimizing the Consequences of Disease Introduction, Establishment and Spread through National and International Biosecurity Strategies** *Birgit Oidtmann – United Kingdom*
14:15 - 15:00	**Identifying and Prioritizing Hazardous Diseases and Evaluating Risks** *Brit Hjeltnes – Norway*

15:00 - 15:30 **Coffee/Tea**

15:30 - 17:00 **Benefits and Compelling Reasons to Develop Biosecurity Plans/Programs**
Session Synopsis/ Panel Discussion, All Speakers

19:00 - 21:00 **IABC Get-together Dinner**

Tuesday, August 18, 2009

08:30 - 09:15 **Determination and Mitigation of Risks of Disease Introduction into Aquatic Animal Sites**
Grace Karreman - Canada

9:15 - 10:00 **Aquatic Animal Disease Surveillance**
Angus Cameron - Australia

10:00 - 10:30 **Coffee/Tea Break**

10:30 - 11:15 **Diagnostic Testing, Veterinary and Farm Record Keeping**
Chris Walster – United Kingdom

11:15 - 12:00 **Contingency Plans for the Control and Eradication of Diseases in Aquaculture**
Niels Jørgen Olesen – Denmark

12:00 - 13:00 **Lunch**

13:00 - 13:45 **Implementing, Auditing and Certifying Biosecurity Programs**
David Scarfe – United States

13:45 - 14:30 **Integrating Components into Effective and Practical Biosecurity Programs**
Dušan Palić – United States

14:30 - 15:00 **Coffee/Tea Break**

15:00 - 16:30 **Refining and Implementing Practical, Effective & Economic Biosecurity Programs- from the Farm to the Nation**
Session Synopsis/ Panel Discussion, All Speakers

16:30 - 17:00 **Conference Summary / Closing Remarks / Future Programs**
Jim Roth – USA / Roar Gudding – Norway

18:30 - 21:00 **Joint IABC/AquaNor Reception**

INTERNATIONAL AQUACULTURE BIOSECURITY CONFERENCE

Practical Approaches for the Prevention, Control, and Eradication of Disease
August 17-18, 2009

Speaker Abstracts

Poster Abstracts

Poster Abstracts (cont'd)

People

General Information

IABC Registration, Secretariat and Information Desk

The Secretariat is located by the conference room of Rica Hotel Nidelven and is open for registration at:

Sunday: 1500-1800
Monday: 0800-1000

Participants will receive name badge and conference bag containing an abstract book, city guide, map etc.

If no one is present at the Registration/Information Desk the conference staff can be reached at telephone + 47 41 66 00 29 or + 47 95 15 01 44.

Name Badge

Your personal badge is your entrance ticket to the conference and all IABC social events. Please wear your badge at all times.

Pre-conference Excursion (Sunday, August 16)

The pre-conference excursion starts at 0900 and ends at 1700. Registered participants should meet in the hotel lobby at 0845. Please wear suitable clothes and shoes for visiting a farmed salmon operation.

Lunch

Lunch Monday and Tuesday will be served between 1200 and 1330 in the restaurant of the conference hotel. The cost of lunch is included in the conference registration.

Reception

The IABC "Get Together" informal dinner on Monday evening (1930) will be held in Café to Tårn, which is located at the visitor centre of Nidaros Cathedral.

The Aqua Nor Reception will be held at Rica Hotel Nidelven on Tuesday evening from 1730 to 2000.

AquaNor

Information about the exhibition is at www.aqua-nor.no. An entrance ticket will be distributed in the conference bag together with the Aqua Nor-catalog.

Walking from the hotel to the exhibition area at Trondheim Spektrum takes approximately 20 min.

Approximately cost for taxi to Aqua Nor is 150 NOK. Tuesday and Wednesday there is a complimentary bus service to Aqua Nor from Hotel Radisson Royal Garden which is located just 100 meters from Hotel Rica Nidelven.

Non-smoking Policy

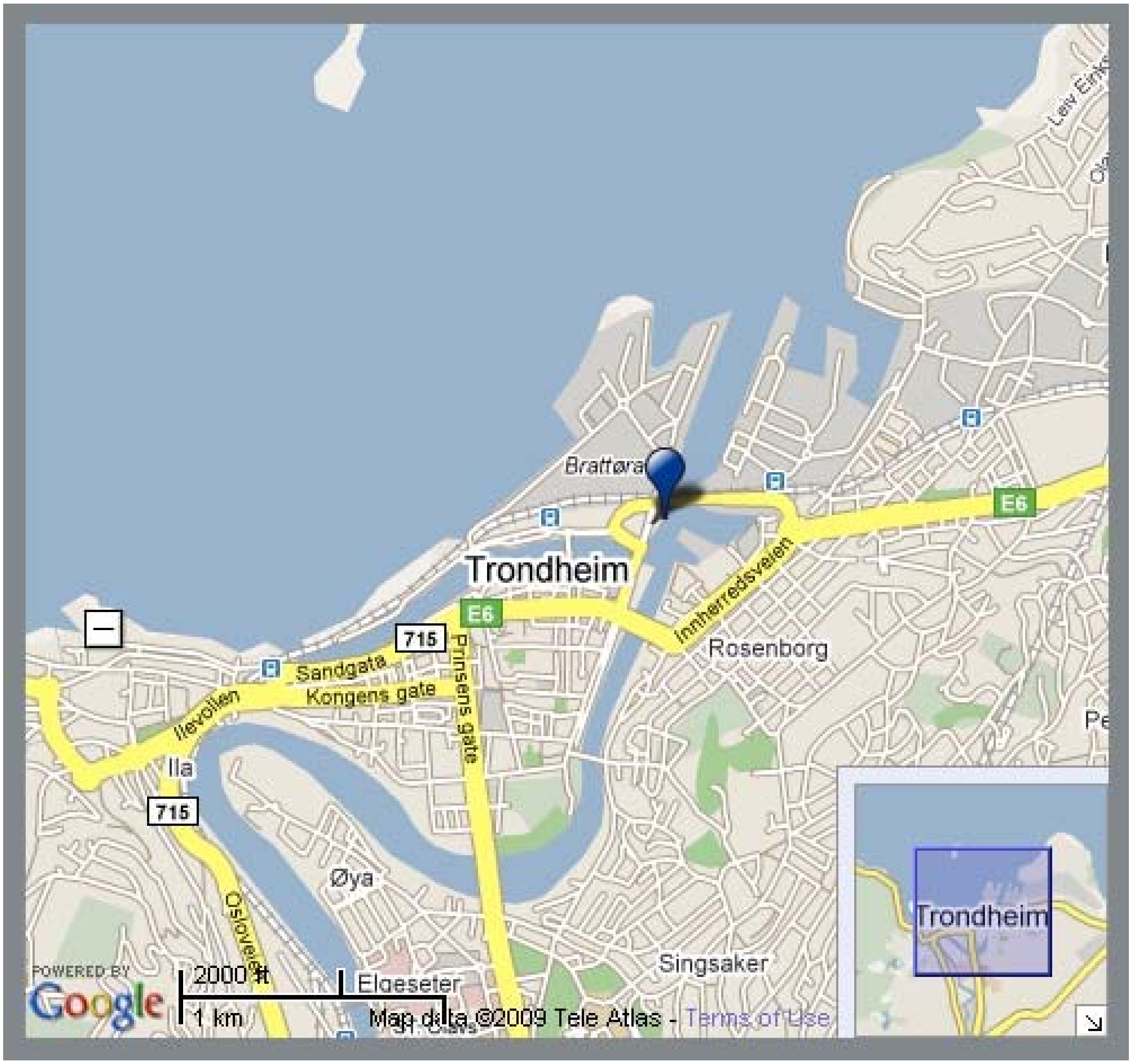
Please observe that smoking is not permitted in the conference, exhibition area and other public areas inside of the hotel. Smokers are requested to use the area outside the main entrance or outside the extra entrance to the conference section, up the stairs from the conference center.

Liability

The organizers accept no liability for personal injuries sustained, or loss or damage to property belonging to conference participants of accompanying persons, either during or as a result of the conference.

Useful Telephone Numbers

- Conference Local Staff: 416 60 029 or 951 50 144
- Rica Hotel Nidelven: 735 68 000
- Local Taxi: 07373 or 08000
- Scandinavian Airlines: 05400
- Norwegian Airlines: 815 21 815
- Norwegian Railways: 815 00 888
- Medical Emergency: 113
- International Code for Norway: +47



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Speaker Abstracts

OIE AND BIOSECURITY PROGRAMMES

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Evidence or the belief that serious diseases of aquatic animals have been, or could be, introduced into their territory from abroad has led some countries to impose strict controls on imports of live aquatic animals and their products. Although national quarantine and health certification requirements for imports are certainly a valid part of national biosecurity measures to prevent introduction of exotic diseases, they must be developed within the context of agreed international standards and should not be used as an unjustified barrier to competitive trade from other countries.

The need to fight animal diseases at global level led to the creation of the Office International des Epizooties through an international Agreement signed on January 25th 1924. In May 2003, the Office became the World Organisation for Animal Health but kept its historical acronym OIE. The OIE provides guidelines for preventing the international spread of animal diseases and these are the only standards recognised under the Sanitary and Phytosanitary Agreement of the World Trade Organisation (WTO) for animal health conditions applying to international trade in animals and animal products. The aim is to ensure the sanitary safety of international trade in live animals and their products. This is achieved by providing guidelines on the health measures to be used by the veterinary authorities of importing and exporting countries to prevent the transfer of agents pathogenic for aquatic animals, while avoiding unjustified trade barriers.

Due to the rapid global growth in aquaculture and the disease risks associated with the increasing international trade in live aquatic animals and their products, OIE activities in the field of aquatic animal health are of increasing importance. The development of OIE biosecurity guidelines for international trade in aquatic animals (fish, molluscs, crustaceans and amphibians) and their products is the result of the continuous work of one of the OIE's Specialist Commissions, the Aquatic Animal Health Standards Commission (AAHSC). The Commission has been continuously developing the standards in the Aquatic Animal Health Code (Aquatic Code) and the Manual of Diagnostic Tests for Aquatic Animals (Aquatic Manual) to better meet the needs for preventing the spread of fish, mollusc, crustacean and amphibian diseases through international trade, and to increase knowledge and awareness of their occurrence and distribution. In light of advances in scientific knowledge the Commission prepares draft texts for new chapters, or revises existing chapters of the Aquatic Code and Manual with the input of internationally renowned independent experts, OIE ad hoc groups, and the expertise at the many OIE Reference Laboratories for aquatic animal diseases. These drafts are further refined with input from OIE member countries before being presented to, and adopted by the national delegates of the 174 OIE member countries and territories during the meeting of the International Committee at the OIE General Session in May each year. The adopted text of new and revised Aquatic Code and Manual chapters are made publicly available as soon as possible on the OIE web site. The updated Aquatic Code is published in book form annually, while the Aquatic Manual is published every three years. The Aquatic Code and Manual therefore provide internationally accepted standards and guidelines, and a uniform approach to the diagnosis of, and surveillance for the diseases listed in the Aquatic Code, so that the requirements for health certification in connection with international trade in aquatic animals and aquatic animal products can be met.

The guidelines in the Aquatic Code are not just for live aquatic animals but are also for products derived from aquatic animals. Recently, criteria have been developed for assessing the safety, from an aquatic animal health perspective, of aquatic animal commodities in international trade. These criteria provide a basis for assessing the safety of aquatic animal commodities irrespective of the country's aquatic animal disease status. One set of criteria deal with the safety of aquatic animal commodities based either on the absence of the aquatic animal disease agent in the traded commodity or on the inactivation of the agent by processing the product. A second set of criteria deal with the safety of aquatic animal products destined for human consumption and are based on the expected volume of waste and absence of the pathogen in the waste tissue, as discarded (waste) tissues are an important pathway for exposure of susceptible aquatic animals to pathogens, if such are present in the imported aquatic animal product. These criteria are applied by the AAHSC for providing guidance for each of the listed diseases in the Aquatic Code as to which, if any, commodities of aquatic animals can be considered as safe for import without health guarantees for a particular disease in the country of origin. It is recommended that other imported commodities should be subject to the OIE health certification standards.

It is important to recognise that national import safeguards based on the OIE biosecurity guidelines alone may not prevent the sudden appearance of a serious disease in a country from which it was previously believed to be absent. Reasons include failure of an import risk analysis, ineffective surveillance for the disease/pathogen in the exporting country and inadequate enforcement of the import restrictions (e.g. illegal imports). Furthermore, there are other possible pathways for pathogen introduction than just the importation of live or dead aquatic animals (or their products for human consumption) e.g. dead wild fish as fresh feed for farmed fish or as fishing bait, live fish transport vehicles that have been used in other countries, and possibly ships' ballast water.

There is also a risk that disease may be introduced to a country or other epidemiological unit as a result of the accidental release of aquatic animal pathogens during or after international transport of packaged materials. Such pathogens may have been imported deliberately or inadvertently. It is therefore necessary to have in place measures to prevent their accidental release. These measures may be applied at national borders by prohibiting or controlling the importation of specified aquatic animal pathogens or pathological material, which may contain them. The OIE Aquatic Code provides detailed guidelines on how such material should be handled, packaged and transported to prevent accidental release.

Details of the key measures in the OIE guidelines will be presented and discussed.

AQUATIC ANIMAL BIOSECURITY: FAO'S MISSION, VISION AND ACTIVITIES

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FAO defines "biosecurity" as a strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) for analysing and managing relevant risks to human, animal and plant life and health, and associated risks to the environment. It covers food safety, zoonoses, the introduction of animal and plant diseases and pests, the introduction and release of living modified organisms (LMOs) and their products (e.g. genetically modified organisms or GMOs), and the introduction and management of invasive alien species. Thus, biosecurity is a holistic concept of direct relevance to the sustainability of agriculture, and wide-ranging aspects of public health and protection of the environment, including biological diversity.

The overarching goal of biosecurity is to prevent, control and/or manage risks to life and health as appropriate to the particular biosecurity sector (human life and health, animal life and health, plant life and health and environmental protection). Biosecurity is an essential element of sustainable agricultural development and food production.

Over the last decade, growing interest in biosecurity has been driven by many factors. These include globalization of trade in food, plant and animal products, changing food production practices and climate with new technologies, more international travels, new outbreaks of transboundary pathogens causing serious disease in animals, plants and people, heightened awareness of biological diversity, greater demand for public health and environmental protection, improved knowledge on the impacts of agriculture on environmental sustainability, and other emerging issues such as soaring food prices, climate change and animal welfare. The increased attention also recognizes the benefits of improving biosecurity, e.g. in safeguarding plant and animal life and health, enhancing food safety, promoting environmental sustainability and protecting biodiversity.

As an outcome, global agreements governing trade in agricultural and food products (e.g. WTO's SPS Agreement and TBT Agreement, CBD and Cartagena Protocol on Food Safety) are putting increased burden on competent authorities to improve their compliance standards that are associated with these agreements. Foremost of these are animal health and food safety standards within the biosecurity framework. Biosecurity lapses have, in many instances, caused impacts of varying magnitudes resulting to damage to environment and livelihoods of many.

Within the overall biosecurity framework, aquatic animal biosecurity is concerned with issues related to managing aquatic animal health, conserving aquatic biodiversity and reducing human health risks associated with consumption of products from aquaculture.

While above international standards are in place, appropriate policies or infrastructure that governs national biosecurity systems including integrated sectoral management are still lacking. There is thus, a need to provide guidance to countries to support the development and implementation of national biosecurity systems which are in accordance with their international obligations and based on their particular needs and priorities.

At the international level, responsibilities for aquatic biosecurity are shared among a number of organizations and bodies. Reflecting its mandate and competencies, FAO plays a leading role in normative work and technical assistance on aquatic biosecurity, for which the Department of Fisheries and Aquaculture has a long history of engagement, both at national and international levels.

Related activities include assistance to FAO members, through technical cooperation projects, in improving compliance to relevant international standards on aquatic animal health and food safety and in implementing the FAO Code of Conduct for Responsible Fisheries (CCRF). In particular, the CCRF Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals provide guidance in reducing the risks of introduction and spread of serious transboundary aquatic animal diseases through aquatic animal health programmes, national strategies on aquatic animal health and biosecurity, and the application of precautionary approach. The Department also pioneered in the application of risk analysis as a decision-making tool to support sustainable aquaculture development. FAO also facilitates discussion and agreement among regional countries to support the development of harmonized policies and regulatory frameworks that will improve governance in aquatic biosecurity. Current global programmes cover many regions, e.g., Asia and the Pacific, the Gulf, and the Western Balkan regions.

Special efforts are also being made to improve aquatic veterinary capacity in member countries through provision of specialised technical assistance and targeted training. FAO works closely with OIE in this area, particularly in Asia where over 90 percent of the global aquaculture is produced, and recently in Southern Africa through a collaborative programme following the outbreak of Epizootic Ulcerative Syndrome (EUS) in the Chobe-Zambezi river system.

ECONOMIC IMPACT OF DISEASE AND BIOSECURITY MEASURES

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The discipline of economics aims to support decision-making in the production of goods and benefits from scarce resources. The economic aspect of aquatic animal disease is closely related to the concept of biosecurity, which can be generally defined as a precautionary risk management practice designed to prevent disease entry or avoid its spread/transmission. This presentation will expand on these concepts and discuss them in terms of fish health management processes, the potential impacts of disease, biosecurity strategies, data requirements and epidemiological patterns.

In recent decades aquaculture has become the fastest growing food production sector in the world. Although the growth is slowing, its significance as a world wide supplier of seafood is steadily increasing. The aquaculture industry includes operations that range in size from small–scale family holdings to global multinational businesses,, and is a core economic activity in many local/regional and national economies. As a result, it greatly influences both financial and socio-economic levels of communities involved. In addition, because aquaculture production and seafood trade operates in one global market, the positive economic effects will be felt at the national level.

Diseases have become one of the main constraints to sustainable aquaculture production and trade. The disease challenge may partly be explained by the novelty of some of the production segments, an over all increasing production efficiency, and the global movement and trade in live animals and their products that has been facilitated by fast transportation systems. Therefore, to maintain growth and trade, and to control and prevent infectious diseases and their economic consequences, it is essential to focus on biosecurity measures at farm, local, national and international levels (including defined programmes guidelines, regulations and legislations).

Consideration of animal health economics and the impact of diseases can be quite complex, requiring a large set of production and epidemiological data for understanding the impact of the disease. Economics is a quantitative discipline measuring values in money. Aspects not easily quantified or easily given a monetary value are therefore traditionally left out of economic analyses. This may include impact on animal welfare and the environment, both of which need increased focus in accordance with their growing impact on market value.

On a macroeconomic level, the impact of disease outbreaks on national production may be devastating. In the worst cases, direct losses have amounted to several hundred million US$ in animal losses, loss of jobs and loss of trade opportunities. Direct production loss due to white spot disease (WSD) alone in China (1993) and Thailand (1996) has been estimated to be more than US$ 900 million. In some instances most farms in an area have gone out of production. In Ecuador WSD caused production losses valued at US$ 600 – 1,000 million, with over 500,000 jobs lost in the sector as a direct or indirect consequence of the disease. On the other hand, due to this global market, farms, countries or segments with biosecurity in place that focus on the prevention, control and eradication of infectious and contagious diseases, may get distinct economic advantage avoiding such outbreaks because of drops in total production volume, increase in prices and opportunities for new market shares.

For investors, diseases and increased production costs may weaken the interest for investing. An example of this was seen on the Oslo stock exchange in the 2007-2008 where the value of seafood companies was reduced with more than US$ 4 billion.

At the farm level, partial budgeting is one method used to estimate the direct cost of a disease. In Norway, the loss due to pancreas disease has recently been estimated at 14 million NOK per farm where an outbreak occurs. Such estimations are important in order to understand the limits for economic opportunity available for control and preventive measures (opportunity costs). As biosecurity measures will effectively apply to several infectious and contagious diseases, the cost of implementing biosecurity measures for each disease would be proportionally reduced – or alternatively, the return for investment of implementing biosecurity programs that address multiple diseases will be compounded. In an economic evaluation of three notifiable diseases in the UK, control and preventive measures for infectious salmon anaemia and viral hemorrhagic septicaemia showed a positive benefit-cost ratio, while similar spending on infectious haematopoietic necrosis could not be economically justified.

COMPONENTS OF IDEAL BIOSECURITY PLANS AND PROGRAMS

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"Biosecurity" is a relatively recent term gaining prominence. It has been defined very broadly to encompass any adverse biological event. However, increasingly it is being applied to describe procedures associated infectious and contagious diseases. Effective biosecurity plans and programs aimed at diseases involve more than simply implementing prevention measures. Particularly because in most situations it may be impossible to totally isolate most livestock or aquaculture operations from any and all diseases at all times, biosecurity programs must also include contingencies for inadvertent disease outbreaks, including control and possible eradication measures.

To be effective, useful and justifiable to all stakeholders (including producers, industries, service providers and government agencies) biosecurity programs need to include: a series of integrated and documentable processes and procedures that focus on optimal disease prevention, control and eradication practices; be founded in sound science; use practical approaches that are easily understood; be as economical as possible; and, have strong incentives to encourage compliance. These requirements are equally important for all programs, whether voluntarily initiated at farm or industry level, or mandated through government legislation and regulations.

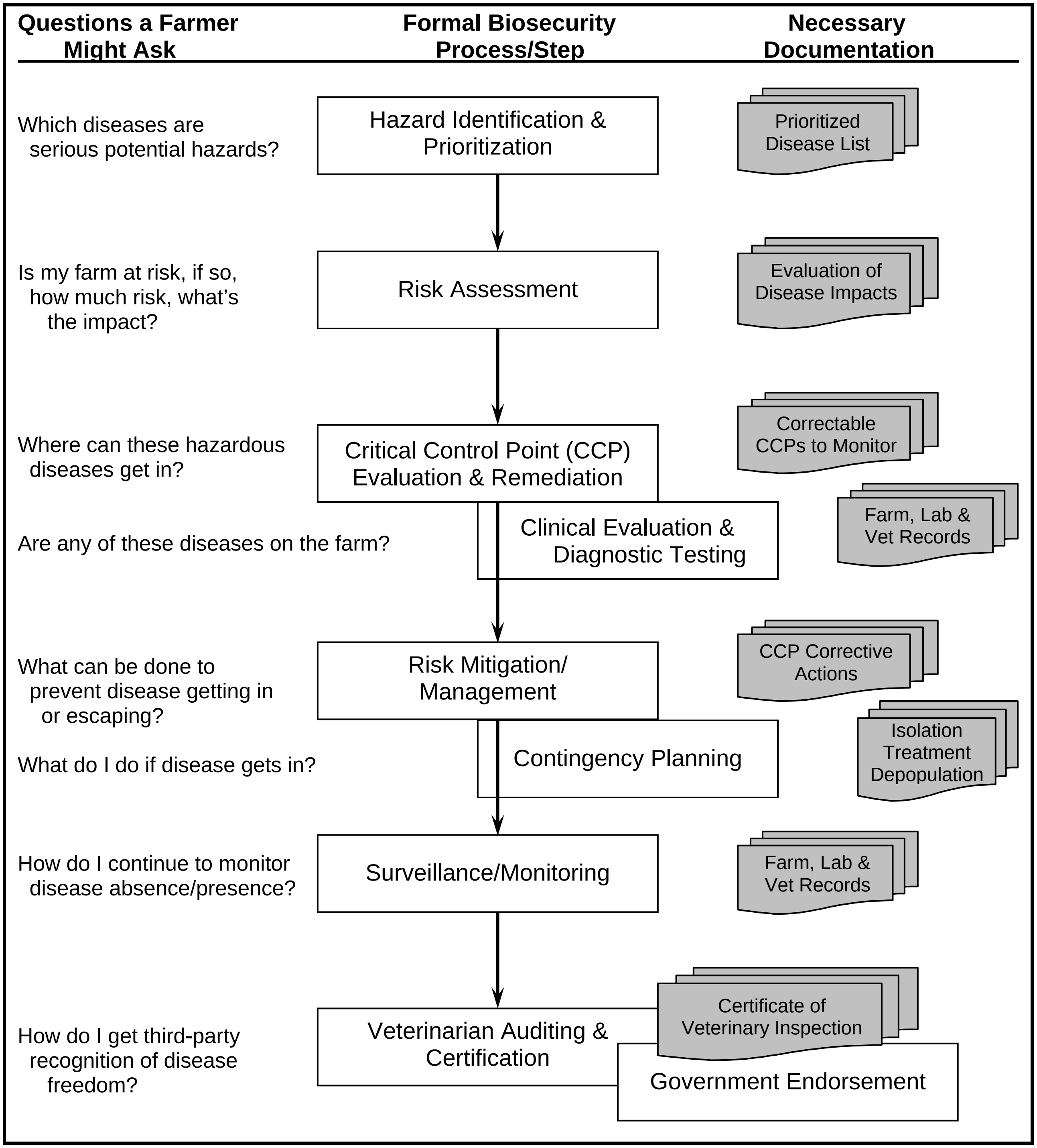
Functionally, aquaculture biosecurity programs must address epidemiological units that can be focused on individual tanks or ponds, whole farms, compartments, zones or watersheds, and can extend to geopolitical areas such as states/provinces, nations, or regions of the world. Ideally, effective, useful and justifiable approaches for developing and implementing biosecurity programs should consider the same principals, irrespective of the size of the epidemiological unit. These can, and to some degree have been implemented as voluntary programs at the level of the farm or industries (often described as "Best Management Practices"). However, equally important, these may be initiated or incorporated at national and international levels (typically through legislation and regulations, or using OIE and FAO standards or guidance documents).

For biosecurity plans and programs to be functional, effective and justifiable for aquaculture they need to involve several formal processes, including:

- ***hazard and risk analysis*** (hazard identification and prioritization, risk assessment/evaluation, risk management/mitigation and risk communication);
- ***analysis and remediation of critical control points*** (including evaluation and mitigation plans for correcting practices where disease could enter or leave the epidemiological unit);
- ***epidemiological principles*** (including necessary diagnostics, surveillance, monitoring and determining the status or freedom of diseases in the epidemiological unit);
- ***emergency preparedness*** (contingency protocols for disease control and eradication); and,
- ***auditing of procedures and records, and certification*** (providing assurance of disease freedom and useful as compliance incentives).

Figure 1 illustrates generalities of how these processes and procedures may be integrated into aquaculture biosecurity plans and programs.

Figure 1. Ideal process of integrated steps for developing, implementing, auditing and certifying a biosecurity program intended to prevent, control and possibly eradicate disease in any epidemiological unit[1] (a tank/pond, farm, state/province, zone, region or country).



[1] Epidemiologic Unit— a defined population of animals, separated to some degree from other populations, in which infectious and contagious diseases can be transmitted

MINIMISING THE CONSEQUENCES OF DISEASE INTRODUCTION, ESTABLISHMENT AND SPREAD THROUGH NATIONAL AND INTERNATIONAL BIOSECURITY STRATEGIES

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With a growing global human population and an increasing demand for food protein, aquatic animal protein has become an increasingly important resource. In several geographic areas, wild stocks have been severely over-fished, increasing the demands on aquaculture. In response, aquaculture production has dramatically risen over the last 30 years. Movement of live aquatic animals, within and between countries, for aquaculture and the ornamental trade, are important routes of disease spread. Over the last several decades, many aquatic animal diseases have emerged to have a substantial economic impact on aquaculture, sometimes with ecological consequences. Examples include: infectious salmon anaemia, koi herpesvirus, white spot syndrome, epizootic ulcerative syndrome, and viral haemorrhagic septicaemia.

Effective biosecurity strategies provide protection to both farmed and wild fish population by minimising the risk of introducing pathogens and minimising the consequences if the pathogen was introduced. The World Organisation for Animal Health (OIE) is the internationally accepted body that provides guidelines and standards for national biosecurity frameworks through the development and updates of the OIE Aquatic Animal Health Code and Manual of Diagnostic Tests for Aquatic Animals.

National biosecurity strategies have been developed and are evolving in some countries that share an interest in protecting and developing its national aquaculture businesses. At a national level, biosecurity strategies of countries that are OIE members need to comply with international standards developed by OIE. The components of national biosecurity frameworks range from laws (legislation and regulations) that regulate trade and disease monitoring and control measures, to industry codes of practices and farm level biosecurity plans. These components combined provide a framework designed to minimise the risk of introduction, early disease detection, and limit the consequences of pathogen introduction.

The cooperation of industry is essential for effective national biosecurity programs and can be compromised if compensation is unavailable when animals have to be destroyed in the event of a disease outbreak. Early detection and rapid response by government to exotic or high priority disease outbreaks is critical to minimising the impacts. Strengthening targeted and general surveillance through improving farmers, veterinarians and diagnostic laboratories capacity and willingness to report disease is critical to rapid detection. Clear disparities exist in the capacity of developed countries with strong veterinary infrastructures to control disease, compared with developing countries. Support from developed countries to support biosecurity in developing countries can be viewed as means to reducing the risk of disease emergence and spread.

Examples of national biosecurity strategies that are already implemented and published aquatic animal disease contingency plans are presented. The scope of these, the extent to which they fulfil requirements of guidelines established by inter-government organisations (OIE, FAO) and their contribution to national and international biosecurity is discussed.

IDENTIFYING AND PRIORITIZING HAZARDOUS DISEASES AND EVALUATING RISKS

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Developing and implementing effective and acceptable biosecurity programs for aquaculture require scientifically-justified approaches to identifying and prioritizing diseases that are hazards to production, and the application of risk analysis principles, including risk evaluation, risk management or mitigation and risk communications.

Good fish health management is a key to success in aquaculture, and a sustainable production relies on this. Recent experiences from aquaculture producing countries such as Canada, Chile, Faeroe Island, Scotland and Norway have confirmed that diseases may constitute a serious threat to the aquaculture industry. Examples of such diseases are Infectious Salmon Anaemia (ISA) and Pancreas Disease (PD). These will be further discussed.

In order to prioritize and develop targeted contingency plans it is necessary to monitor the disease situation. A close cooperation between industry, fish health services and governmental authorities is required to achieve this. A high scientific and ethical standard of the different parts is fundamental. Monitoring must be based on adequate legislation defining obligations to report both notifiable diseases and emerging diseases, and the disease information should ideally cover the total panorama of disease information. Correct disease information relay on skilled diagnostic laboratories. Furthermore, competent and well functional fish health services are essential to identify early signs of disease and health problems. Several fish diseases do not show acute outbreaks with high mortality, but may over time result in significant losses and represent major fish health and welfare problems.

New and potentially emerging diseases will often require further investigations to identify causality and evaluate future risks. To get the whole picture, information needs to be collected in a centralized system for trend analyzes and identification of risks. Studies may include screening programs, challenge trials and epidemiological studies. Collection of fish health data should be done in a cost effective way and electronic registration systems are being developed.

DETERMINATION AND MITIGATION OF RISKS OF DISEASE INTRODUCTION INTO AQUATIC ANIMAL SITES

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Biosecurity can be defined as a system of processes (i.e., inputs, movements and other activities), each with a set of procedures, that taken together minimize the risk of introduction and spread of infectious organisms within or between aquatic animal populations. Biosecurity measures at the site level include bioexclusion (prevention of pathogens from entry), within-site infectious disease control (management of pathogens within a facility) and biocontainment (prevention of pathogens from release). This presentation will focus on bioexclusion of pathogens/diseases from commercial aquaculture facilities. Viral hemorrhagic septicaemia virus (VHSV) in salmonid species will be used as an example.

Although HACCP or HAACP-like analyses have been used to look at biosecurity measures in aquatic facilities, HACCP is designed to identify risks of contamination by food-borne pathogens and to institute measures to keep levels below scientifically justifiable critical limits. Infectious disease control, which focuses on disease freedom and negligible risk of tranferring pathogens that replicate within a host to produce disease, relies on risk assessment that identifies mitigation points and mitigation measures intended to reduce risk to neglible in aquatic animal populations. A new model needs to be developed that incorporates both infectious disease control principles and the monitoring and verification steps from HAACP.

A risk assessment can estimate the risks of introducing pathogenic organisms or disease into an aquatic animal site and provide recommendations for mitigation of the risks. Components of an introduction risk assessment include hazard identification (i.e., diseases of concern), hazard characterization (presentation of the appraised science, the susceptible species list and information for mitigation measures) and estimation of the likelihood of introduction of each identified hazard given the introduction scenario (in this case, it is assumed the consequences are similar for each hazard). Sources of disease introduction include aquatic animals, water, fomites, vectors and feed.

An on-site analysis provides the scenario for pathogen introduction into the site. There must be a working understanding of the production biology of the species, the physical layout of the facility and the process flow for operations. Specific points of pathogen introduction can be identified by systematically evaluating *every step* in the process flow for potential inputs of the pathogen into the site, by:

- Infected or exposed live animals
- Contaminated water
- Contaminated vectors
- Contaminated fomites
- Contaminated feed

The mitigation measures in place to reduce the risk to negligible should also be identified. There are approximately 20 generic types of mitigation measures applicable to potential introductions though animals, water, vectors, fomites and feed. Gaps where mitigation measures should be in place are also identified.

A documented biosecurity plan is the only way of demonstrating that disease control is happening without an ongoing effective testing plan. After the risk assessment is complete, the site can produce a biosecurity plan outlining the identified points of pathogen introduction and the mitigation measures to reduce the risk of introduction to negligible. The plan includes the production biology of the species, the physical layout of the facilities and the process flow for operations. Standard operating procedures (SOP's) are developed for each of the mitigation measures using a standardized format. The plan includes all records necessary to document the appropriate implementation of the mitigation measures. The plan also includes quality control checklists to record verification that the mitigation measures are being followed. Plans are typically reviewed once yearly to incorporate physical, biological, and operational changes that necessitate updates to the plan.

AQUATIC ANIMAL DISEASE SURVEILLANCE

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Biosecurity decision making

Implementing an effective biosecurity plan, either at the farm level or the national level, requires a series of sometimes complex decisions. Some of these decisions are based on technical knowledge of pathogens and production systems, but others require information about disease threats. In biological systems, it is rare that we have a complete understanding of the situation. One view of epidemiology is that it is a science that assists us to make good decisions in the presence of uncertainty. This is achieved through an understanding of risk and probability, the integration of multiple sources of information, and the use of practical and efficient techniques for getting the required information when it is not already available. Disease surveillance describes a suite of approaches to gathering information on the disease status of populations, in order to make good decisions.

Characteristics of surveillance systems

The purpose of disease surveillance can be divided into two broad areas. For diseases that are present, the purpose is to describe the level and / or distribution of the disease, or observe how these change over time. The most commonly used measure is prevalence, although incidence and other measures may be used. For diseases that are *not* present, the purpose of surveillance is to demonstrate that the farm or country is free from the disease, or to provide a system for early detection of disease if it should enter the farm or country. While sample collection in the field and laboratory analysis may be similar, the analytical methods used for these two situations (disease present or disease absent) are fundamentally different and should not be confused.

In order to design an effective surveillance system, or evaluate existing systems, it is important to understand the characteristics of a surveillance system. These include features such as the coverage of the population, representativeness, disease focus, source of surveillance data and reason for its collection, purpose and objectives of the surveillance, type of data collected, cost, practicality and quality of surveillance.

The quality of surveillance is measured in different ways depending on the purpose. For surveillance for diseases that are present, the key quality indicators are precision (lack of random error) and accuracy (lack of systematic error). For surveillance for diseases which are absent, the key quality indicator is sensitivity, or the probability that the surveillance system would be able to detect disease, if it were present at some specified level.

Approaches to surveillance

Aquatic animal disease surveillance is often more challenging than surveillance for diseases in terrestrial species. There are a wide range of situations that need to be considered, from largely static populations (farmed adult molluscs), tightly enclosed and controlled populations (aquaria and tanks), semi-open populations (caged fish in lakes or oceans), linear populations (rivers or coast-lines), or unrestricted wild populations in lakes or the ocean. Each of this variety of different situations offers new challenges and new opportunities for efficient surveillance. Some of the challenges include difficulty finding and seeing the animals, the large size of some populations, difficulties in achieving a representative sample, the high value of individuals for some species and the seasonal expression of signs and the ability of pathogens. To face these and other challenges, and to exploit available opportunities, it is advisable to have a broad range of surveillance options available when designing the optimal surveillance system for a given situation.

Surveys and structured sampling have formed the mainstay of aquatic disease surveillance for many years. These approaches are important and valuable in many situations, but other options exist, including passive disease reporting, syndromic and indirect surveillance of indicators of disease, surveillance at processing plants, and sentinel surveillance. Newer analytical techniques mean that ‘messy’ non-random surveillance data can now be analysed to produce valid measures.

Surveillance for diseases that are present

Bias and precision are important measures when undertaking surveillance for diseases that are present. Precision is largely determined by sample size, but also the level of variation in the population. Bias may arise from a number of different sources, including selection bias, measurement bias, confounding and analytical bias. Where possible, these should all be avoided. When this isn’t possible, an alternative approach is to endeavour to clearly understand the bias and take it into account in the data analysis. The avoidance of bias has important implications for survey design, and usually requires representative sampling.

Surveillance for diseases that are not present

Sensitivity is the main measure of quality for this type of surveillance. In contrast to surveillance for diseases that are present, risk-based surveillance (also called targeted or biased sampling) can increase sensitivity and be of significant benefit when trying to demonstrate freedom or detect incursions of disease.

While sensitivity is often used to measure the quality of surveillance to demonstrate freedom from disease, a more useful and easily understood outcome is the probability of freedom. In calculating the probability of freedom based on the sensitivity of surveillance, it is also possible to take into account important factors such as the benefit of previous (historical) surveillance, the risk of introduction of disease due to imperfect biosecurity, and the contribution of multiple different surveillance activities.

Surveillance standards

The use of these concepts and approaches for demonstration of freedom from disease creates new opportunities for redefining national, regional or global standards for surveillance. Instead of defining surveillance standards in terms of inputs (for instance, the number of fish to be tested and frequency of testing), standards can be defined in terms of the output achieved (the probability of freedom from disease). This means that the actual surveillance activities that are used on farms can be tailored to the specific needs, taking into account the existing level of biosecurity, the history of surveillance, and the most cost effective approaches to surveillance given the farm’s individual circumstances.

DIAGNOSTIC TESTING, VETERINARY AND FARM RECORD KEEPING

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It is crucial for effective biosecurity programs aimed at preventing, controlling or eradicating selected diseases, to have written biosecurity plans and documentation of key husbandry procedures applied to epidemiological units (i.e., a tank/pond, establishment, compartment, zone or country). This documentation should include: identifying and prioritizing which diseases are targeted; assessing the level of risk from these diseases; evaluating critical points for introduction or transmission; specific actions mitigating introductions or transmission; contingency or emergency procedures to be implemented in the event of a disease outbreak; and, veterinary medical records of periodic clinical assessment of animal populations including diagnostic test results. Documentation will require the involvement of several individuals knowledgeable about biosecurity processes and requirements at the farm-level. Collectively, these records will provide information for the assessment of the effectiveness on previous management actions. Application of these elements to an example aquaculture operation (farm or establishment) will be described.

Farm and veterinary records are necessary for the review and certification of disease status. Depending on the specific intent of the biosecurity program, including consideration of practical implementation, appropriate diagnostic testing will be selected based on veterinary and farm records. Important components of these decisions include: movement of stock, personnel and equipment, measurements of water quality and other environmental parameters, crude and cause-specific mortality frequency, and the use of vaccines and therapeutic agents. For any biosecurity program to work efficiently and effectively it is essential to have a consistent communication between the attending veterinarian, the farm, the diagnostic laboratory, the competent authority and in some cases, neighbouring facilities. These concepts will be illustrated through examples of hazard determination, implementation of mitigation procedures, and use of farm, veterinary, and diagnostic records to evaluate disease status, and certificates of veterinary inspection.

Sufficient documentation of biosecurity procedures, provided the measures are practical, is likely to increase successful implementation and farm compliance when owners and farm managers understand the reasoning behind suggested procedures. However, the most important factor ensuring compliance is that stakeholders must recognize a real benefit, usually an economic return, for any increased labour or expense related to the biosecurity program. Certifying commercial operations are free of specific diseases is likely to raise the value of products and expedite trade, but only if all facilities undergo the same scrutiny.

CONTINGENCY PLANS FOR THE CONTROL AND ERADICATION OF DISEASES IN AQUACULTURE

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The aquaculture industry is rapidly developing towards highly intensive production. Industries producing more than 3,000 tons fish in the same sites are no longer unusual and outbreak of serious infectious diseases in such production units can have devastating impact. The rapid increase in aquaculture production and trade and the growing general awareness of health issues should prompt the National Competent Authorities in countries with aquaculture to issue contingency plans for serious diseases of economic importance in order to reduce the serious impact of diseases in cases of outbreaks.

Outbreaks of infectious salmon anaemia from 2001-2003 caused a breakdown of the salmon industry in the Faroe Islands with a reduction in production of 90%. Recent outbreaks of the same disease have caused loss of more than 7,000 jobs due to reductions in the Chilean salmon industry. The fact that infectious hematopoietic necrosis has spread to many areas in the world is most probably due to trade. Only by implementing efficient trade regulation and other measures, the risk of further spread of the disease can be reduced. Viral haemorrhagic septicaemia is causing serious losses in rainbow trout production in Europe. Due to efficient implementation of contingency plans the disease have in recent years been contained and eradicated from both newly infected and endemically infected areas in Northern Europe. General requirement for contingency planning in aquaculture and examples of successful and failed control programs is described.

Criteria and requirements for contingency planning in aquaculture are described in the OIE Aquatic Animal Health Code, in Council Directive 2006/88/EC, and in several other international standards. In general, these guidelines shall ensure that contingency plans meet at least the following requirements:

1. The **legal powers** needed to implement contingency plans and put into effect a rapid and successful eradication campaigns;
2. The access to **emergency funds, budgetary means and financial resources** in order to cover all aspects of the fight against the diseases;
3. A **central decision-making unit** must be in charge of the overall direction of control strategies and a chain of command must be established to guarantee a rapid and effective decision-making process for dealing with emerging diseases;
4. Detailed plans must be available for the immediate establishment of **local disease control centres** in the event of an outbreak;
5. **Adequate resources** to ensure a rapid and effective eradication, including personnel, equipment and laboratory capacity must be allocated;
6. **Adequate laboratory facilities and skills** to ensure correct diagnosis (e.g. proficiency and quality assurance and quality control processes must be in place in participating and reference diagnostic laboratories);
7. An up-to-date **operations manual** must be available, with a detailed, comprehensive and practical description of all the actions, procedures, instructions and control measures to be employed in handling the diseases including emerging diseases;
8. Detailed plans must be available for **emergency vaccination**, where appropriate;
9. Staff must be regularly involved in **training** in clinical signs, epidemiological enquiry and control of epizootic diseases;

10. Take into account the surge capacity and **resources needed to control a large number of outbreaks** occurring within a short period of time;
11. Ensure that **sanitary slaughter** is carried out in accordance with recommended welfare principles;
12. Ensure that actions on veterinary and **environmental safety issues** are properly coordinated; and,
13. Take into account any **mass disposal** of aquatic animal carcasses and aquatic animal **waste** is done without endangering animal and human health, including the identification of appropriate sites for the **treatment or disposal of animal carcasses and animal waste**.

A rapid emergency response epidemiological investigation is mandatory in order to determine the source of an infection and thereby to decide upon the most efficient response to apply. Such epidemiological studies will include clinical inspections, sampling and laboratory diagnostic testing.

The most common sources of new infections are the direct introduction by trade, infection from neighbouring farms through water supply, birds or personnel, infection from wild aquatic animals or the conversion of previously undetermined non-pathogenic agents into high virulent pathogens. At a first glance a disease outbreak will often be associated with the introduction of animals in preclinical stages of a disease, but in several cases such outbreaks could also be due to the introduction of highly susceptible species into contaminated environments.

Even if the source of infection remains undetermined it is very important to rule out a number of classical pathways of infection in order to reduce the risk of further spreading. Therefore trained personnel, appropriate laboratory facilities, and close collaboration between competent authorities and the aquaculture industry are the key elements of a successful determination of source of infection. For re-evaluating and correcting critical control points and personnel and management the principles of HACCP (hazard analysis and critical control point evaluation) should be applied in contingency and crisis planning in order to be prepared for rapid and efficient reactions to changes.

Inclusion of vaccination and treatment strategies in relation to control and eradication (stamping-out) programs has become more and more acceptable with the increased focus on ethical and animal welfare issues. With the development of DIVA, vaccines that clearly differentiate vaccinated animals from natural infection should be used. By example, the Faroe Islands implemented an eradication program for ISA that included a vaccination campaign of all farmed Atlantic salmon in order to reduce the infection pressure of ISA virus. While IHN has traditionally been controlled through traditional eradication programs in western Canada vaccination programs using DNA vaccines are now used for controlling the spread of IHN. As more efficient vaccination and treatment tools become available these may become common features in future contingency planning.

Contingency planning shall include overall plans and strategies for recovery and regaining disease free status, including requirements to health status and origin of aquaculture animals for restocking. Detailed programs for re-establishing disease free status should be available when, and should including disease surveillance inspection schemes and laboratory diagnostic testing within a specified time frame. In the EU, such guidelines for regaining disease free status are given in Commission Decisions under Council Directive 2006/88/EC. Alternatively the competent authorities might decide to leave a new emergence to be handled and managed by the industry alone and to disregard a possibility for official control with risks for implication on trade.

Practical applications of contingency plans and examples of source determination and management of disease outbreaks will be given, including information on: First outbreak of BKD in Denmark, 1996; First finding of VHS in United States 1991; First outbreak of VHS in Finland 2000 and in Sweden 1999 and their consequences; Outbreak of VHS in Norway 2007; and Eradication of VHS from Denmark 1965-2009.

IMPLEMENTING, AUDITING, AND CERTIFYING BIOSECURITY PROGRAMS

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The primary objectives of implementing a biosecurity plan or program is to establish and maintain a high level of assurance that a selected epidemiological unit (tank/pond, farm, zone, country, etc) is not diseased, or infected with specific infectious and contagious pathogens. Certifying an operation, or other epidemiological unit, as specific pathogen free (SPF) offers a number of obvious benefits and advantages. For commercial aquaculture advantages include greater animal production, increased economic value of saleable products, and a distinct trade advantage. Similarly, the release of SPF certified animals for habitat or resource replenishment will also positively impact aquatic ecosystems.

Developing, implementing, auditing and certifying any comprehensive biosecurity program may be complex and comes at a cost. The benefits and costs, along with developing practical approaches for implementing and applying biosecurity principles, and the need for necessary education, training, credentialing and certification programs for all involved, will need to be carefully assessed. This will be particularly important for the large number of resource-limited, small-scale producers that are involved with a considerable share of the world's aquaculture production.

Implementing, auditing and certifying biosecurity programs may be driven by industry and/or governmental needs, but inevitably the most palatable, feasible and practical will be those that involve government-industry partnerships and cost-sharing. Several voluntary, industry-driven biosecurity or certification programs are evolving and may have some application to animal health and biosecurity. Some examples include: U.S. Marine Shrimp Farming SPF Program; World Wildlife Fund-led Aquaculture Dialogues; Global Partnership for Good Agricultural Practice (GLOBALGAP); Global Aquaculture Alliance's Best Aquaculture Practices (BAP) certification standards. Currently no voluntary biosecurity certification schemes have fully integrated the veterinary biosecurity principles, approaches and infrastructure required to effectively meet biosecurity objectives. Several national programs with industry-government involvement are in progress in, for example, Europe, N. America and Australia. Increasingly disease-free and biosecurity program requirements are being addressed in legislation and regulations (e.g. 2006/88/EC) and government-endorsed international standards (e.g. OIE Code) for use in live animal trade and commerce.

Implementation of biosecurity plans or programs to meet the primary objectives will require input, documentation and vigilance of many individuals, including the personnel overseeing animal and facility care and maintenance, veterinary and diagnostic service providers, and competent government officials. Education and training programs will be needed for producers and private and government sector service providers to ensure all involved have a full understanding of all biosecurity principles, including: hazard identification and prioritization; risk assessment/evaluation, risk management/mitigation and risk communication; analysis and remediation of critical control points where disease could enter or leave the epidemiological unit; epidemiological principles, diagnostics, surveillance, monitoring and determining the status of, or freedom from diseases; emergency preparedness and contingency protocols for disease control and eradication; and, record keeping, auditing and the use of certificates that address declarations related to biosecurity procedures not typically found in existing model certificates used for documenting animal health. The complexity and time involved in implementing these requirements and achieving and maintaining freedom from disease (SPF) may require a biosecurity certification system that progressively recognized increasing levels of biosecurity. As has been done elsewhere, web-based, train-the-trainer, and on-farm workshops will be effective tools for disseminating this information.

The auditing of implemented biosecurity procedures and records, and certifying disease-freedom or SPF needs to be undertaken by a credible, knowledgeable and experienced independent third-party, as these responsibilities are accompanied by legal and professional liability. Traditionally these responsibilities are assigned to veterinarians but, in some jurisdictions that have a reduced veterinary workforce, veterinary paraprofessionals (e.g. fisheries officers) are sometimes utilized. Validation, verification (auditing) and certification that effective biosecurity plans or programs have been developed and implemented are the basis for issuing Certificates of Veterinary Inspection (CVI; health certificates). Inspection certificates are a very effective risk communication tools to document that the epidemiological unit has been evaluated, that appropriate disease risk mitigating procedures (prevention and control) are in place, and to validate that animals have been examined and tested to verify the absence (or prevalence) of disease. When endorsed by the government agency with regulatory authority over aquatic animal health (competent authority), biosecurity certificates provide the official credibility that the primary biosecurity objectives have been met. Having a sufficient experienced and credentialed workforce to provide these services to support aquaculture is imperative, particularly if done with government oversight or involvement and if used for international trade purposes. Evaluating this workforce capacity using the OIE VPS Tool may be warranted in some countries, and a system for competent authorities to accredit this workforce as competent officials to perform aquatic regulatory functions (similar to existing national veterinary accreditation systems in many countries) would substantially expand national capacities to support aquaculture industry growth and trade.

INTEGRATING COMPONENTS INTO EFFECTIVE AND PRACTICAL BIOSECURITY PROGRAMS FOR AQUACULTURE

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Biosecurity programs for aquaculture operations are important and necessary measures that can fulfil three objectives: 1) prevent, control and possibly eradicate a disease within a respective epidemiological unit – from tank or pond, to the nation; 2) provide financial dividends to the producer (private or government); and, 3) fulfil requirements for existing or emerging legislation, regulations and international standards when used for intra- and inter-national trade.

Development and implementation of effective, justifiable, practical, and economical biosecurity plans and programs requires the efforts and cooperation of experienced and knowledgeable veterinary and para-veterinary health professionals, aquaculture producers and government officials. Therefore, the goal of this presentation is to provide an overview of the necessary components for the design and implementation of integrated aquaculture biosecurity programs and the roles of appropriate parties in the following activities:

1. Identifying stakeholders: government (local/state/national), producer (type/operation), service providers (veterinarian; para-veterinary fish health biologists; insurance agent, etc.), industry service providers (shipping, feed suppliers, wholesalers);
2. Building relationships to understand the producer's and governmental goals, type of operation and target achievements;
3. Identifying and prioritizing specific disease hazards, followed by assessment of the actual risk and impacts from a disease outbreak;
4. Identifying and prioritizing critical control points, followed by the development of a plan and application of standard biosecurity procedures;
5. Developing a schedule of disease diagnostic sampling, submission and clinical inspection;
6. Supervising and optimizing record keeping and disease occurrence monitoring;
7. Auditing, issuing (or revoking) veterinary aquaculture biosecurity certificates of inspection (V-ABC);
8. Ensuring compliance with the local, state, national regulations and requirements or international trade agreements/rules, and seeking official government endorsement of the V-ABC.

The optimal implementation of any effective biosecurity program will therefore require utilizing an integrated approach of experienced and credentialed teams of individuals with a full understanding of epidemiology, pathobiology, clinical and laboratory diagnostic assays for hazardous diseases, and biosecurity, disease transmission routes, and risk analysis and assessment of critical control points. In addition, it will be important for all parties to understand auditing and certification and the associated professional ethics and liability, a producer's operation and business goals, and government and trade regulations and requirements.

Poster Abstracts

BIOSECURITY STRATEGY OF THE LIVE GENE BANK PROGRAMME FOR WILD ATLANTIC SALMON IN NORWAY

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The National Veterinary Institute in Norway operates the Gene Bank Programme for Norwegian Atlantic Salmon (*Milt bank* and *Live Gene bank)* on behalf of the Directorate for Nature Management. The purpose of the live gene bank is to establish a living reservoir of genetic material from the most endangered stocks of Norwegian wild Atlantic salmon. This living reservoir can be employed in rapid reestablishment or enhancement of threatened stocks when conditions in the rivers allow it. The live gene bank presently consists of fish from 22 endangered Norwegian salmon stocks.

To a certain extent the live gene bank employs many of the technologies and procedures customary of commercial aquaculture. The biosecurity strategy of the live gene bank is however quite unique and is based on freshwater rearing and isolation throughout the lifespan of the fish. Scales readings exclude escapees from the broodfish material, and stock identity is established by DNA analysis. Furthermore all wild broodfish undergo a full necropsy and testing for Infectious pancreas necrosis virus (IPNV), *Aeromonas salmonicida* and *Renibacterium salmoninarum* (BKD). Hence, only disinfected eggs from wild, SPF broodfish are introduced to the gene bank facilities.

To detect and exclude infected groups each year-class is kept isolated for four years. After four years, individually tagged fish from the oldest year-classes are reared together. Stocks are however kept apart the whole lifespan.

The biosecurity strategy of the living gene bank is presented. The feasibility of integrating this biosecurity strategy in commercial brood stock rearing is discussed.

A QUALITATIVE ASSESSMENT OF THE RELATIVE RISKS OF INFECTIOUS SALMON ANAEMIA TRANSMISSION ASSOCIATED WITH THE MOVEMENT OF LIVE AND DEAD FISH TO HARVEST IN SHETLAND

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Following confirmation of Infectious Salmon Anaemia (ISA) in January 2009, in the south west Shetland mainland, movement controls have been established to minimise its spread. At the time twelve stocked farm sites were in the process of harvesting three thousand tonnes of fish, mainly Atlantic Salmon. The harvest process involves: corralling fish within each cage; pumping fish to well boat; transportation of live or dead fish to processing plant, either within or out with the management area; primary processing of fish, involving evisceration, followed by discharge of treated effluent to sea. All procedures are guided by industry codes of practice (A code of good practice for Scottish finfish aquaculture, COGP) to ensure containment of fish, blood and blood products from farm site to process, and while controls are in place these procedures are under the supervision of government officials.

Since the ISA outbreak, fish farming companies have applied to harvest fish live by well boat. No live fish movements by well boat have historically been approved by Scottish officials out with an ISA affected management area. Staff of the marine laboratory has conducted a qualitative risk assessment to determine the relative risks associated with the harvest of live and dead fish, taking into account the development of well boats as a secure means of moving live fish. Consideration is also given to the risk of non-compliance with procedures and the possible impact on the control of ISA within Shetland and Scotland. This risk assessment consisted of assessments of the individual risks associated with different processes associated with alternative harvesting methods.

The greatest risks identified include: escapes or the release of fish at each stage of procedure and during transportation by well boat; inadequate disinfection of vessels when operating at a new site from a control zone; release of blood water and untreated effluent out with the controlled area; and poor biosecurity, particularly inadequate cleaning and disinfection of equipment. These practices can result in the spread of ISA within and out with the control zone. Risks from these practices can be minimized by following good working protocols, under conditions of audit and inspection.

Risks associated with dead fish movements are judged higher than that of live fish harvest. Biosecurity while loading and unloading fish appears to pose higher risks than the method of harvest and transport, however risk reduction methods are considered achievable and non-compliance judged to be low – dependent on adherence to procedures.

ECONOMIC IMPACT AND RISK CONTROL EFFECTS OF VHS (*Viral hemorrhagic septicemia*) ON FISH FARMING IN FINLAND

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VHS-virus (VHSV), among other fish diseases, may have large impact on fish farming profitability. VHS is economically one of the most important fish diseases in European Rainbow trout farming. VHSV may cause high mortalities, loss of production and other costs in fish farming units. Therefore it is important that the virus is not wide-spread in the industry.

In Finland VHS was observed in turn of the Millennium. In the first occasions attempts to eradicate the disease were made and the fish farmers got full compensation from the Finnish Government. However the disease spread rapidly and thereafter government was forced to think other options to oppose virus in industry. Finnish Food Safety Authority (Evira) started to evaluate more practical and economical biosecurity program against VHSV. In co-operation with Evira the task of Finish Game and Fisheries Research (FGFRI) Socio-Economic unit was to assess economical risk to fish farmers.

The assessment of economical impact and risk was designed to commit in two methodological steps. First those entrepreneurs, of whom units VHSV has contaminated, were interviewed in purpose to clarify the effect of the disease to the production and farming practices. According to interviews and knowledge from literature it was determined, how the characteristics of the virus affect farming production and how the effects could be avoided with pre and post risk control. Next we used bio-economic production planning model, designed for fish farming profitability analysis, to evaluate Economic effects. Production planning applications are useful in analysis where several variables affect the result simultaneously.

The effects of VHSV were analyzed for four diverging production lines or cycles, because it was seen, that the effects vary in different production practices. Economical effects were modelled to four postal effect and risk control options; effects of mortality, maintaining production capacity when mortalities concern fingerling, immediate harvesting and effects of decontamination and production brakes. The pre risk control effects were assessed to change in production cycle length, procurement price of a fingerling and location strategy of farming units.

The largest economical impacts arise when fish die close to harvesting, when the value of fish are the highest. It is expensive to decrease volumes and economic of scale due to possible production breaks because of biosecurity sanitizing, if the production cannot be maintained with new fingerling purchase. Decentralizing the risk to other dispersed units is also inefficient. Change in production practices may also cause large changes in profitability due to market price and increased production cost.

SPRING VIRAEMIA DISEASE OF CARP (SVC) MONITORING AND SURVEILLANCE PROGRAMME IN VIETNAM

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Ornamental fish aquaculture is one of the important and valuable export industries within Vietnamese fisheries products. Major ornamental species are freshwater fishes, located mainly in Ho Chi Minh and surrounding areas. In 2008, total 250 ornamental fish farms in Ho Chi Minh City areas were able to produce 45 million fishes and to export about 4.2 million fishes. Recently, in order to increase exportation values of the ornamental fish, the government of Vietnam has recognized the need to establish a disease control and surveillance program to meet international standards. Spring viraemia disease of carp (SVC) monitoring and surveillance program was first selected to operate in four well-known ornamental farms in the Ho Chi Minh areas. This programme aimed to certify SVC-free farms in Vietnam under the Docket No. APHIS-2006-0107 dated August 30, 2006 by Animal and Plant Health Inspection Service, USDA, and pursuant to the Agreement on the Application of Sanitary and Phyto-sanitary Measures and the Aquatic Animal Health Code and the Manual of Diagnostic Tests for Aquatic Animals of the World Organization for Animal Health. The programme was implemented by the Fisheries Quality Assurance and Aquatic Resources Protection Department of Ho Chi Minh City. Strong collaboration was made with South East Asia Fisheries Development Center (SEAFDEC). Observation was initially by the National Fisheries Quality Assurance and Veterinary Directorate (NAFIQAD) and followed by the Department of Animal Health (DAD) due to the merge of the Ministry of Fisheries (MoFi) into the Ministry of Agriculture and Rural Development (DARD) in January 2008. Two training courses on PCR and EPC cell culture techniques for SVC detection in October 2006 and August 2007 with 7 laboratory technicians of NAFIQAVED and the Ho Chi Minh City Fisheries Quality Assurance and Aquatic Resources Protection Department were held. Four samplings were carried out during 2 years programme period and total 337 koi carps were screened. The result showed that no SVC susceptible fish in the koi carp population of the three sampled farms was found. Daily farm records and biosecurity practices were also regularly investigated by authority competent. As the result, three following farms had met all requirements and certified by the Department of Animal Health as being SVC-free:

1) Sai Gon Aquarium Corporation, Code No.: 01/TY-ATDB;

2) Ba Sanh Koi farm, Code No.: 02/TY-ATDB;

3) Chau Tong fish farm: Code No.: 03/TY-ATDB.

FACTORS BEHIND EMERGENCE OF DISEASES IN SCOTTISH AQUACULTURE

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Production of farmed salmon has increased rapidly in recent decades. However, this increase has been interrupted by diseases and parasites. The reasons for the emergence of these diseases can be understood in terms of activities associated with aquaculture using a method based on Risk Analysis. Processes are divided into pathogen introduction to aquaculture, spread to farms, invasion of farms which causes disease (consequence).

1) The pathogen may come from a variety of sources. It may already be present in the country, or it may be imported from abroad especially with movement of fish or fish products, or a pathogen may evolve from non-pathogenic organisms.

2) The spread of pathogen between sites determines the scale of any emergence. The most effective means of spread is with movement of live fish, but fish products or equipment can also spread pathogens, as may water currents or by escaped fish.

3) Having reached a farm site the pathogen must invade the farm population. Factors associated with poor aquaculture practice can enhance this. However, biosecurity, medicines or good husbandry can reduce disease risk.

4) Consequence, or disease results in losses of life, welfare or production; this step is rarely evaluated properly. But ultimately risk cannot be assessed, or appropriate control budgets set, without a consequence assessment.

MANAGEMENT OF RISK TRANSMISSION OF VIRUS DISEASES VIA FOOD USED TO FEED BLUEFIN TUNA (*Thunnus thynnus*) IN MURCIA (SE SPAIN)

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The fattening of bluefin tuna is a very important economic activity for Spanish aquaculture, and mainly for the Mediterranean area. The feeding is exclusively based on full specimens of little pelagic and cephalopods species, which come from fishing grounds different to Mediterranean. In order to prevent future infections, The Fisheries and Aquaculture Service of Murcia Govern have started in 2006, an experimental program to assess the risks derived from the introduction of exotic viruses in local wild fishes and in aquaculture farms because of this feeding process.

The 410 specimens investigated were negative, therefore no pathogen viruses were found. The meaning of these epidemiologic data and the basis for future monitoring campaigns are discussed.

DEVELOPMENT OF A PILOT PROGRAMME FOR EPIDEMIOLOGIC VIGILANCE OF VIRUS DISEASES IN MURCIA (SE SPAIN)

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The Fisheries and Aquaculture Service of Murcia Govern have started in 2007 an experimental program of epidemiology vigilance in aquaculture in order to measure the risks coming from some virus diseases from aquaculture farms and from wild fish. Besides, it is necessary to know the risk of virus transmission between both sides of the nets. We have studied fish grown in farms, fish from the same species but coming from the wild, species that can be usually found around aquaculture farms and monitored these species for virus diseases.

From the 1622 fish studied (2007-2008), 585 came from aquaculture and the remaining fish came from the wild. The viruses investigated were: Viral Encephalopathy and Retinopathy (VER), Viral Hemorrhagic Septicaemia (VHS) and Infectious Pancreatic Necrosis (IPN). We have found positive samples for nodavirus and Infectious Pancreatic Necrosis but we have not found any positive sample for Viral Hemorrhagic Septicaemia. The discussion covers the epidemiological meaning of the data. Finally, new monitoring campaigns are recommended based on this information and experience.

AN OVERVIEW OF THE SCOTTISH CONTINGENCY PLAN FOR *Gyrodactylus salaris*

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Scottish Government, in co-operation with relevant stakeholders including aquaculture and wild fisheries interests, has produced a contingency plan to deal with the presence and detection of the monogenean helminth parasite *Gyrodactylus salaris*, within Scotland. *G. salaris* has caused extensive mortality among wild Atlantic salmon (*Salmo salar*) populations in parts of Norway. This, combined with the evidence that Scotland's wild salmon strains are susceptible to the pathogen, highlights the need to prevent the introduction of the parasite into Scotland and elsewhere in the United Kingdom. It also highlights a requirement to be prepared to act in the event of an outbreak should biosecurity be breached and *G. salaris* become established in Scottish waters. The policy of the contingency plan is based upon eradication, where this is deemed possible, and where it is not, a policy of containment prevails. This poster considers the steps necessary to help prevent the introduction of *G. salaris* into Scotland and gives an outline of the contingency plan with emphasis on its development and key components.

A MODELLING APPROACH TO ASSESS THE ROLE OF FARM SIZE IN THE TRANSMISSION OF WATERBORNE PATHOGENS BETWEEN FARMS

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One of the routes by which infection can spread between net pen farms is through movements of water. A coupled hydrodynamic particle model is derived to ascertain the impact of farm size on the water-borne transmission of pathogens between farms over varying distances. The simple hydrodynamic aspects of the model include the representation of sinusoidal tidal currents, constant advection and random turbulence diffusion. Idealised pathogens are shed from infected individuals in a farm and move within the hydrodynamic part of the model and decay with exposure to the environment. Should these particles become in contact with susceptible individuals at a secondary farm then there may be exposure leading to these individuals becoming infectious, and subsequently release additional source of infection. The derived discrete epidemiological model with a free living pathogen phase allows for simulations to be produced which represent low level through to very high levels of infection.

Within the model framework the number of individuals within farms can be altered to represent farm size. The model indicates that farm size and distance between farms are important for predicting pathogen dispersal. Large farms produce more pathogen particles than small farms, and also are more susceptible to exposure and establishment of infection. Initial results indicate that pathogens with higher decay rates (such as ISAV) are more likely to be controlled through the implementation of large farms located with greater separation distances. However, for pathogens with greater environmental survival, the increased pathogen production and susceptibility render the strategy of having fewer larger farms ineffective.

The model is currently being used to assess the establishment of infection in secondary farms to ascertain possible strategies to minimise farm to farm transmission of a range of pathogens. The model will be supported with a questionnaire study of other processes that affect biosecurity and are related to farm size.

DETECTION AND SEROTYPE DISTRIBUTION OF *Listeria monocytogenes* IN RAW AND SALTED ANCHOVY AND RAW MUSSELS USING IMS BASED CULTIVATION TECHNIQUE AND PCR

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Listeriosis is a severe infectious disease characterized by meningitis, abortion, septicemia, and high mortality rate. Numerous foodborne outbreaks of *L. monocytogenes* have been documented worldwide due to consumption of contaminated foods. *L. monocytogenes* has been isolated from a variety of foods including meat, poultry, sea foods, and vegetables. Sea foods including ready-to-eat products, which are not cooked or processed before consumption, have also been found to be contaminated with *L. monocytogenes*. Serotyping has been widely used to characterize *L. monocytogenes* and has epidemiological importance. Serotypes 4b, 1/2a, and 1/2b are the predominant serotypes associated with human listeriosis. Epidemiology and surveillance of transmitting diseases are important tools to produce safe foods from farm to table, to prevent public health and for biosecurity. However, there is little information available concerning the serotype distribution of *L. monocytogenes* in sea products especially anchovy and mussels.

The objectives of this study were to detect *L. monocytogenes* in raw and salted anchovy (*Engraulis encrasicolus*) and raw mussel (*Mytilus galloprovincialis*) samples using IMS based cultivation technique and PCR, and to determine the serotype distribution by multiplex PCR.

In the present study a total of 150 samples including 50 raw anchovy, 50 salted anchovy and 50 raw mussel samples collected from the retailers and small scale producers in Samsun province from Black Sea region of Turkey were used as material.

L. monocytogenes was isolated from 2.0 % (1/50), 12.0 % (6/50) and 2.0 % (1/50) of the raw and salted anchovy, and raw mussel samples tested, respectively. According to the serotype distribution, 7 out of 8 *L. monocytogenes* isolates (6 from salted anchovy and 1 from raw anchovy) were identified as 1/2b and only one *L. monocytogenes* isolated from mussel belonged to both of 1/2b and 4b serotypes.

The result of the study indicated that high numbers of salted anchovy samples were found to be contaminated with *L. monocytogenes* serotype 1/2b, which may pose a potential risk. Therefore precautionary measures in all stages of production should be taken for food safety and public health.

MANAGEMENT APPROACH IN CONTROLLING STREPTOCOCCOSIS IN TILAPIA CAGE CULTURE SYSTEM IN MALAYSIA

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Results of a 2-year epidemiological study on *Streptococcus agalactiae* infection in caged tilapia revealed high prevalence of streptococcosis in huge-sized reservoirs and rivers and low prevalence in small-sized irrigation canal, mining pool and ponds. High water temperature of 31-32 ^{o}C recorded in April to July was strongly associated with disease outbreaks. Furthermore, tilapia of more than 200-300 g in weight was apparently more susceptible. As such, management approaches may significantly reduce the incidence of streptococcosis. Measures to avoid keeping tilapia of more than 300 g during the critical hot months of April to June should be considered seriously. Therefore, strategic management of 'all-in all-out' culture system that avoids keeping susceptible-sized tilapia during the hot months can reduce stress, lateral transmission and incidence of streptococcosis. The above management measures could considerably help in controlling outbreaks of streptococcosis in cage-cultured tilapia that caused an alarming economic loss to tilapia farmers at present.

PRELIMINARY STUDY OF DETECTION OF ANTIBODIES TO KOI HERPESVIRUS IN KOI STOCKS IN MALAYSIA USING AN ELISA

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Koi herpesvirus (KHV) (also known as Cyprinid herpesvirus 3, CyHV-3) infection is an OIE listed disease that has caused high losses in common and koi carp in Indonesia and Japan in 2002 and 2003. Since mid-2006, the PCR has been used in Malaysia for surveillance of koi fingerlings for detection of the virus nucleic acid, but it produced unreliable results. An alternative ELISA technique for the detection of antibody against KHV was used find evidence of KHV infection in koi carp stocks on farms that had been sampled for PCR.

A total of 245 serum samples from koi carp stocks (>6 months) were collected from 15 farms in Tronoh, Perak, Malaysia. All sera were tested for antibody to KHV by the ELISA at the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) laboratory, Weymouth, UK. 208 samples were negative but 37 samples were either definitely positive or close to borderline positive and all were retested. The final result showed that 222 (90%) samples were confirmed as negative and 19 (8%) samples were definitely positive (antibody titres of 1:800 or greater). Four samples (1.6%) were positive at dilutions of 1:400 or 1:200 but cross reactions with CyHV-1 (causing herpesviral epidermal hyperplasia) can occur at those dilutions. Three of those samples were the only positive fish at two sites, but the fourth sample came from a site at which there were 4 definite positive samples (from 20 fish sampled).

This study confirmed that Malaysian koi stocks have been previously exposed to KHV, even though the farmers claimed that they were using local stocks without new introduction or importation of broodstocks in the last 30 years. With the lack of bio-security measures and awareness, there was a high probability that the koi carp had been exposed to KHV leading to subclinical infections and possibly some fish may have become carriers of the virus. Hence, further screening and studies need to be conducted to determine the true situation of KHV infection in Malaysia.

PROTECTION OF KURUMA SHRIMP *Marsupenaeus japonicus* AGAINST WHITE SPOT DISEASE VIRUS INFECTION USING RNA INTERFERENCE

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White spot disease virus (WSDV) is a major cause of high economic losses in kuruma shrimp *Marsupenaeus japonicus*, since 1993. So far, several antiviral therapies have been demonstrated to control and eradicate WSDV in shrimp. They include DNA vaccine, recombinant protein vaccines and herbal immunostimulants to protect shrimp. Recent applications using RNA interference technology against WSDV are found to be promising and effective strategies in controlling the disease. In the present study, a gene specific and full length double stranded RNA was prepared for WSDV-VP28 gene by in vitro transcription method. Challenge experiments were performed in *M. japonicus* (10 g) by intramuscular injection of VP28-dsRNA (2.5 µg per shrimp) followed by WSDV infection after 24 hrs, expecting 95-100% mortality in 9 days of duration. The results revealed that the protective efficiency of VP28-dsRNA in *M. japonicus* against WSDV infection is more than 85%, which was observed up to 25 days post infection (d.p.i.), whereas mortality of positive control reached 100% in 10 d.p.i. Various assays including bioassay, RT-PCR, western blotting, immunohistochemistry (IHC), histology and DAPI staining were performed to confirm the knockdown of VP28 gene. No positive signals were observed in the selected organs sampled in VP28-dsRNA/WSDV infected shrimp at 7 d.p.i. by the RT-PCR and western blot. No symptom was observed in the sections of gills and Oka organs of VP28dsRNA/WSDV infected group by histology and IHC, whereas occlusion bodies and specific anti-VP28 positive staining of WSDV-infected tissue sections. DAPI staining of hemocytes revealed no sign of condensation and fragmentation in VP28-dsRNA administered group, those which were observed in WSDV infected group. Experiments are ongoing to develop an effective oral delivery method of VP28-dsRNA for implementation in shrimp farms. RNAi might be a promising prophylactic approach and efficient strategy to control and/or eradicate WSDV in *M. japonicus* culture farms.

THE POTENTIAL OF AUTOGENOUS VACCINES FOR THE CONTROL OF RAINBOW TROUT FRY SYNDROME, REDMARK SYNDROME AND ENTERIC RED MOUTH IN SALMONIDS

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Rainbow Trout Fry Syndrome (RTFS) and Enteric Red Mouth (ERM) cause major economic and welfare costs for the salmon and trout aquaculture industries of the UK. *Flavobacterium psychrophilum* has also been implicated as the aetiological agent of Red Mark Syndrome (RMS) in trout. Sampling for *F. psychrophilum* and *Yersinia ruckeri* was carried out to assess the prevalence of different serotypes in hatcheries and associated on-growing sites for autogenous vaccine production. Pulse Field Gel Electrophoresis (PFGE) typing was also carried out to assess the genetic relatedness of isolates of *F. psychrophilum*. From a salmon farm with problems with RTFS a range of different serotypes of *F. psychrophilum* were isolated. In contrast, trout farm isolates that were cross-reactive to sera to both serotypes O1 and O3 were predominant. Nine of thirteen of the O1&O3 positive isolates from three geographically distinct and independent production systems shared the same PFGE pulso-type. This suggests the clonal expansion of this particular strain in the UK trout industry. From salmon farms with problems with ERM *Y. ruckeri* serotypes O2 and O5 predominated. Autogenous immersion vaccines based on *Y. ruckeri* and/or *F. psychrophilum* were used in 1-2 g salmon and trout fry as part of a disease control programs. In a salmon hatchery where RTFS and ERM caused up to 10% mortality use of an autogenous vaccine in conjunction with metaphylactic antibiotic therapy has largely eliminated RTFS and ERM in fry and parr for three consecutive years. In a trout hatchery unvaccinated batches saw mortalities due to RTFS at 20%. In vaccinated batches of fish RTFS was still seen and fry were medicated however mortality levels were reduced to < 1%. An autogenous injection vaccine based on *F. psychrophilum* was also used at a trout farm with RMS. In 13 ponds of unvaccinated fish RMS was seen in 10-15% of fish. In two ponds containing 50,000 vaccinated fish RMS was seen in <1%. This study further implicates *F. psychrophilum* with the aetiology of RMS and demonstrates autogenous vaccines can be a useful as part of a disease control plan.

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