

Risk Analysis for Movements of Live Aquatic Animals



An Introductory Training Course

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Foreword

Risk analysis is now widely applied in many fields that touch our daily lives. These include decisions about risks due to chemical and physical stressors (natural disasters, climate change, contaminants in food and water, pollution, etc.), biological stressors (human, plant and animal pathogens; plant and animal pests; invasive species, invasive genetic material), social and economic stressors (unemployment, financial losses, public security, including risk of terrorism), construction and engineering (building safety, fire safety, military applications) and business (project operations, insurance, litigation, credit, etc.). Risk analysis is thus a pervasive but often unnoticed component of modern society that is used by governments, private sector and individuals in the political, scientific, business, financial, social sciences and other communities.

The application of risk analysis in aquaculture has recently gained attention. Because it is not always possible to know and predict every potential source of harm and its pathways, applying risk analysis can be an effective management and decision-making tool to assess the threats and uncertainties from new species or innovations in aquaculture development. It offers a common approach when making informed decisions on managing biosecurity threats, in a systematic manner to protect the health and well-being of animals, plants and people, and to maintain the functions and services of the ecosystems.

This manual will assist in facilitating the understanding and application of the risk analysis process in order to support FAO's goal of contributing to food and nutritional security through responsible and sustainable aquaculture development.

Jia Jiansan
Chief, Aquaculture Service

Preparation of this document

For more than 15 years, the Food and Agriculture Organization of the United Nations (FAO), through its Fisheries and Aquaculture Department, has been assisting FAO Member countries in developing risk analysis capacity for the safe movement of live aquatic animals. During this period, numerous workshops and trainings have been conducted at the regional and national levels in various parts of the world. One of the most significant of these was the FAO/NACA Expert Workshop on Understanding and Applying Risk Analysis in Aquaculture, held in Rayong, Thailand, from 7 to 11 June 2007 (Bondad-Reantaso, Arthur and Subasinghe, 2008). A major accomplishment of the workshop was the commissioning of practical guidance on “Understanding and applying risk analysis in aquaculture: a manual for decision-makers” (Arthur *et al.*, 2009) which provided a unified overview of the application of risk analysis in seven aquaculture risk sectors.

This manual, “*Risk Analysis for Movements of Live Aquatic Animals. An Introductory Training Course*” was conceived by Dr Melba B. Reantaso, Aquaculture Officer, Aquaculture Service (FIRA) as a means of presenting risk analysis training materials (Working Group exercises and supporting lecture materials, i.e. powerpoint presentations) developed through FAO activities in a format that could be easily adapted for use in short courses (four days duration) by regional and national experts charged with preparing risk analysis training course offerings for local participants.

This manual draws particularly on (i) a series of Working Group Exercises and supporting materials (including case studies) that were developed as part of the FAO/FSM Department of Resources Development “National Workshop on Risk Assessment in Aquaculture Development”, which was held in Pohnpei, Federated States of Micronesia (FSM) from 24 to 27 May 2010. These exercises were supported by (ii) a series of powerpoint lecture presentations on risk analysis and aquatic animal health management prepared by Dr Richard Arthur (FAO consultant) and Dr Melba B. Reantaso for various national and regional workshops organized by FAO. Preparation and publication of this document was made possible by FAO funds provided through the FAO project TCP/MIC/3201: Risk Assessment in Aquaculture Development in FSM, developed and implementation facilitated by Mr Masanami Izumi, Fisheries and Aquaculture Officer of the FAO Subregional Office for the Pacific Islands (SAP).

Abstract

Risk analysis is complex subject that is best learned by actual experience. This manual will assist national competent authorities and others involved in the assessment and management of risks associated with the international or domestic movement of live aquatic animals in training professional staff and raising awareness and understanding among other stakeholders of the principles and methodology of risk analysis. Using the training course manual and the recommended supplementary materials, responsible managers will be able to train staff in the planning and supervision of risk analyses. The training course will also assist specialists in the fields of disease, genetics or ecology of aquatic animals to successfully conduct risk analyses in a manner that incorporates best scientific knowledge, is transparent and includes adequate stakeholder consultation.

Using a structured step-wise process, the training course guides trainees through the risk analysis process as applied in the analysis of ecological, genetic and pathogen risks. Through the use of a series of lectures (provided on an accompanying CD in the form of 11 PowerPoint presentations), and using case studies and a series of five linked working group exercises that should be adapted by trainers to reflect local situations and priorities, the course provides an in-depth look at risk analysis as currently applied for evaluation of risks due to pathogens (import risk analysis). Trainees are guided from the initial process of establishing a commodity description and scoping a risk analysis through to conducting the four risk analysis components of hazard identification, risk assessment, risk management and risk communication. They are also encouraged to evaluate their national experiences with introductions and transfers of live aquatic animals, and to assess their current capacity, and any policy, legislative or technical improvements needed to effectively implement risk analysis for the safe movements of live aquatic animals.

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Abbreviations and acronyms

ALOP	Appropriate level of protection
ALOR	Acceptable level of risk
CBD	Convention of Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EUS	Epizootic ulcerative syndrome
FAO	Food and Agriculture Organization of the United Nations
FIPS	Statistics and Information Service
FIRA	Aquaculture Service
FSM	Federated States of Micronesia
KHV	Koi herpesvirus
MCRV	Mud crab reovirus
OIE	World Organisation for Animal Health
Ppt	Powerpoint presentation
SAP	Sub-Regional Office for the Pacific Islands of FAO
SPS Agreement	Sanitary and Phytosanitary Agreement of WTO
TAADs	Transboundary Aquatic Animal Diseases
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
WG	Working Group
WSSV	Whitespot syndrome virus
WTO	World Trade Organization

1.1 Purpose

1. Introduction



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1.1 Purpose

The purpose of this manual is to present a structured step-wise process, including supporting materials, that can be used by national and regional trainers as a basis for formulating short-courses (four days duration) on the application of risk analysis to aquaculture development.

Such training courses are designed to assist in raising awareness and understanding on the application of risk analysis to aquaculture production among government policy-makers, managers and technical officers (fisheries officers, aquaculture specialists, researchers, etc.) and members of the private sector (aquatic animal health professionals, aquatic veterinarians, non-government agencies, private aquaculturists) by providing basic knowledge on the risk analysis process and how it can be applied to assist decision-making and the development of a responsible and sustainable aquaculture sector.

Its primary goal is to provide information and experience needed to design risk analyses and oversee their conduct so that they can ensure that risk analyses are conducted in a manner that incorporates best scientific knowledge, is transparent and includes adequate stakeholder consultation.

Risk analysis is a complex subject, with each aquaculture risk sector having its own methodologies and requiring its own specialized expertise (see Arthur *et al.*, 2009). Thus by itself, this manual will not prepare most participants to undertake a formal risk analysis. However, following this introduction and drawing on the supplementary resources (see Chapters 4 and 5), specialists with wide experience in the fields of disease, genetics or ecology of aquatic animals should be able to successfully initiate risk analyses. In this regard, it should be noted that risk analysis is a discipline that is best learned by actual experience.

1.2 Overview of course structure and content



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1.2.1 Course structure

The core of this training manual is a series of seven **Working Group (WG) Exercises** that are based on hypothetical **aquatic species translocation scenarios** (see **Figures 1 and 2**) and which lead the participants through the complete risk analysis process as it is conducted for pathogen risk analysis.

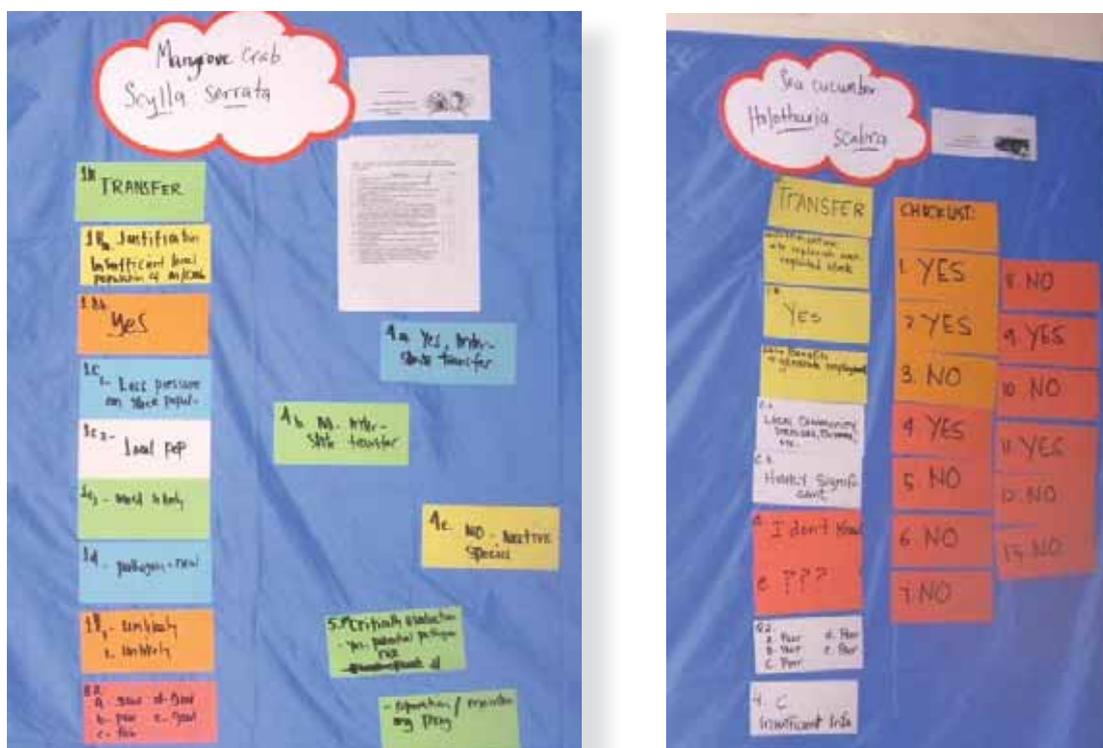


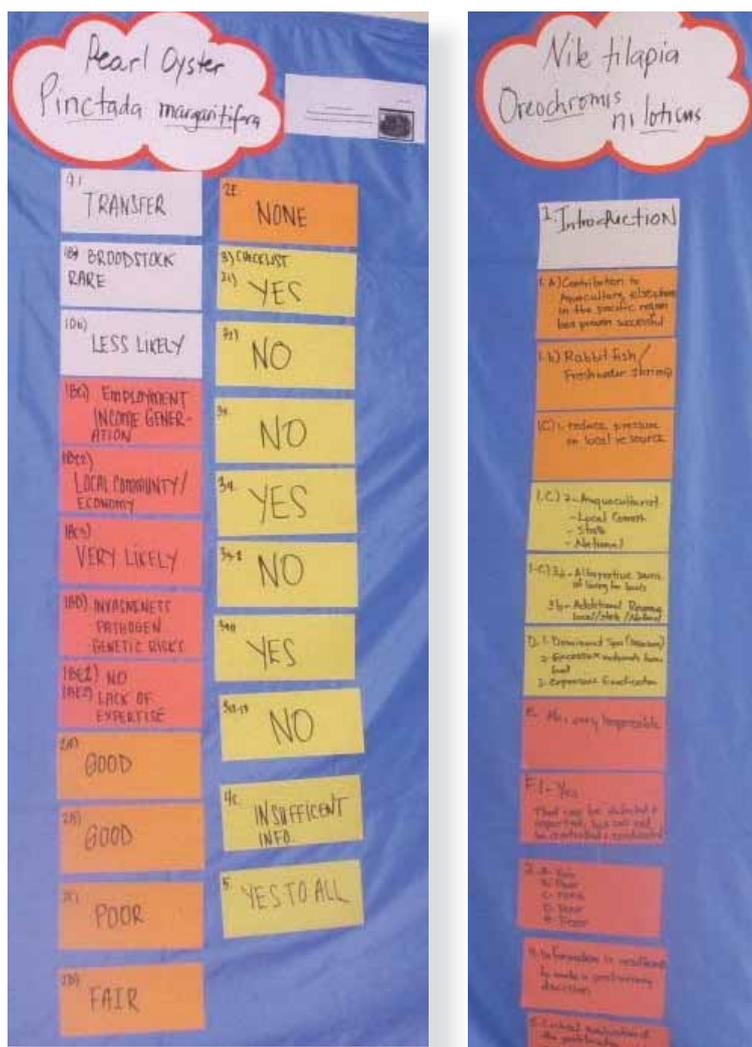
Figure 1. Examples of translocation scenarios

Each **WG** is assigned a **commodity** (an aquatic species, chosen for its relevance to the national or regional context of the particular training course being offered) that is being proposed for introduction or transfer for aquaculture development.

Each WG then follows its assigned commodity through the risk analysis process (using a qualitative risk analysis approach and drawing from pathogen risk analysis methodology), including: proposal assessment, establishing a risk analysis team, scoping a risk analysis, hazard identification, risk assessment (release assessment, exposure assessment, consequence assessment and risk estimation) and risk management (risk evaluation, option evaluation, implementation, and monitoring and review).

1.2.1 Course structure

Figure 2. Examples of translocation scenarios



Each WG Exercise concludes with presentation of WG findings, plenary discussion and preparation and presentation of a synthesis of results and conclusions by the course facilitators.

The WG Exercises are to be supported by a series of lectures and case studies. Background information on the risk analysis process relevant to each exercise is presented in the lecture(s) preceding the exercise.

To assist trainers in preparing appropriate lecture material, a **CD-ROM containing a series of 11 lectures** (of approximately 20 to 60 minutes length each) that have been developed and tested through previous FAO training workshops is provided with the manual. Readers should note that as each course must be tailored to local circumstances.

These powerpoint (ppt) presentations are provided as a resource to be used in the preparation of lectures appropriate to the course that is to be offered. The material is so structured that trainers can easily adapt it to fit their specific needs and objectives.

1.2.1 Course structure

As shown in the **example Training Course Programme** given in **Table 1** (see below), various introductory and concluding lectures should be prepared as appropriate to the precise focus of the course, the time allotted, the geographical region or country in which the training is being held and the knowledge and experience of the participants.

TABLE 1
Example programme for a four-day training workshop on introduction to risk analysis for aquaculture development.¹

Date	Activities
Day 1	24 May, Monday
08:30-09:00	Registration
09:00-09:15	Chairman of the workshop: Deputy Assistant Secretary, FSM- Department of Resources and Development Workshop opening <ul style="list-style-type: none">• Welcome statement (FAO Subregional Representative for the Pacific)• Opening statement (Acting Secretary, FSM Department of Resources and Development) Introduction of participants
09:15-09:25	Presentation 1: Background and objectives of the workshop
09:25-09:45	Presentation 2: Regional trends in aquaculture and key issues for sustainable development
09:45-10:15	Presentations 3: Current status and future trends in aquaculture development in FSM <ul style="list-style-type: none">(i) Chuuk State(ii) Kosrae State(iii) Pohnpei State(iv) Yap State
10:15-10:40	Group photo Tea/Coffee
10:40-11:00	Presentation 4: Movements of live aquatic animals: Historical experience in FSM and potential future proposals

¹ Participants at this example workshop were primarily staff from relevant national and State agencies, but also included representatives from local NGOs and the private sector. In addition to risk analysis training, the workshop also included presentations providing orientation to the regional, national and state situations regarding aquaculture development, past experience and likely future proposals for introductions and transfers, and current procedures used when considering requests for movements.

1.2.1 Course structure

(TABLE 1 *cont.*)

11:00-11:20	Presentation 5: Current procedures for assessing proposals for translocations of aquatic species in FSM
11:20-12:20	Working Group Exercise 1: Identifying issues and potential risks in proposals for species translocations for aquaculture development in FSM
12:20-13:15	Lunch
13:15-14:45	Presentation 6: Introduction to risk analysis – Overview and general principles
14:45-15:00	Tea/Coffee
15:00-16:00	Presentation 7: Pathogens and pests: Issues and impacts based on global experience <ul style="list-style-type: none"> • Pathogen risks • Ecological/pest and invasive species/environmental risks • Genetic risks
16:00-17:00	Working Group Exercise 2: Identifying current risk analysis frameworks and procedures for FSM
Day 2	25 May, Tuesday
08:30-09:30	Presentation 8: Introduction to global risk analysis frameworks and guidance
09:30-10:00	Presentation 9: Conducting a risk analysis: Example using pathogens as risks - Part 1 <ul style="list-style-type: none"> • Preliminary activities • Risk communication • Hazard identification
10:00-10:20	Tea/Coffee
10:20-11:00	Presentation 9 (continued)
11:00-12:00	Working Group Exercise 3: Case Studies – Pathogen risk analysis for FSM - Scoping to hazard identification
12:00-13:00	Lunch
13:00-14:40	Working Group Exercise 3 (continued)
14:40-15:00	Tea/Coffee
15:00-15:40	Presentation 10: Appropriate Level of Protection (ALOP), the Precautionary Principle

1.2.1 Course structure

(TABLE 1 *cont.*)

15:40-17:00	Working Group Exercise 4: Determining an ALOP for FSM
Day 3	26 May, Wednesday
08:30-09:30	Presentation 11: Conducting a risk analysis: Example using pathogens as risks: Part 2-Risk assessment and risk management (risk evaluation) <ul style="list-style-type: none"> • Risk assessment: Release, exposure, and consequence assessment • Risk assessment: Risk estimation • Risk management: Risk evaluation
09:30-09:50	Tea/Coffee
09:50-12:00	Working Group Exercise 5: Case Studies: Risk assessment (release, exposure, and consequence assessment); risk estimation; risk management (risk evaluation)
12:00-13:00	Lunch
13:00-14:40	Presentation 12: Conducting a risk analysis: example using pathogens as risks: Part 3- Risk management <ul style="list-style-type: none"> • Option evaluation • Implementation • Monitoring and review
14:40-15:00	Tea/Coffee
15:00-17:00	Working Group Exercise 6: Case Studies: Risk management (continued) (option evaluation, implementation, monitoring and review)
Day 4	27 May, Thursday
08:30-09:15	Presentation 12: Summary of results of risk analysis
09:15-10:15	Presentation 13: Summary of four risk analysis Case Studies <ul style="list-style-type: none"> • Pearl oyster • Tilapia • Sea cucumber • Mangrove crab
10:15-10:35	Tea/Coffee
10:35-12:00	Discussion
12:00-13:00	Lunch
13:30-15:30	Working Group Exercise 7: Implementing risk analysis in FSM: Identification of needs and recommendations
15:00-15:30	Tea/Coffee
15:30-16:10	Presentation 13: Conclusions and way forward
16:10-16:25	Workshop closing

1.2.2 Course content

The seven **WG Exercises** are presented in **Sections 2.1 to 2.7** of this manual. **WG Exercises** flow logically from one to the next, presenting the risk analysis process (as used in pathogen risk analysis) in a simplified form.

The exercises are supported by a series of **Resource documents** (presented following each **WG Exercise**). It is envisioned that each course offering will be supported by a series of introductory and concluding presentations that are course-specific (see **Table 1**, see pages 7-9 for example).

The more general presentations on the risk analysis process should be tailored to cover the information essential to allow the participants to complete each subsequent **WG Exercise**. These can be drawn from the series of 11 ppt presentations (contained on the accompanying **CD-ROM**) and whose contents are summarized below.

Using materials drawn from the literature on pathogen risk analysis and from a series of case studies prepared by FAO (see example given as **Annex 1**, see page 125), the participants are then asked to conduct a simple qualitative risk analysis, through which they gain experience in hazard identification, risk assessment (release assessment, exposure assessment, consequence assessment and risk estimation, including the use of pathways analysis and scenario trees), risk management (risk evaluation, options evaluation, monitoring and review) and risk communication.

Each exercise begins with **brief summary** of what should be covered in the **supporting lecture(s)** (drawing on the ppt presentations given in the accompanying **CD-ROM**), and a **summary description** of the WG or Plenary Group activity, including its **learning objectives, intended learning outcomes** and its **approximate duration**.

The **WG Exercises** and their supporting **resource documents** were prepared specifically for the FAO/FSM Department of Resources Development “National Workshop on Risk Assessment in Aquaculture Development” held in Pohnpei, Federated States of Micronesia, from 24

1.2.2 Course content

to 27 May 2010 (see **Figure 3**). However, they can be easily modified by trainers for use in similar risk analysis training courses to be given in other countries and regions.



Figure 3. Participants and resource persons during the FAO/FSM Department of Resources Development “National Workshop on Risk Assessment in Aquaculture Development”, Pohnpei, FSM, 24 - 27 May 2010.

1.2.2 Course content

The contents of each **WG Exercise** are presented below:

- **WG Exercise 1 (Resource Document 1.1) – Identifying issues and potential risks in proposals for species translocations for aquaculture development:** Presents each WG with a series of questions designed to stimulate thought and discussion on the possible benefits and risks of a hypothetical species movement and develop skills for the critical evaluation of proposals for species movements.
- **WG Exercise 2 (Resource Document 2.1) – Identifying current risk analysis frameworks and procedures:** As a group in plenary session, participants outline the major steps in the current national process used to reach a decision on a proposal to introduce or transfer an aquatic species, assess the current process with regard to various broad criteria relevant to risk analysis, and identify the international and regional treaties, agreements and memberships that obligate their country when considering introductions and transfers. They briefly evaluate their nation's past experiences, identify current problems related to invasive species, and weigh the value that their country places on its natural biodiversity.
- **WG Exercise 3 (Resource Document 3.1) – Pathogen risk analysis – Scoping to hazard identification:** During the exercise, the WGs will evaluate a commodity description for completeness and will make an initial decision (e.g. approve, reject, request more information). They will then define the scope of a hypothetical risk analysis. Using the pathogen list and the pathogen summaries provided, they will then conduct a short hazard identification. Finally, the WGs will conduct a brief risk communication exercise, in which they identify potential stakeholders and outline a risk communication strategy.
- **WG Exercise 4 (Resource Document 4.1) – Determining an appropriate level of protection (ALOP):** Through examination of relevant national policy statements, past history of introductions

1.2.2 Course content

WG Exercises

- **WG Exercise 1 (Resource Document 1.1)** – Identifying issues and potential risks in proposals for species translocations for aquaculture development
- **WG Exercise 2 (Resource Document 2.1)** – Identifying current risk analysis frameworks and procedures
- **WG Exercise 3 (Resource Document 3.1)** – Pathogen risk analysis – Scoping to hazard identification
- **WG Exercise 4 (Resource Document 4.1)** – Determining an appropriate level of protection (ALOP)
- **WG Exercise 5 (Resource Document 5.1)** – Risk assessment (release, exposure and consequence assessment, risk estimation); Risk management (risk evaluation)
- **WG Exercise 6 (Resource Document 6.1)** – Risk management (option evaluation, implementation, monitoring and review)
- **WG Exercise 7 (Resource Document 7.1)** – Implementing risk analysis: identification of needs and recommendations

1.2.2 Course content

and transfers in all sectors and their knowledge of national values and priorities, participants are asked to reach a consensus as to what the national ALOP is (or should be).

- **WG Exercise 5 (Resource Document 5.1) – Risk assessment (release, exposure and consequence assessment, risk estimation); Risk management (risk evaluation):** Continuing in their assigned WGs, the participants follow their commodities through the pathogen risk analysis process. A simple qualitative risk assessment procedure is used to familiarize them with the use of scenario trees and pathways analysis. They are asked to calculate risks of exposure, release and consequence and an overall risk estimate. They then begin risk management by determining if the estimated risk is within the Appropriate Level of Risk (ALOR).
- **WG Exercise 6 (Resource Document 6.1) – Risk management (continued from WG Exercise 5) (option evaluation, implementation, monitoring and review):** Participants continue the risk analysis process by taking their assigned commodity through the remainder of the risk management process. They will prepare a short list of possible management options for one of the identified hazards and consider their likely effectiveness and feasibility. They will then recalculate a new risk estimate for this hazard and determine if the ALOP has been met. They are then asked to briefly consider some practical aspects of implementation and monitoring and review.
- **WG Exercise 7 (Resource Document 7.1) – Implementing risk analysis: identification of needs and recommendations:** This concluding exercise asks participants to consider current risk analysis procedures and capacity in their country, identify areas that can be improved, and suggest ways to achieve the required expertise and capacity. The outputs of the WGs can later be synthesized by the trainers into a list of recommendations for future development of national risk analysis capacity.

1.2.2 Course content

The contents of the supporting lectures (presented as ppt presentations) contained on the accompanying **CD-ROM** are listed below:

- **Part I – Course introduction:** Information on course resource personnel, course goals and limitations, course overview and course outline. **(14 slides)**
- **Part 2 – Overview of trade in aquatic animal commodities:** Why trade is “risky”, the global growth of aquaculture and trade in aquatic products and the driving forces, and the nature of the trade. **(20 slides)**
- **Part 3 – Overview of risks in aquaculture:** The nature of risk and the types of risk inherent in aquaculture development, the seven risk sectors, the invasive species problem, overview of genetic risks, balancing the risks and benefits of aquaculture. **(37 slides)**
- **Part 4 – Overview of risk analysis:** What is risk?, important terms, protection vs. free trade; What is risk analysis?; Who uses risk analysis?; Relation of risk analysis and national biosecurity; National biosecurity actions; Why do countries need to be able to conduct risk analysis?; Two sides of the coin – risks to and from aquaculture; The four risk analysis questions; Approaches to risk analysis; Simplified risk analysis process; The World Organisation for Animal Health (OIE) framework (risk communication, hazard identification and the concept of hazard, risk assessment, risk management); Examples of risk analysis frameworks for various risk sectors; Simplified process for pathogen risk analysis. **(60 slides)**
- **Part 5 – Relevant international treaties, agreements and guidance:** Key treaties and agreements; World Trade Organization Sanitary and Phytosanitary (WTO SPS) Agreement main regulatory instruments; Key guidance (voluntary guidelines, guidance manuals, completed pathogen risk analyses, global and farm-level guidelines); Online resources. **(21 slides)**

1.2.2 Course content

Introduction to the Use of Risk Analysis in Aquaculture presented as powerpoint presentation

- **Part 1** – Course introduction
- **Part 2** – Overview of trade in aquatic animal commodities
- **Part 3** – Overview of risks in aquaculture
- **Part 4** – Overview of risk analysis
- **Part 5** – Relevant international agreements, treaties, memberships and guidance
- **Part 6** – Pathogen risk analysis – Transboundary aquatic animal diseases, introduction and preliminaries
- **Part 7** – Pathogen risk analysis – Hazard identification
- **Part 8** – Pathogen risk analysis – Risk assessment
- **Part 9** – Pathogen risk analysis – Risk management
- **Part 10** – Risk communication
- **Part 11** – Concluding session

1.2.2 Course content

- **Part 6 – Pathogen risk analysis – Transboundary aquatic animal diseases (TAADs), introduction and preliminaries:** Examples of TAADs: koi herpesvirus, white spot syndrome virus, epizootic ulcerative syndrome; Estimates of losses due to disease; What is pathogen risk analysis?; What is import risk analysis?; Historical aspects; Summary of completed formal risk analyses; Major risk factors; The risk analysis process; The risk analysis team and its duties; How risk analyses are initiated; The proposal to import; The risk analysis working group; Scoping a risk analysis (including an example from an actual risk analysis); Special issues and problems. **(59 slides)**
- **Part 7 – Pathogen risk analysis – Hazard identification:** Screening criteria; Summary of procedure; Summary of hazards identified from completed risk analyses, giant river prawn as an example. **(18 slides)**
- **Part 8 – Pathogen risk analysis – Risk assessment:** Overview; Qualitative versus. quantitative methods; Use of scenario trees and pathways analysis; Release assessment; Exposure assessment; Consequence assessment; Risk estimation; Practical example using giant river prawn. **(36 slides)**
- **Part 9 – Pathogen risk analysis – Risk management:** Overview; Risk evaluation; ALOP/ALOR; Practical example using giant river prawn; Possible outcomes of risk evaluation; Summary of results from completed risk analyses; Options evaluation; Summary of risk management measures from completed risk analyses; The precautionary principle and its application to pathogen risk analysis; Practical example using giant river prawn; Implementation; Monitoring and review; Reporting and report preparation. **(44 slides)**
- **Part 10 – Risk communication:** Overview; Purpose; Strategies; Identifying stakeholders; Risk communication methods; The risk analysis report **(15 slides)**

1.2.2 Course content

- **Part 11 – Concluding session:** Some universal principles of risk analysis; What is needed to implement risk analysis?; Risk analysis and developing countries; Characteristics of risk analysis that support good governance; Regional approaches; Constraints; Evaluating your country's current situation. **(26 slides)**

What is "Risk"?

Risk has two components:

1. The **probability** of something bad happening

and

2. The negative **consequences that result** if it does happen



FACE OF DISASTER ... A worker, Awang Muhammad, sumping out the dead fish from the cage

Thousands of fish in cages found dead

3

1.2.3 How to use this material

It should be emphasized that while the material presented in this manual could be directly used to provide training on risk analysis, it is presented with the expectation that it will be **adapted to the specific circumstances of the training being planned**.

This includes:

- the number of days allotted to the workshop;
- the backgrounds, expertise and experience of the participants;
- the specific aquaculture risk sector(s) of interest/importance to the participants;
- the regional or national situation with regard to aquatic species whose introduction/transfer is being considered or is likely to be proposed; and
- the national and/or regional disease situation for the key commodities, including pathogens likely to be of high concern.

1.2.3 How to use this material

In this regard, the preparation of one or more "**case studies**" prior to each workshop is quite valuable. **Case studies** can provide an in-depth examination of a proposed or probable introduction or transfer of a live aquatic animal of direct relevance to the country (or region) in which the risk analysis training will be conducted.

Example Case Study

Mangrove crab
(*Scylla serrata*)
to Kosrae State,
Federated States of Micronesia



The case studies can include a brief expert assessment of the issues that should be considered during evaluation of a proposal to move a specific aquatic species (commodity). They thus can provide background material for use in species movement scenarios, aquatic species profiles, pathogen lists, etc. that will be used by the participants during the **WG Exercises**.

By presenting the results of case studies towards the end of the workshop and after the participants have completed their exercises, the participants can compare their work and the resulting conclusions with that of an experienced risk analyst.

Although not risk analyses, the case study(ies) can provide background information and guidance that can be used by participants to initiate specific risk analyses following completion of the workshop.

An example of such a case study (prepared for the FAO national workshop that was held in Pohnpei, Federated States of Micronesia), which supports some of the example documents used in this manual is given as **Annex 1** (see page 125).

1.2.3 How to use this material

Prior to each workshop, **relevant specific supporting materials will need to be prepared or revised**, as appropriate.

These may include, for example:

- Any "lead in" presentations designed, for example, to orient participants to the national and/or regional situation (e.g. history, present status, future trends) with regard to aquaculture development, introductions and transfers of aquatic animals, current legal procedures, experiences with invasive species, etc. (see, for example, **Presentations 1 to 6** as given in the example Workshop Programme presented in **Table 1**; see page 7);
- WG exercises and their supporting lectures;
- Aquatic species translocation scenarios (see **Resource Document 1.2**; see page 51);
- Aquatic species profiles (see **Resource Document 1.3**; see page 53);
- Example abbreviated lists of pathogens for the relevant aquatic species (see **Resource Document 3.3**; see page 73);
- Pathogen information sheets (see **Resource Document 3.4**; see page 74);
- Information relevant to determining national ALOP; and
- Relevant case studies (see example case study given in **Annex 1**; see page 125).

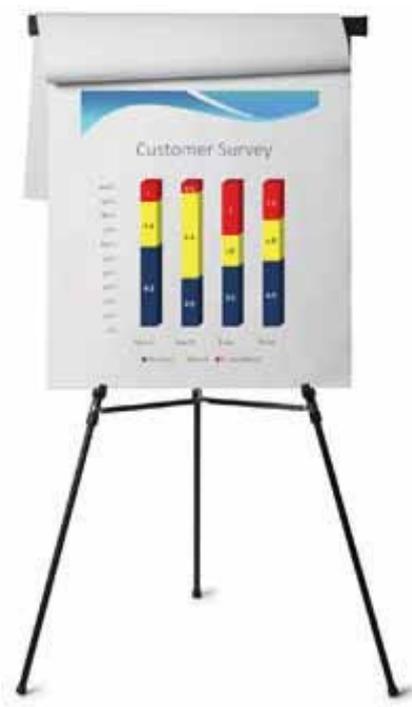
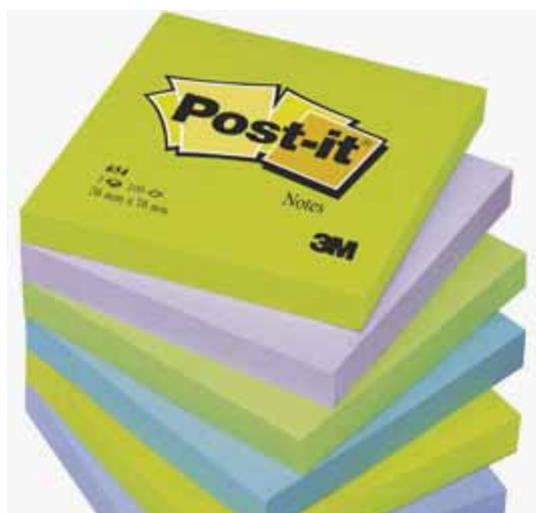
For **WG Exercises**, the course facilitators can **divide the participants into working groups of four to eight members** based on participants' knowledge, experience and interest in the various species translocation scenarios that have been specifically developed for the individual workshop.

1.2.3 How to use this material

In general, each WG works independently on each **WG Exercise**, the composition of the WGs remaining the same throughout the entire workshop and each WG following its assigned commodity through the simplified risk analysis process used during the workshop.

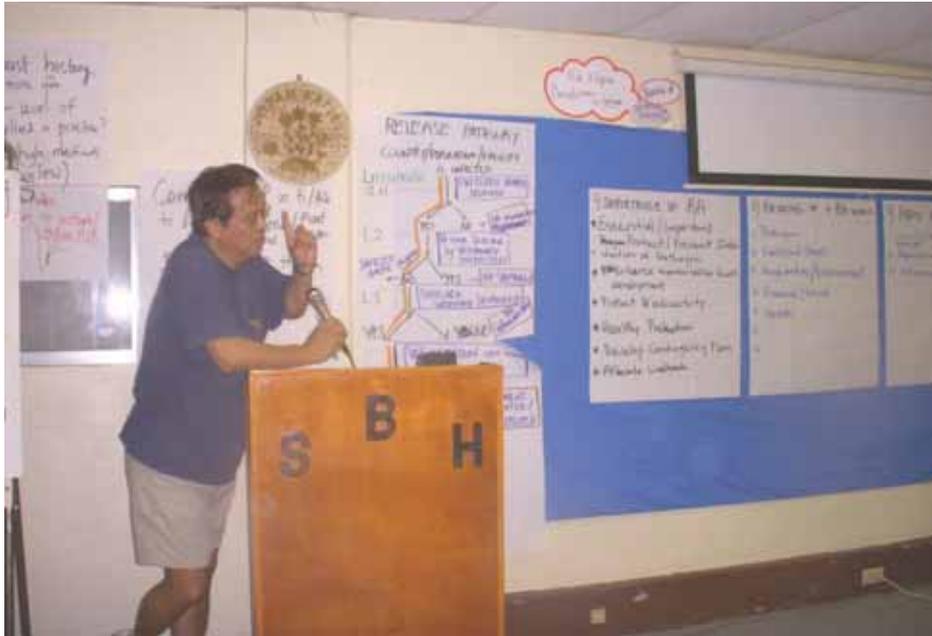
Some WG Exercises, such as identifying current risk analysis frameworks and procedures (**WG Exercise 2**), discussion of national ALOP (**WG Exercise 4**) and implementing risk analysis: needs and recommendations (**WG Exercise 7**) are best conducted in plenary.

At the end of each **WG Exercise**, the participants reconvene in plenary to present and discuss their findings. Where possible, it is often best to designate one of the participants to act as discussion moderator.



The use of flip charts, post-it notes, white board, projector, etc. (facilitation materials) to present findings, draw pathways and organize and frame participants' contributions is recommended.

1.2.3 How to use this material



Course facilitators should act to guide WG and plenary discussions, clarify thinking, organize outputs and provide technical information and expert opinion, when requested to do so.



1.3 Background to risk analysis

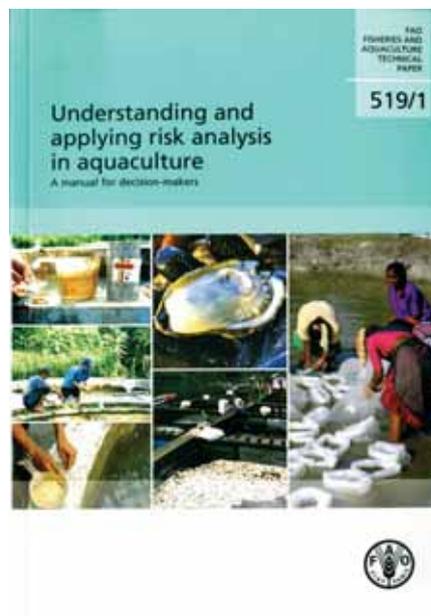
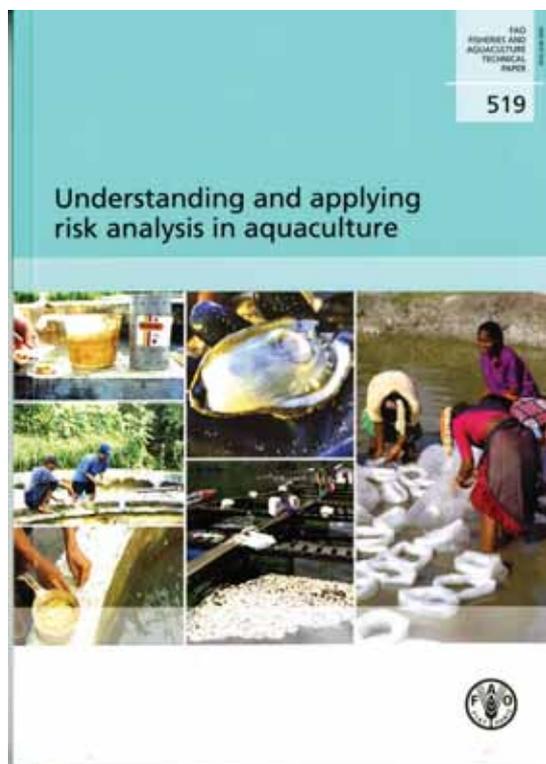
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1.3 Background to risk analysis

Governments and the private sector must often make **decisions based on incomplete knowledge and a high degree of uncertainty**. Such decisions may have far-reaching social, environmental and economic consequences.

Risk analysis is a process that provides a flexible framework within which the risks of adverse consequences resulting from a course of action can be evaluated in a systematic, science-based manner.

The risk analysis approach permits a defensible decision to be made on whether the risk posed by a **particular action or “hazard”** is acceptable or not, and provides the means to evaluate possible ways to reduce the risk from an unacceptable level to one that is acceptable.



1.3.1 The concept of risk

The concept of “**risk**” varies somewhat depending on the sector. Most definitions incorporate the concepts of:

- uncertainty of outcome (of an action or situation),
- probability or likelihood (of an unwanted event occurring),
and
- consequence or impact (if the unwanted event happens).

Thus “**risk**” is the potential for realization of unwanted, adverse consequences to human life, health, property or the environment. Its estimation involves both the likelihood (probability) of a negative event occurring as the result of a proposed action and the consequences that will result if it does happen.

As an example, taken from pathogen risk analysis, the Aquatic Animal Health Code (OIE, 2010) defines risk as:

“... the likelihood of the occurrence and the likely magnitude of the biological and economic consequences of an adverse event or effect to animal or human health”.

While some sectors incorporate consideration of potential benefits that may result from a “**risk**” being realized (e.g. financial risk analysis), others specifically exclude benefits from being taken into account (e.g. pathogen risk analysis).

1.3.2 What is risk analysis?

“**Risk analysis**” is usually defined either by its components and/or its processes. The Society for Risk Analysis (<http://www.sra.org/>) offers the following definitions of “risk analysis”:

- a detailed examination including risk assessment, risk evaluation and risk management alternatives, performed to understand the nature of unwanted, negative consequences to human life, health, property or the environment;
- an analytical process to provide information regarding undesirable events;
- the process of quantification of the probabilities and expected consequences for identified risks.

It can also be defined as:

An objective, systematic, standardized and defensible method of assessing the likelihood of negative consequences occurring due to a proposed action or activity and the likely magnitude of those consequences, or, simply put, it is “science-based decision making”.



1.3.3 The risk analysis process

In simple terms, a **risk analysis** typically seeks to answer **four questions**:

- What can go wrong?
- How likely is it to go wrong?
- What would be the consequences of its going wrong?
- What can be done to reduce either the likelihood or the consequences of its going wrong? (see MacDiarmid, 1997; Rodgers, 2004; Arthur *et al.*, 2004).

The general framework for risk analysis typically consists of **four major components**:

- **Hazard identification** – the process of identifying hazards that could potentially produce consequences;
- **Risk assessment** – the process of evaluating the likelihood that a potential hazard will be realized and estimating the biological, social and/or economic consequences of its realization;
- **Risk management** – the seeking of means to reduce either the likelihood or the consequences of it going wrong; and
- **Risk communication** – the process by which stakeholders are consulted, information and opinions gathered and risk analysis results and management measures communicated.

1.3.3 The risk analysis process

The **risk analysis process** is quite flexible.

Its structure and components will vary considerably depending on:

- The sector (e.g. technical, social or financial),
- The user (e.g. government, company or individual),
- The scale (e.g. international, local or entity-level) and
- The purpose (e.g. to gain understanding of the processes that determine risk or to form the basis for legal measures).

It can be:

- Qualitative (probabilities of events happening expressed, for example, as high, medium or low) or
- Quantitative (numerical probabilities).

1.3.4 The concept of “hazard”

All **risk analysis** sectors involve the assessment of risk posed by a threat or “**hazard**”. The definition of “**hazard**” depends on the sector and the perspective from which risk is viewed (e.g. risks **to** aquaculture or risks **from** aquaculture).

A hazard can thus be:

- **a physical agent having the potential to cause harm, for example:**
 - ◆ a biological pathogen (pathogen risk analysis);
 - ◆ an aquatic organism that is being introduced or transferred (genetic risk analysis, ecological risk analysis, invasive alien species risk analysis);
 - ◆ a chemical, heavy metal or biological contaminant (human health and food safety risk analysis, environmental risk analysis); or
- **the inherent capacity or property of a physical agent or situation to cause adverse affects, as in:**
 - ◆ social risk analysis;
 - ◆ financial risk analysis; and
 - ◆ environmental risk analysis.

1.3.5 Risk analysis terminology

The terminology used by some **risk analysis sectors** is well established (e.g. pathogen risk analysis, food safety, environmental risk analysis), and there is often **considerable differences** in how individual terms are defined.

An attempt at **cross-sectoral standardization of terms** is thus probably **futile**, and it is thus important that that **terms** used by the various risk analysis sectors be **fully defined at the outset**.



1.3.6 Some general principles

Some basic principles that appear to be common to all types of risk analysis are presented below.

These involve the broader concepts of common sense, uncertainty, precaution, objectivity, transparency, consistency, scientific validation, stakeholder consultation, stringency, minimal risk management, unacceptable risk and equivalence (see Arthur, 2008).

- **The principle of common sense** – In assessing risks, the use of “common sense” should prevail. In many cases, the outcomes of a risk analysis are obvious and uncontroversial, and a decision can be made without resulting to a full risk analysis, which can be a lengthy and expensive process.
- **The principle of uncertainty** – All risk analyses contain an element of uncertainty. A good risk analysis will seek to reduce uncertainty to the extent possible.
- **The principle of precaution** – Those involved in the aquaculture sector have a responsibility to err on the side of caution, particularly if the outcomes of a given action may be irreversible. If the level of uncertainty is high, the **Precautionary Principle** can be applied to delay a decision until key information is obtained. However, steps must be taken to obtain the information in a timely manner.
- **The principle of objectivity** – Risk analyses should be conducted in the most objective way possible. However, due to uncertainty and human nature, a high degree of subjectivity may be present in some risk analyses. A risk analysis should clearly indicate where subjective decisions have been made.
- **The principle of transparency** – Risk analyses, particularly those conducted by public-sector agencies, should be fully transparent, so that all stakeholders can see how decisions were reached. This includes full documentation of all data, sources of information, assumptions, methods, results, constraints, discussions and conclusions.

1.3.6 Some general principles

Some General Principles

- The principle of common sense
- The principle of uncertainty
- The principle of precaution
- The principle of objectivity
- The principle of transparency
- The principle of consistency
- The principle of scientific validation
- The principle of stakeholder consultation
- The principle of stringency
- The principle of minimal risk management
- The principle of unacceptable risk
- The principle of equivalence

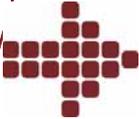
1.3.6 Some general principles



1.3.6 Some general principles

- **The principle of consistency** – Although risk analysis methodology continues to evolve, it is important that decisions, particularly those made by government, are reached via standardized methods and procedures. In theory, two risk analysts independently conducting the same risk analysis should reach roughly similar conclusions.
- **The principle of scientific validation** – The scientific basis of a risk analysis and the conclusions drawn should be validated by independent expert review.
- **The principle of stakeholder consultation** – If the results of a risk analysis are likely to be of interest to, or impact upon others, then stakeholder consultations should be held. This is accomplished by risk communication, the interactive exchange of information on risk among risk assessors, risk managers and other interested parties. Ideally, stakeholders should be informed/involved throughout the entire risk analysis process, particularly for potentially contentious risk analyses (e.g. ecological, genetic and pathogen risk analyses for the introduction of new aquatic species).
- **The principle of stringency** – The stringency of the risk management measures to be applied should be in direct proportion to the risk involved.
- **The principle of minimal risk management** – Risk management measures that impinge on the legitimate activities of others should be applied only to the extent necessary to reduce risk to an acceptable level.
- **The principle of unacceptable risk** – If the level of risk is unacceptable and no effective or acceptable risk management measures are possible, then the activity should not take place.
- **The principle of equivalence** – Risk management measures proposed by trading partners that meet the acceptable level of risk should be accepted by the importing country.

1.4 Use of risk analysis in aquaculture development

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1.4 Use of risk analysis in aquaculture development

As a food-producing sector, aquaculture has surpassed both capture fisheries and terrestrial farmed meat production in terms of average annual growth rate.

However, a number of biosecurity concerns pose risks to sustainable aquaculture development and to the broader aquatic environment and society.

Aquaculture faces risks similar to those of the agriculture sector. As aquaculture is very diverse in terms of species, environments, systems and practices, the range of hazards is broad and the perceived risks are complex.

Multiple objectives are driving the application of risk analysis to aquaculture. Foremost is for resource protection (human, animal health



1.4 Use of risk analysis in aquaculture development

and welfare aquaculture; wild fisheries and the general environment) as embodied in international treaties, memberships, agreements and informal guidance.

Of equal importance, the other drivers of risk analysis are: (i) food security; (ii) trade; (iii) consumer preference for high-quality and safe products; (iv) production profitability; and (v) other investment and development objectives.

Recently, **seven major risk sectors in aquaculture** have been identified (Bondad-Reantaso, Arthur and Subasinghe, 2008).

These are:

- (i) pathogen;
- (ii) food safety and public health;
- (iii) ecological (pests and invasives);
- (iv) genetic;
- (v) environmental;
- (vi) financial; and
- (vii) social risks.

While the hazards and risks in some of the sectors are clearly recognized (i.e. pathogens and food safety) and methodologies (as well as standards) for their assessment have been developed and applied, the hazards and risks in many of these areas of concern are still vaguely understood and methods for their assessment are not yet clearly defined. Nevertheless, **all these sectors** are **inextricably linked** and pose serious biosecurity threats if their risks are not managed responsibly.

1.4 Use of risk analysis in aquaculture development

Risk analysis has wide applicability to aquaculture.

To date, it has been mainly applied in assessing risks to society and the environment posed by hazards created by or associated with aquaculture development (**Box 1**). These include the risks of environmental degradation; introduction and spread of pathogens, pests and invasive species; genetic impacts; unsafe foods; and negative social and economic impacts.

The use of risk analysis can provide insights and assist in making decisions that will help to avoid such negative impacts, thus helping aquaculture development to proceed in a more socially and environmentally responsible manner.

Risk analysis is less commonly used to achieve successful and sustainable aquaculture by assessing the risks to aquaculture posed by the physical, social and economic environment in which it takes place (**Box 2**). These include reduction of environmental risks (e.g. due to poor siting or severe weather events), biological risks (infection by pathogens via transfer from native stocks, predation by seals and sharks, red tides, etc.), operational risks (poor planning, work-related injuries), financial risks (market changes, currency fluctuations, emergence of new competitors, etc.) and social risks (negative image and resulting product boycott, lack of skilled manpower, competition from other sectors).

There exists, therefore, considerable scope to develop and expand the use of risk analysis for the benefit of aquaculture and the social and physical environments in which it takes place.

An integrated approach to risk analysis will assist the aquaculture sector in reducing risks to successful operations from both internal and external hazards and can similarly help to protect the environment, society and other resource users from adverse and often unpredicted impacts. This could lead to improved profitability and sustainability of the sector, while at the same time improving the public's perception of aquaculture as a responsible, sustainable and environmentally friendly activity.

1.4 Use of risk analysis in aquaculture development

Box 1: Examples of risks to society from aquaculture¹

- **Environmental risks**

- ◆ pollution from feeds, drugs, chemicals and wastes
- ◆ alteration of water currents & flow patterns

- **Biological risks**

- ◆ introduction of invasive alien species, exotic pests and pathogens
- ◆ genetic impacts on native stocks
- ◆ destruction/modification of ecosystems and agricultural lands (mangrove deforestation, salination of ricelands)

- **Financial risks**

- ◆ failure of farming operations
- ◆ collapse of local industry/sector

- **Social risks**

- ◆ displacement of artisanal fishers

- **Human health risks**

- ◆ food safety issues

¹ Source: Arthur, J.R., Bondad-Reantaso, M.G. Campbell, M.L. Hewitt, C.L. Phillips M.J. & Subasinghe, R.P. 2009. *Understanding and applying risk analysis in aquaculture. A manual for decision-makers*. FAO Fisheries and Aquaculture Technical Paper No. 519/1, Rome, FAO, 113 pp.

1.4 Use of risk analysis in aquaculture development

Box 2: Examples of risks to aquaculture from society and the environment¹

- **Environmental risks**
 - ◆ severe weather patterns
 - ◆ pollution (e.g. agricultural chemicals, oil spills)
- **Biological risks**
 - ◆ pathogen transfer from wild stocks
 - ◆ local predators (seals, sharks, etc.)
 - ◆ toxic algal blooms, red tide
- **Operational risks**
 - ◆ poor planning
 - ◆ poor design
 - ◆ workplace injuries
- **Financial risks**
 - ◆ market changes
 - ◆ inadequate financing
 - ◆ currency fluctuations
 - ◆ emergence of new competitors
- **Social risks**
 - ◆ negative image/press
 - ◆ lack of skilled manpower
 - ◆ competition for key resources from other sectors
 - ◆ theft, vandalism

¹ Source: Arthur, J.R., Bondad-Reantaso, M.G. Campbell, M.L. Hewitt, C.L. Phillips M.J. & Subasinghe, R.P. 2009. *Understanding and applying risk analysis in aquaculture. A manual for decision-makers*. FAO Fisheries and Aquaculture Technical Paper No. 519/1, Rome, FAO, 113 pp.

1.4 Use of risk analysis in aquaculture development

For more than 15 years, the Food and Agriculture Organization of the United Nations (FAO), through its Fisheries and Aquaculture Department, has been assisting FAO Member countries in developing risk analysis capacity. During this period, numerous workshops and trainings have been conducted at the regional and national levels in various parts of the world. One of the most significant of these was the FAO/NACA Expert Workshop on Understanding and Applying Risk Analysis in Aquaculture, held in Rayong, Thailand from 7 to 11 June 2007 (Bondad-Reantaso, Arthur and Subasinghe, 2008).

A major accomplishment of the workshop was the commissioning of practical manual on “Understanding and applying risk analysis in aquaculture: a manual for decision-makers” (Arthur *et al.*, 2009) which provided a unified overview of the application of risk analysis in the seven aquaculture risk sectors mentioned above.

This manual draws particularly on:

- (i) A series of **Working Group (WG)** exercises and supporting materials (including case studies) that were developed as part of the FAO/FSM Department of Resources Development “National Workshop on Risk Assessment in Aquaculture Development” which was held in Pohnpei, Federated States of Micronesia from 24 to 27 May 2010; and
- (ii) A series of **powerpoint lecture presentations** on risk analysis prepared by Drs Richard Arthur and Melba Reantaso on various national and regional training workshops on risk analysis in aquaculture and aquatic animal health management organized by FAO.



2.1 Identifying issues and potential risks in proposals for species translocations for aquaculture development (Working Group Exercise 1)

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2.1.1 Overview

Identifying issues and potential risks in proposals for species translocations for aquaculture development

Learning objectives: To assist workshop participants in identifying the major issues and risks that are raised by proposals for aquatic species translocation (introduction or transfer) for aquaculture development.

Learning outcomes: Participants are able to screen a request or proposal to introduce or transfer a live aquatic animal and make a decision as to whether the proposal can be immediately rejected or approved, held pending collection of missing essential information, or referred for further evaluation and possible risk analysis.

Module duration: WG Exercise – 1 hour (40 minutes preparation, 20 minutes presentation); Supporting lecture(s) – to be determined based on the individual course being given.



2.1.2 Summary of Working Group Exercise 1 and of supporting lecture material

Working Group Exercise

Working Group Exercise 1 (Resource Document 1.1) presents each WG with a series of questions designed to stimulate thought and discussion on the possible benefits and risks of a hypothetical species movement and develop skills for the critical evaluation of proposals for species movements. The questions are to be discussed among the group and a consensus reached as to the best response to each. The exercise is supported by the provision of:

- **Aquatic Species Translocation Scenarios** (an example scenario for a hypothetical transfer of mangrove crab is presented as **Resource Document 1.2**, see page 51) and
- **Aquatic Species Profiles** (see **Resource Document 1.3**, see page 52 which provides an example profile for mangrove crab).

Using these documents (and with facilitator support), the WGs are asked to complete a **Preliminary Proposal Evaluation Form (Resource Document 1.4**, see page 57). The WGs then reassemble in plenary to present, discuss and justify their decisions. The discussion chairperson and the course facilitators assist in organizing the WG findings into a concise format which they then summarize for the participants.

Supporting lecture material

Lecture material supporting WG Exercise 1 must be developed on an individual course and country-specific basis. As shown in the example workshop programme given as **Table 1** (see page 7) it might consist of a series of presentations prepared by national and international experts on:

- (i) regional trends in aquaculture and key issues for sustainable development (**Presentation 2**, see page 15),
- (ii) the current status and future trends in national/state aquaculture development (**Presentation 3**, see page 15),
- (iii) national historical experience with movements of live aquatic animals and current or likely future proposals for introductions and transfers (**Presentation 4**, see page 15) and
- (iv) a review of current national and/or state procedures for assessing proposals for translocations of aquatic species (**Presentation 5**, see page 15).

Working Group Exercise 1

Identifying issues and potential risks in proposals for species translocations for aquaculture development

Time allotted: 1 hour (40 minutes preparation, 20 minutes presentation)

Purpose: The exercise will assist participants in identifying the key issues and risks that will need to be addressed for four potential introductions/transfers of aquatic species.



Methods: Participants will be divided into four Working Groups (WGs) based on interest in the commodities being assessed. WGs will elect a chairperson to lead their discussions, a rapporteur and a presenter.

Materials: Each WG will be provided with brief “translocation scenario” for an introduction/transfer of an aquatic species (**Resource Document 1.2**), an aquatic species profile (**Resource Document 1.3**), a proposal evaluation form (**Resource Document 1.4**), and a white board and/or flip chart and coloured markers. Consultants and experts will be available to answer questions and act as resource persons.

Outputs: Members of each WG should discuss the questions listed below and reach a consensus as to their answers. WGs should prepare a concise summary of their responses for presentation to plenary.

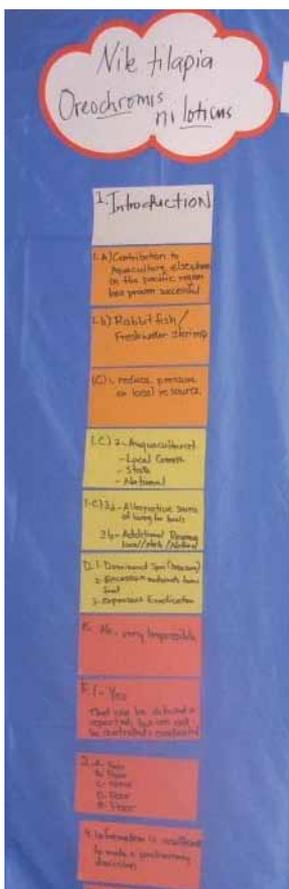
Working Group Exercise 1

Outputs: Members of each WG should discuss the questions listed below and reach a consensus as to their answers. WGs should prepare a concise summary of their responses for presentation to plenary.

1. Does the proposed translocation involve a species introduction or a transfer?

A. If an introduction:

a. What are the justifications for introducing this species?



b. From your knowledge of FSM's aquatic fauna, can you name a native species that could fill this need?

c. Benefits:

- What benefits might occur if the species was introduced?
- Who will benefit?
- How significant are the benefits likely to be?

d. What negative impacts could potentially result from the introduction?

e. Once introduced, if the species becomes established in natural waters and becomes invasive or a pest, is it likely that control or eradication would be possible?

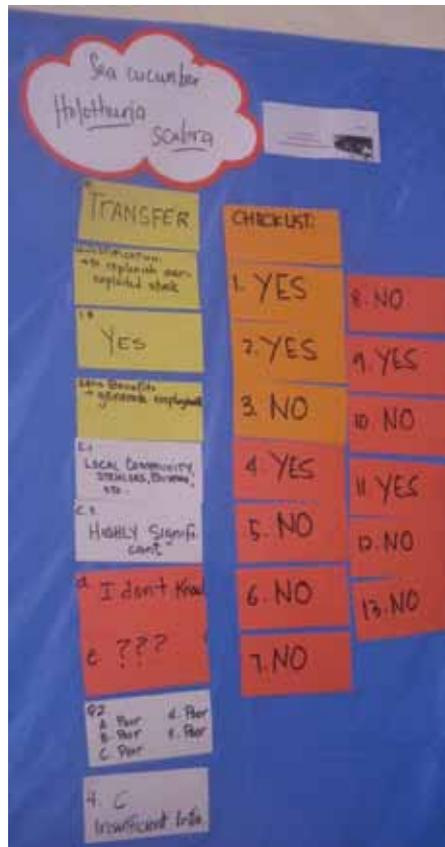
f. If the introduced species should bring in an exotic disease, what is the likelihood that the disease would be:

- Rapidly detected and reported by aquaculturists or governments?
- Controlled or eradicated?

Working Group Exercise 1

B. If a transfer:

- What are the justifications for transferring this species?
- Is it likely that a breeding programme using native stocks of the same species could be established?
- Benefits:
 - What benefits might occur if the species was transferred?
 - Who will benefit?
 - How significant are the benefits likely to be?
- What potential negative impacts could result from the transfer?
- If the transferred stock should bring in an exotic disease, what is the likelihood that it would be:
 - Rapidly detected by aquaculturists or government?
 - Controlled or eradicated?



Working Group Exercise 1

2. What is your initial impression of the general state of knowledge (excellent, good, fair, poor, none) of this species with regard to:

- a. Development of aquaculture technology for its culture
- b. Genetics (e.g. breeding techniques, population structure)
- c. Pathogens and diseases
- d. Ecology (geographic distribution, life cycle, breeding, migratory habits, population biology, feeding habits, etc.)
- e. Past experiences with introductions/transfers.

3. Each group will be provided with a preliminary proposal assessment form (Document 1.3, see page 53) that they should complete.

4. What is the preliminary group consensus with regard to a proposal to introduce/transfer this species to FSM (provide support for your decision)?

- a. likely to be accepted
- b. likely to be rejected
- c. information is insufficient to make a preliminary decision

5. What further evaluations or risk analyses would you be likely to recommend for this introduction/transfer?

- a. Critical evaluation of the justification, proponent's capabilities to accomplish it (financial, technical, etc), and magnitude of the benefits (social, economic, ecological) likely to be realized?
- b. Consideration of potential ecological/environmental/pest risks?
- c. Consideration of potential genetic risks?
- d. Consideration of potential pathogen risks?
- e. Evaluation of other countries' experiences with the species in question?
- f. Other evaluations?

Aquatic species translocation scenarios

Mangrove crab (*Scylla serrata*) to Kosrae State, Federated States of Micronesia

As Competent Authority for aquatic animal health in Kosrae State, your department has just received a letter from the leader of a local community-based aquaculture project requesting your assistance in facilitating a permit to transfer juvenile mangrove crabs from other states within FSM.

The juvenile crabs will be purchased from collectors in Pohnphei, Yap or Chuuk states, who will collect them from wild stocks. Upon arrival in Kosrae, they will be transported by road to the aquaculture site where they will be stocked directly into pens constructed in a mangrove area. Crabs will be “fattened” by feeding with trash tuna obtained from transshipment boats in port and upon obtaining sufficient size, will be marketed both locally and possibly to the restaurant trade in Guam.

The transfer of crabs from sources outside Kosrae State is justified by the proponent by the fact that local crab populations are already being harvested to the point where the State Fisheries Department feels that any further increase in collecting pressure would be detrimental to the sustainability of local populations.

The proponent envisions a continuous requirement for 1 000 juvenile crabs to be translocated at six-month intervals. He has also suggested that if adequate domestic supplies of juveniles cannot be obtained, that the possibility of importing juvenile crabs from the Philippines will be considered.

Aquatic species profile^{1,2}

Scylla serrata Forskal, 1775

Common names: Mangrove crab, Mud crab, Serrate swimming crab, Samoan crab

Identification: *Scylla serrata* is a large swimming crab with four blunt frontal teeth, all more or less in line with each other. The carapace is smooth, with strong transverse ridges. Gastric area of the carapace with a relatively faint H-shaped groove, setae on carapace restricted to the hepatic region. Nine broad teeth on each anterolateral margin, all of similar size and projecting obliquely outwards. Strong chelipeds with well developed spines on outer surface of carpus and on anterior and posterior dorsal parts of propodus. Color is variable and has been described as entirely grayish green or purple-brown or as deep ferruginous brown ranging to light purplish brown. There are irregular small whitish spots on the carapace and fifth legs. Color has been used to separate fresh specimens of *Scylla* spp., but this feature is useless in preserved material.

Taxonomic notes: The taxonomy of *Scylla* is confusing, with one or several species recognized depending upon the author. It has been reported that *S. serrata* exhibits different phenotypes and that these forms were differentiated by Southeast Asian fishermen on the basis of color. The existence of four forms of *Scylla* has been recognized in Viet Nam and the Philippines. Some authorities have regarded the four species as a single species, considering that morphological differences are due to variation in environment. Based on genetic studies, the existence of three species was noted in Japan: *S. serrata*, *S. tranquebarica*, and *S. oceanica*. Based on PCR-RFLP analyses, a fourth species has been noted in the Indo-West Pacific, *S. paramamosain*.

¹ Compiled from: Perry, H. 2010. *Scylla serrata*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. RevisionDate: 4/11/2006 (available at: <http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=192>); FAO Species Fact Sheets (<http://www.fao.org/fishery/species/2637/en>); http://www.sms.si.edu/irlspec/scylla_serata.htm.

² Note that in this summary all reference citations have been removed.

Aquatic species profile

Scylla serrata Forskal, 1775

Size: A male specimen was reported as having a 190 mm carapace width.

Habitat: This crab inhabits soft muddy bottoms in brackish water along the shoreline, mangrove areas, and river mouths where it digs deep

Reproduction: Becomes reproductively mature starting at around 90 mm carapace width, often within the first year of life. Male crabs approach female crabs before the females have undergone a precopulatory molt, grasping them with their chelipeds and first pair of walking legs and carrying them around for up to several days until the females molt. On molting, males turn the females over and initiate copulation, delivering non-motile spermatozoa that may be retained by the females for up to several weeks to months before being used to fertilize multiple clutches of up to 2 million eggs each. Females bearing egg masses on their pleopods migrate offshore (up to 50 km) where the eggs hatch in a few weeks.

Larval development: An extended larval duration has been reported. Experimental work has revealed a mean larval development time to the megalopa stage ranging from 20.6 to 22.6 days at 25°C, shortened by several days at higher developmental temperatures. One hundred percent larval mortality at 15 ppt salinity and high survival at salinities above 20 ppt have been noted. This finding is consistent with the observed migration of egg-bearing females to high-salinity offshore waters prior to spawning.

Temperature tolerance: Adults and subadults are broadly eurythermal, while larvae exhibit a somewhat narrower tolerance. An impressive tolerance range of 3- 45°C has been reported for *S. serrata* in the Karnafully River estuary, Bangladesh. Successful pen culture of the species has been reported in waters that ranged seasonally between 25 and 36°C. However, considerable larval mortality has been reported at temperatures above 25°C. Larval tolerance of temperatures as low as 5 °C has been reported, although individuals become inactive below 10°C.

Aquatic species profile

Scylla serrata Forskal, 1775

Salinity tolerance: Adults are broadly euryhaline, although individuals other than spawning females preferentially inhabit brackish inshore habitats. Specific metabolic responses have been reported that allow animals to persist at low salinities (i.e. amino acid catabolism and formation of ammonia to reduce osmolality at 10 ppt), as well as high salinities (i.e. initiation of urea synthesis and moderation of nitrogen excretion at 40 ppt).

Diet: *Scylla serrata* is principally a carnivore, preying on small invertebrates such as molluscs, crustaceans and polychaetes and on small quantities of detritus and plant material.

Associated species: No obligate associations are known, although infestation of the gill chambers of the crab by cyprid larvae of stalked barnacles of the genus *Octolasmis* has been documented.

Native range: *Scylla serrata* is noted to have a native Indo-Pacific distribution that likely encompasses East and South Africa to Tahiti, north to Okinawa, and south to Australia and New Zealand.

Economic significance: Commercially-harvested in areas where it has been introduced and populations have become established. It is considered an excellent and sought-after delicacy in Asia and females with mature ovaries are particularly expensive. The mud crab is the most important crab for commercial culture in the Indo-West Pacific region and commands a high price in both the domestic and export markets.

Scylla serrata has now spread throughout the Indo-Pacific, occurring in Japan, the Philippines, Indonesia, East and South Africa and the Red Sea.

Means of introduction: Most introductions have been intentional with the intent to establish commercial fisheries. The mud crab is noted to have an extended larval phase and that suggests a high dispersal potential. A study of genetic differentiation in Indian Ocean populations,

Aquatic species profile

Scylla serrata Forskal, 1775

however, found reduced gene flow, even between geographically close sites. In contrast, another study reported that the southwest region of Australia was colonized by large numbers of *S. serrata* from northwest Australia through a planktonic recruitment event enhanced by a strong 1999/2000 Leeuwin Current.

Invasion history: In 1962, Approximately 30 pairs of *S. serrata* were intentionally released to coastal waters in Collier County on the Gulf coast of Florida in an effort to establish a commercial crab fishery. This introduction failed to lead to an established population and the present status of the species in Florida is currently unknown. *Scylla serrata* was also intentionally introduced to Hawaii between 1926 and 1935, with established populations noted by 1940. Established populations now reportedly occur off of Maui, Hawaii, and Kauai.

Although most initial introductions of *S. serrata* were intentional releases for the purposes of establishing commercial fisheries, the protracted larval period likely confers high dispersal potential to populations of new recruits. The species has successfully spread through most of the Indo-Pacific, now occurring in Japan, the Philippines, Indonesia, East and South Africa and the Red Sea.

Impacts of introduction: *Scylla serrata* is economically important as both a wild-harvested stock and a commercial aquaculture product and is commercially harvested in those areas to which it has been intentionally introduced and where established populations have resulted. Large-scale negative economic impacts resulting from introduction of this species have not been reported. Ecological impacts resulting from introduction of *S. serrata* into areas in which the species has become established have yet to be assessed. The animal has been described as an active, aggressive species, and some degree of competition with co-occurring native species is likely. In Hawaii, commercial fishing keeps the population of mud crabs under control and the species is not considered invasive.

Aquatic species profile

List of information in an aquatic species profile

- Common names
- Identification
- Taxonomic notes
- Size
- Habitat
- Reproduction
- Larval development
- Temperature tolerance
- Size
- Habitat
- Reproduction
- Larval development
- Temperature tolerance
- Salinity tolerance
- Diet
- Associated species
- Native range
- Economic significance
- Means of introduction
- Invasion history
- Impacts of introduction

Preliminary proposal evaluation form

Table 2 outlines the minimum information needed by the Competent Authority (CA) to make a rapid preliminary screening of a request (preproposal) to introduce or transfer an aquatic species. This information can be used to develop a commodity description and make a decision if the request can be:

- (i) immediately approved;
- (ii) immediately rejected; or
- (iii) routed to more detailed evaluation and a possible risk analysis.

If a decision is made to conduct a risk analysis, the proponent will be asked to supply additional information (a formal proposal may be required) and the risk analysis team will need to conduct a preliminary literature review to identify issues and define the scope of the analysis to be conducted. An example of the detail to be required in a proponent proposal to translocate an aquatic animal can be found in Annex A of the International Council for the Exploration of the Sea (ICES) (ICES, 2005).

The ICES approach is to have the proponent supply as much of the background information as possible (a time consuming process, ensuring that the request to introduce/transfer a species is not frivolous or ill-conceived). However, the requirements can be separated into:

- (i) information that must be supplied by the proponent as essential to the CA to make initial decisions and to scope a risk analysis; and
- (ii) information that is important to a detailed decision-making or risk analysis process, but is based on scientific literature, expert opinion, etc. and which can be supplied/obtained by the proponent, the CA or the risk analysis team if it is required.

TABLE 2

Checklist of questions for ensuring that the information needed to make a preliminary decision on a request to translocate an aquatic species has been provided by the proponent.

	Checklist Item	Yes/No
1	Organism to be translocated is clearly identified by common and scientific name?	
2	Source of animals to be translocated is clearly indicated (country, supplier, wild population, hatchery, exporter, etc.)?	
3	Life cycle stage is clearly specified (e.g. eggs, fry, postlarvae, juveniles, adults, broodstock)?	
4	Quantity to be translocated is clearly indicated (number of shipments, number of organisms/shipment)?	
5	Proposed date(s) of shipment is indicated?	
6	Availability of information/guarantees on health status of supplying stock/facility, population of animals is clearly indicated (e.g. mortality records, diagnostics records of facility; health certificate to accompany shipments (including nature of any diagnostics tests to be performed))?	
7	Pre-transit checks to be made on health status of animals (inspection, diagnostics, quarantine, etc.) (if any) are indicated?	
8	Pre-transit checks for “fellow travellers” (if appropriate) are described?	
9	Justification/rationale for translocation is provided? (including description of expected end uses)?	
10	Person/business/agency responsible for reception of translocated animals is clearly indicated?	
11	Initial destination of translocated organisms is clearly indicated and clearly described?	
12	Post-entry sanitary measures to be carried out by the proponent (if any) are described (quarantine, diagnostics, treatments, etc.)?	
13	Additional post-entry measures (if any) for monitoring of health status, ensuring secure holding of organisms (prevention of escapes) and contingency planning for escapes/disease outbreaks to be applied by proponent are described?	

2.2 Identifying current risk analysis frameworks and procedures (Working Group Exercise 2)

2.1	Identifying issues and potential risks in proposals for species translocations for aquaculture development (Working Group Exercise 1)	44
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2.2.1	Overview	61
2.2.2	Summary of Working Group Exercise 2 and of supporting lecture material Working Group Exercise 2	62
2.3	Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)	66
2.4	Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)	78
2.5	Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation) (Working Group Exercise 5)	86
2.6	Risk management (option evaluation, implementation, monitoring and review) (Working Group Exercise 6)	104
2.7	Implementing risk analysis: identification of needs and recommendations (Working Group Exercise 7)	112

2.2.1 Overview

Identifying current risk analysis frameworks and procedures

Learning objectives: To assist workshop participants in identifying and understanding the relevant international and regional agreements, memberships and guidance relative to risk analysis and the current national risk analysis frameworks and procedures that are in place for their country.

Learning outcomes: Participants will have basic understanding of the relevant international standards, treaties, agreements and memberships relevant to risk analysis for aquaculture development and an understanding of their country's status, rights and obligations with regard to membership/participation in them.

They will understand how proposals to introduce/transfer aquatic animals into their country arise and how they are currently processed.

From this, they will begin to consider what changes may be needed to improve the process and meet international obligations and standards.

Module duration: WG Exercise – 1 hour (40 minutes preparation, 20 minutes presentation); Supporting lecture(s) – to be determined based on individual course.

2.2.2 Summary of Working Group Exercise 2 and of supporting lecture material

Working Group Exercise

Working Group Exercise 2 (Resource Document 2.1) is best conducted in plenary. The participants are asked to outline the major steps in the current national process used to reach a decision on a proposal to introduce or transfer an aquatic species. They are then asked to assess the current process with regard to various broad criteria relevant to risk analysis. They are asked to identify the international and regional treaties, agreements and memberships that obligate their country when considering introductions and transfers, to evaluate their nation's past experiences, identify current problems related to invasive species, and weigh the value that their country places on its natural biodiversity.

The discussion chairperson (chosen from among the participants) and the course facilitators assist in organizing the WG findings into a concise format which they then summarize for the participants.

Supporting lecture material

Lecture material supporting this exercise may include presentations on:

- (i) current national/state procedures for assessing proposals for translocations of aquatic animals (Example Programme, **Presentation 5**).
- (ii) overview of risk analysis (**Presentation 6**)
- (iii) pathogens and pests: issues and impacts based on global experience (**Presentation 7**)
- (iv) relevant international treaties, agreements and guidance (**Presentation 8**).

Working Group Exercise 2

Identifying current risk analysis frameworks and procedures

Time allotted: 1 hour (40 minutes preparation, 20 minutes presentation)

Purpose: The exercise will assist participants in understanding how proposals to introduce/transfer aquatic species to FSM are made and to begin to consider where improvements to the process might be needed.

Methods: WG Exercise 2 is best conducted in plenary. Participants will chose a discussion moderator who will be assisted by the course trainers. They should be given a short period to consider the questions individually before the group discussion begins.

Materials: Participants will be provided with copies of the relevant national/state regulations, procedures and/or guidance related to introductions/transfers of aquatic species, and a white board and/or flip chart and coloured markers. They will also consider the information presented in the relevant plenary presentations.

Outputs: Participants should discuss the questions listed below and reach a consensus as to their answers. The course moderator and the trainers should prepare a concise summary for presentation to plenary at the end of the exercise (continued on next page)

Working Group Exercise 2

3. How can the process be improved?
4. What are some of the major international treaties and memberships that obligate FSM when considering introductions and transfers? (examples: World Trading Organization, World Organisation for Animal Health, United Nations, FAO, Convention for the International Trade of Endangered, Convention of Biological diversity, United Nations Convention on the Law of the Sea)
What are the relevant regional agreements and working groups regarding introductions of aquatic species?



5. How would you describe the general experience of FSM with regard to introductions and transfers of aquatic species for aquaculture development?
6. How would you describe the general experience of FSM with regard to detecting and preventing/eradicating invasive species in general?
7. What are the major invasive species problems currently affecting FSM?
8. How would you describe the value that FSM places on its natural biodiversity?

2.3 Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)

2.1	Identifying issues and potential risks in proposals for species translocations for aquaculture development (Working Group Exercise 1)	44
2.2	Identifying current risk analysis frameworks and procedures (Working Group Exercise 2)	62
	2.3 Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)	66
2.3.1	Overview	67
2.3.2	Summary of Working Group Exercise 3 and of supporting lecture material	68
	Working Group Exercise 3	69
	Commodity description form	72
	Abbreviated list of potential pathogens for a commodity	73
	Pathogen sheet	74
	Criteria for a pathogen, parasite or disease	75
	Blank table for hazard identification - Table 3	76
2.4	Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)	78
2.5	Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation) (Working Group Exercise 5)	86
2.6	Risk management (option evaluation, implementation, monitoring and review) (Working Group Exercise 6)	104
2.7	Implementing risk analysis: identification of needs and recommendations (Working Group Exercise 7)	112

2.3.1 Overview

Pathogen risk analysis – scoping to hazard identification

Learning objectives: To assist workshop participants in understanding the preliminary activities that need to be undertaken prior to initiating a risk analysis (e.g. preparation of a commodity description, preliminary decision-making, assembling a risk analysis project team, establishing criteria for hazard identification and developing a risk communication strategy) and conducting a preliminary screening of an abbreviated list of pathogens for potential hazards.

Learning outcomes: Participants will have basic understanding of what is needed to commence a pathogen risk analysis and will have some basic experience with identifying potential hazards for their particular commodity.

Module duration: WG Exercise – 2 hours 45 minutes (2 hrs preparation, 40 min presentation); Supporting lecture(s) – to be determined based on individual course offering.

2.3.2 Summary of Working Group Exercise 3 and of supporting lecture material

Working Group Exercise

For WG Exercise 3, the WGs will continue to use the materials provided in previous exercises (e.g. **translocation scenario (Resource Document 1.2)**, **species profile (Resource Document 1.3)**, etc. They will also be provided with a **commodity description form (Resource Document 3.2)** a **list of five possible hazards (Resource Document 3.3)** and **associated Pathogen Profile Sheets for each pathogen (Resource Document 3.4)** summarizing information on pathogen biology, pathogenicity, host range, etc. They will also consider the information presented in the relevant plenary presentations. Each WG will have access to a course resource person, who will play the roles of:

- (i) the “proponent” of the proposal; and
- (ii) an expert on host and pathogen biology.

During the exercise, the WGs will evaluate the commodity description for completeness and will make an initial decision (approve, reject, request more information). They will then define the scope of a hypothetical risk analysis. Using the pathogen list and the pathogen profiles, they will then conduct a short hazard identification. Finally, the WGs will conduct a brief risk communication exercise, in which they identify potential stakeholders and outline a risk communication strategy.

Supporting lecture material

Lecture material supporting this exercise may include presentations on:

- (i) current national/state procedures for assessing proposals for translocations of aquatic animals (Example Programme, **Presentation 5**) and
- (ii) overview of risk analysis (**Presentation 6**) and
- (iii) pathogens and pests: issues and impacts based on global experience (**Presentation 7**) and
- (iv) relevant international treaties, agreements and guidance (**Presentation 8**).

Working Group Exercise 3

Pathogen risk analysis – scoping to hazard identification

Time allotted: 2 hrs 50 min (2 hrs preparation, 50 min presentation)

Purpose: The exercise will assist participants in understanding the risk analysis process by planning and initiating a pathogen risk analysis and will cover:

- (i) preparation of a commodity description,
- (ii) preliminary decision-making
- (iii) assembling a risk analysis project team,
- (iv) developing a time frame,
- (v) establishing criteria for hazard identification and
- (vi) developing a risk communication strategy.

Methods: Participants continue with the four WGs formed during Exercise 1. WGs will elect a chairperson to lead their discussions, a rapporteur and a presenter.

Materials: WGs will continue to use the materials provided in previous exercises (e.g. translocation scenario, aquatic species profile, relevant guidance). They will be provided with a **Commodity Description form (Resource Document 3.2)** and an **abbreviated list of five possible hazards (Resource Document 3.3)** and associated **Pathogen Profile Sheets (Resource Document 3.4)** for each pathogen summarizing information on pathogen biology, pathogenicity, host range, etc. They will also consider the information presented in the relevant plenary lectures. Each WG will have access to a course resource person, who will play the roles of:

- (i) the “proponent” of the proposal and
- (ii) an expert on host and pathogen biology.

⁴ Note: This and subsequent exercises assume that the commodity has already been evaluated with regard to potential economic/social benefits and that any concerns related to possible ecological/pest invasive/environmental/genetic risks have been addressed (i.e. the species has, in principle, been cleared for translocation and the conditions under which this will occur have been established; the remaining issue is “can this movement be accomplished without undue risk of introducing serious pathogens?”).

Working Group Exercise 3

Outputs: WGs will consider the following questions/activities and be prepared to justify their decisions. WGs should prepare a concise (10 minutes) summary for presentation to plenary.

1. Commodity description

- a. Using the Translocation Scenario (**Resource Document 1.2**) and the Preliminary Proposal Evaluation Form (**Resource Document 1.4**), each group should complete, as far as possible, the blank Commodity Description Form (**Resource Document 3.2**). Does the commodity description lack any information essential to making a preliminary decision on how the request to import should be handled? (If “yes”, the WG should ask the “proponent” for any additional information or clarification required to complete these documents.)
- b. Does the information provided by the proponent with regard to the source, life cycle stage, end use, health status of the originating stock and/or the shipment and any other risk management measures provide sufficient guarantee to allow immediate approval to import?
- c. Or, is the proposal clearly unacceptable such that the request can be immediately rejected?

2. Scoping the risk analysis

Using the guidance provided, the WG should define the scope of the risk analysis. This should include:

- a. time frame
- b. composition of risk analysis Working Group (expertise needed)
- c. internal oversight (risk analysis project team)
- d. external review
- e. criteria for preliminary listing of potential hazards (provided as **Resource Document 3.5**)

Working Group Exercise 3

3. Hazard identification

Using the list of five pathogens provided for their commodity, the WG should discuss each organism in turn, comparing it with the agreed upon criteria for identification as a potential hazard (see [Resource Document 3.5](#)). Information should be entered into the blank table provided (Table 3 [Resource Document 3.6](#)). Which of the pathogens require further consideration during risk assessment? (i.e. which are potential hazards?)

DISEASE	DISEASE CAUSING ORGANISM	COMMODITY
DIPHTHERIA	<i>Clostridium botulinum</i>	INDIA
TUBERCULOSIS	<i>Mycobacterium tuberculosis</i>	INDIA
CHOLERA	<i>Vibrio cholerae</i>	INDIA
		CHINA

4. Risk communication

The WG should:

- a. Identify a preliminary list of stakeholders for the risk analysis
- b. Develop a risk communication strategy that will ensure that all potential stakeholders will be aware of the pending risk analysis and will be able to contribute to it.
- a. Identify the communication methods (television, radio, newspaper, e-mail, telephone, public meetings, etc.) that will be most effective in reaching the stakeholders
- b. Identify key points in the risk analysis timeframe where risk communication should be scheduled.

Commodity description form

Commodity description form
Species to be translocated:
Proposed date of importation:
Life cycle stage to be imported:
Importer:
Exporter:
Source:
Proposed number of shipments:
Volume:
Proposed destination:
Health status:
Proposed risk reduction measures:
Other relevant information:

Abbreviated list of potential pathogens for a commodity

Example

(A) Mangrove Crab

1. Whitespot syndrome virus
2. *Vibrio harveyi*
3. *Amyloodinium ocellatum*
4. *Sacculina granifera*
5. Mud crab reovirus (MCRV)

Pathogen sheet

Mangrove crab reovirus (MCRV)

Mangrove crab reovirus (MCRV)

MCRV has recently been described as a serious pathogen of mangrove crabs. Its viral nature and high pathogenicity are characteristics that could allow it to become a serious transboundary aquatic animal disease (TAAD) of wild and cultured mangrove crabs.

Species affected: This virus is only known to affect mangrove crab (*Scylla serrata*). The possibility that MCRV causes diseases in other crabs or that other crustaceans may act as carriers has not been investigated.

Geographical distribution: MCRV has so far only been recorded from southern China.

Economic impact: Reported to have caused large losses of cultured mangrove crabs and “sleeping disease”.

Pathology: The virus infects connective tissue cells of the hepatopancreas, gills and intestine, developing in the cytoplasm. One hundred percent mortality was observed in mud crab experimentally infected by intramuscular injection, bath inoculation and oral inoculation, while cohabitation infection caused 80 percent mortality.

Diagnosis: An RT-PCR detection method has been developed.

Control: As with other viral diseases, the only means of control in aquaculture situations is the destruction of the infect stocks, disinfection of aquaculture facilities and elimination of possible carrier organisms. Once established in wild crab populations, the control or elimination of MCRV would probably be impossible.

References:

Weng S.P., Guo Z.X., Sun J.J., Chan S.M. & He J.G. 2007. A reovirus disease in cultured mud crab, *Scylla serrata*, in southern China. *Journal of Fish Disease*, 30(3): 133-138.

Criteria for a pathogen, parasite or disease

For consideration as a potential hazard, all these criteria must be met:

- The pathogen or parasite, disease or syndrome is likely to be caused by a biological agent.
- The pathogen or parasite, disease or syndrome is reported or likely to infect the life cycle stage of the commodity that will be translocated.
- The pathogen or parasite, disease or syndrome is present or potentially present in the exporting country (if international source) or region (island) or State (if a domestic source is used).
- The pathogen or parasite, disease or syndrome is absent from the importing country (if international movement) or state or local population (if a domestic movement), or, if present, it should be an OIE-listed disease or a disease subject to a programme of eradication or control.
- The pathogen or parasite, disease or syndrome causes significant disease in the commodity or in other species found in the receiving country or State.

Blank table for hazard identification

TABLE 3

Pathogens, parasites and symbionts [insert species scientific and common names] (Y=Yes, N=No, P=Plausible,?=Uncertain).

Pathogen (scientific and common name)	Infects [insert life cycle stage]	Causes significant disease?	Further consideration required?	References	Comments
1.					
2.					
3.					
4.					
5.					

Pathogen	Infects Cycle stage	Cause Signif. consid. Disease	Further Consider	Reference	Comments
AKOYA Virus	SPAT Adult	YES	YES	YES	
P. olseni	Adult	YES	YES	YES	
Papoviridae Papovir-like Virus	Larvae - - ADULT	YES	YES	YES	
Ostracodella implexa (shell disease)	SPAT	YES	YES	YES	NEED Picture
Sulcasorhis sulcata	Stomach ulcers ADULT	YES	YES	YES	Pearl Oyster

Pathogen	Life cycle	Signifi Cant Dx	Further Consider	Reference	Comments Decision
Corpus Marlini (fish)	N	N	NO		of no interest/no value
Cymatocera sp. isopod	Y	Y	3P, 2Y NO		
Skin Ulceration disease	Y	Y	Yes		
Licoporeus orbicularis crab	N	N	NO		SEA Cucumber Crab
Lichtheimia Mandibularis copepod	-	-	NO		SEA Cucumber

2.4 Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)

2.1	Identifying issues and potential risks in proposals for species translocations for aquaculture development (Working Group Exercise 1)	44
2.2	Identifying current risk analysis frameworks and procedures (Working Group Exercise 2)	60
2.3	Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)	67
2.4	Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)	78
2.4.1	Overview	79
2.4.2	Summary of Working Group Exercise 4 and of supporting lecture material Working Group Exercise 4	80
2.5	Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation) (Working Group Exercise 5)	81
2.6	Risk management (option evaluation, implementation, monitoring and review) (Working Group Exercise 6)	86
2.7	Implementing risk analysis: identification of needs and recommendations (Working Group Exercise 7)	104
		112

2.4.1 Overview

Determining an appropriate level of protection (ALOP)

Learning objectives: To assist workshop participants in understanding the concepts of appropriate level of protection (ALOP) and appropriate level of risk (ALOR) and to help them determine the explicit or implicit ALOP for their country.

Learning outcomes: Participants will have basic understanding of ALOP and how the risk analyst can determine national ALOP for application in aquatic animal pathogen risk analysis.

Module duration: Working Group Exercise – 40 minutes (15 minutes individual preparation, 25 minutes plenary discussion); Supporting lecture(s) – to be determined based on individual course offering.



2.4.2 Summary of Working Group Exercise 4 and of supporting lecture material

Working Group Exercise

WG Exercise 4 is a short exercise that is best conducted in plenary, the discussion moderator being a local expert selected from among the participants. The participants will independently consider the exercise questions and be prepared to justify their decisions.

The discussion moderator will then assist by moderating the group discussion and with the assistance of the course facilitators, will prepare a concise summary for presentation to plenary.

Supporting lecture material

Lecture material supporting this exercise may include presentations on:

- (i) national experience with movement of live aquatic animals; and
- (ii) current national/state procedures for assessing proposals for translocations of aquatic animals (Example Programme, **Presentations 5 and 6**, country/course-specific presentations); and
- (iii) overview of ALOP/ALOR (**Presentation 9**)

Working Group Exercise 4

Determining an appropriate level of protection (ALOP)

Time allotted: 40 minutes (20 minutes preparation, 20 minutes presentation).

Purpose: The exercise will assist participants in determining the likely explicit or implicit national ALOP.

Methods: This WG Exercise is best conducted in plenary, with the discussion moderator being selected from among the participants.

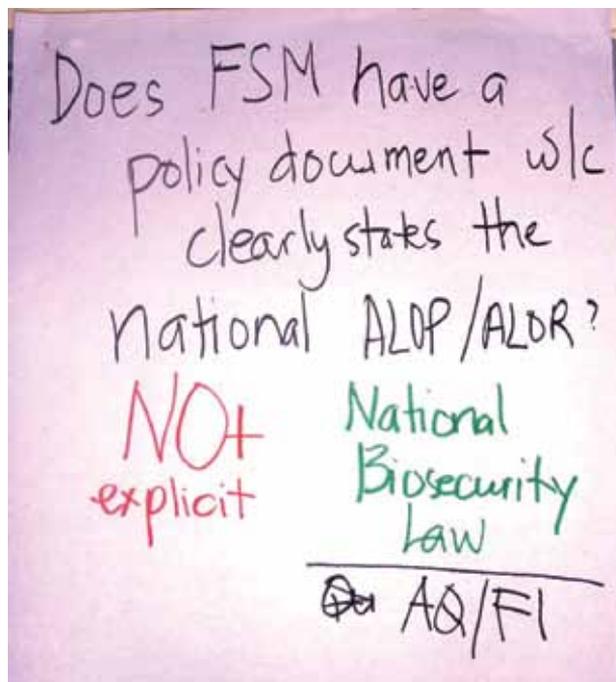
Materials: Each WG will be provided with any relevant policy statements and several recent examples of import decisions from the aquaculture/fisheries, plant and terrestrial animal sectors. WGs should also take into consideration relevant plenary presentations.

Outputs: The participants will independently consider the following questions/activities and be prepared to justify their decisions. The discussion moderator will assist by moderating group discussion and with the assistance of the course facilitators, will prepare a concise summary for presentation to plenary (continued on next page).

Working Group Exercise 4

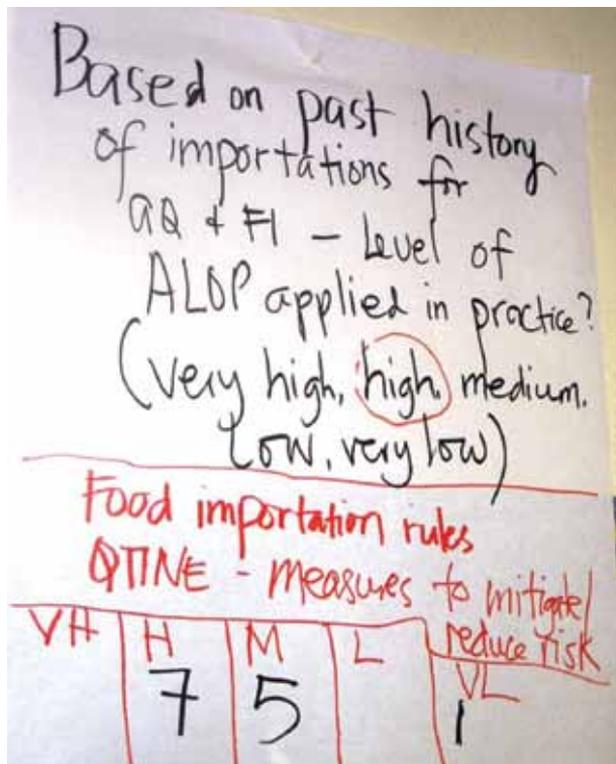
Outputs: The participants will independently consider the following questions/activities and be prepared to justify their decisions. The discussion moderator will assist by moderating group discussion and with the assistance of the course facilitators, will prepare a concise summary for presentation to plenary.

1. Does your country have a policy document that clearly states the national ALOP/ALOR?



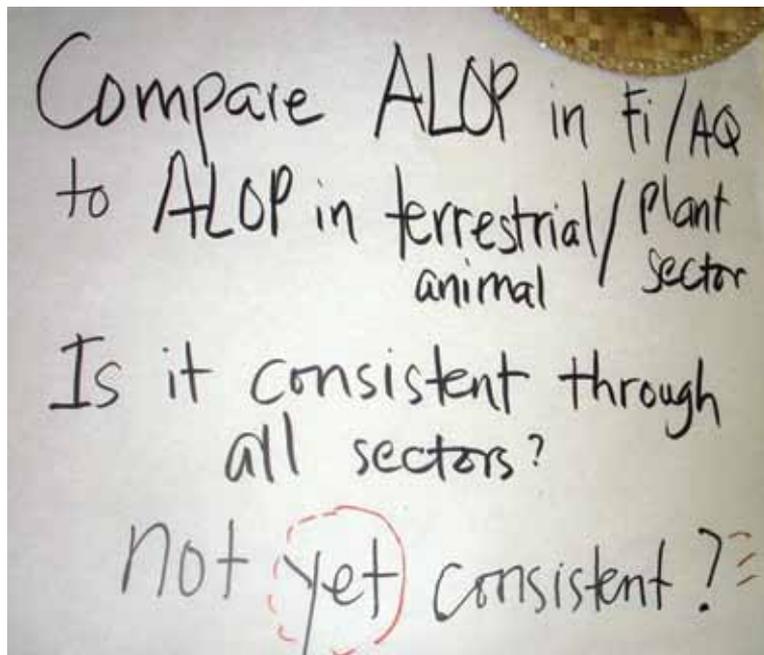
Working Group Exercise 4

- Based on past history of importations for the aquaculture and fisheries sectors, what level of ALOP has been applied in actual practice for this sector (e.g. very high, high, medium, low, very low)?



Working Group Exercise 4

3. Compare your estimated ALOP for the aquaculture/fisheries sectors with recent experiences for the plant and/or terrestrial animal sectors. Does the ALOP appear to be consistent across all three sectors?



Working Group Exercise 4

4. Based on this exercise and your knowledge of the value that the citizens of your country place on their natural ecosystems and biodiversity, their social values and the national need for economic development, what do you think the national ALOP should be?



2.5 Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation) (Working Group Exercise 5)

2.1	Identifying issues and potential risks in proposals for species translocations for aquaculture development (Working Group Exercise 1)	44
2.2	Identifying current risk analysis frameworks and procedures (Working Group Exercise 2)	60
2.3	Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)	66
2.4	Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)	78
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2.7	Implementing risk analysis: identification of needs and recommendations (Working Group Exercise 7)	112

2.5.1 Overview

Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation)

Learning objectives: Continuing to build understanding of the pathogen risk analysis process through completion of the risk assessment portion (exposure assessment, release assessment, consequence assessment and risk estimation) of a simplified risk analysis for the assigned commodity. Understanding of the risk evaluation portion of risk management by use of the ALOP agreed upon in WG Exercise 4 to determine if the unmanaged risk is acceptable.

Learning outcomes: Participants will gain a basic understanding of the risk assessment portion of a qualitative pathogen risk analysis. They will be introduced the use of scenario trees and pathways analysis, the combining of risk likelihoods and the estimation of total risk. They will gain experience in determining if an estimated risk level is acceptable or unacceptable.

Module duration: WG Exercise – 2 hour 10 minutes (1 hour 30 minutes preparation, 40 minutes presentation); Supporting Lectures – 60 minutes (Supporting lectures Part 8 and Part 9)

2.5.2 Summary of working group exercise 5 and of supporting lecture material

Working Group Exercise

WG Exercise 5 (**Resource Document 5.1**) is one of the **most intensive exercises of the series**. Using translocation scenarios and other supporting documents provided in earlier lessons and with additional new material, the participants will continue the simplified risk analysis for their commodity. Using one of the hazards identified, they will conduct the release and exposure assessments by developing **scenario trees** and using **pathways analysis**, estimating and combining likelihoods in each to **obtain release and exposure estimates** and determining if the risk estimate for each is negligible or non-negligible. They will then combine these risk estimates to obtain an **overall risk of release and exposure**.

They then proceed to **consequence assessment**, drawing up a list of the five most serious consequences that might result from the pathogen becoming established in the new environment. Consequences are estimated and an overall estimate of consequence obtained. The participants then **combine the three risk estimates** (release, exposure and consequence) to obtain an **estimate of the overall risk** posed by the hazard. To complete the risk evaluation step of risk management, they then **compare the estimated total risk to a ALOR matrix to determine if the hazard poses significant risk**.

Lecture material supporting this exercise include Lecture Series Part 8 – Risk Assessment and Part 9 – initial section on overview and risk evaluation).

Supporting lecture material

Lecture material supporting this exercise may include presentations on:

- (i) national experience with movement of live aquatic animals and
- (ii) current national/state procedures for assessing proposals for translocations of aquatic animals (Example Programme, **Presentations 5 and 6**, country/course-specific presentations), and
- (iii) overview of ALOP/ALOR (**Presentation 10**)

Working Group Exercise 5

Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation)

Time allotted: 2 hours 10 minutes (1 hour 30 minutes preparation, 40 minutes presentation)

Purpose: The exercise will assist participants in understanding the risk assessment portion of the pathogen risk analysis process and will cover (A) Risk assessment: (i) Release Assessment, (ii) Exposure assessment, (iii) Consequence assessment and (iv) Risk estimation; and (B) Risk management: (i) Risk evaluation.

Methods: Participants will continue with the four WGs established during WG Exercise 1. WGs will elect a chairperson to lead their discussions, a rapporteur and a presenter. Each WG will be asked to further evaluate two of the potential hazards that they identified during WG Exercise 3.

Materials: Each WG will use the information provided/developed during WG Exercises 1-4 (translocation scenario, commodity description, relevant guidance, pathogen profiles; ALOP). They will also consider the information presented in the relevant plenary lectures. WGs will be provided with:

- (i) Definitions of descriptive likelihoods (**Resource Document 5.2**);
- (ii) Blank scenario tree (**Resource Document 5.3**);
- (iii) Matrix for combining risk likelihoods (**Resource Document 5.4**);
- (iv) Matrix for adding pathways likelihoods (**Resource Document 5.5**);
- (v) Definition of consequence levels (**Resource Document 5.6**);
- (vi) Matrix for combining consequences (**Resource Document 5.7**);
- (vii) Matrix for estimating total risk posed by a hazard (**Resource Document 5.8**); and
- (viii) Example matrices for comparing overall risk with ALOR (**Resource Document 5.9**). Each WG will have access to a course resource person, who will play the roles of:
 - (i) the “proponent” of the proposal and
 - (ii) an expert on host and pathogen biology.

Working Group Exercise 5

Outputs: WGs will consider the following questions/activities and be prepared to justify their decisions. WGs should prepare a concise (10 minutes) summary for presentation to plenary.

1. Release assessment

- a. Using the example blank scenario tree provided as a model (**Resource Document 5.3**), develop a scenario tree with two major pathways for pathogen release. Show all the major steps that would need to be completed for the pathogen to move from the source country to the border of FSM.
- b. Using the definitions of likelihoods (**Resource Document 5.2**), estimate the likelihoods for completion of each of the steps in each pathway.
- c. Using the matrix for combining risk likelihoods (**Resource Document 5.4**), calculate the likelihood of completion for each pathway.
- d. Using the matrix for adding pathway likelihoods (**Resource Document 5.5**), combine the likelihoods for the two pathways to get an estimate of the likelihood of release occurring.
- e. Is the risk of release non-negligible? (If the risk of release is negligible, the risk analysis would stop here).

Working Group Exercise 5

2. Exposure assessment

- a. For a pathogen having a non-negligible risk of exposure, develop an exposure scenario tree with two major pathways (**Resource Document 5.3**). Show all the major steps that would need to be completed for the pathogen to move from the border of FSM to exposure of cultured and/or wild stocks and its establishment in the natural environment.
- b. Using the definitions of likelihoods (**Resource Document 5.2**), assign likelihoods for completion of each of the steps in each pathway.
- c. Using the matrix for combining risk likelihoods (**Resource Document 5.4**), calculate the likelihood of completion for each pathway.
- d. Using the matrix for adding pathways likelihoods (**Resource Document 5.5**), combine the likelihoods for the two pathways to get an estimate of the likelihood of exposure occurring.
- e. Is the risk of exposure non-negligible? (if the risk of exposure is negligible, the risk analysis for the hazard would be completed).

3. Combining release and exposure likelihood estimates

- a. Using the matrix for combining risk likelihoods (**Resource Document 5.4**), combine the release and exposure estimates to obtain an estimate of the Likelihood of Release x Exposure.
- b. Is the combined estimate of likelihood of release x exposure non-negligible? (if negligible, the risk analysis for the hazard would be completed)

4. Consequence assessment

- a. Draw up a list of the 5 most serious consequences that might result from the pathogen becoming established in aquaculture and the natural environment. Consider both direct and indirect impacts.

Working Group Exercise 5

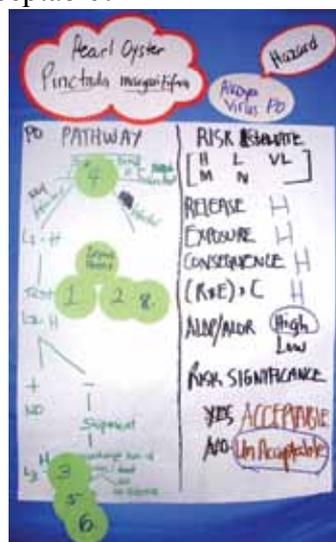
- b. Using the descriptions of consequences provided (**Resource Document 5.6**), make a preliminary assessment of the level of consequence in each case.
- c. Using the matrix for combining consequences (**Resource Document 5.7**), combine the individual consequences to obtain an overall estimate of consequence.
- d. Is the overall consequence non-negligible? (if negligible, the risk analysis for the hazard would be completed).

5. Risk estimation

- a. Using the matrix for estimating total risk (**Resource Document 5.8**), combine the estimate of likelihood of release x exposure with the consequence estimate (risk = likelihood x consequence!) to obtain the overall risk estimate for the hazard.

6. Risk Management – Risk Evaluation

- a. Using the ALOR matrix (**Resource Document 5.9**), compare your total risk estimate for the hazard(s) with the workshop's suggested ALOP (ALOR) for FSM. Is the risk posed by the hazard(s) acceptable or unacceptable?



Definitions for descriptive likelihoods

In qualitative risk analysis, release and exposure assessment use various terms to describe the likelihood of an event occurring. Note that definitions can differ between individual risk analyses and risk analysts; thus, it is important to define likelihood descriptors at the start of each risk analysis.

For this exercise, we will use a system with five levels of likelihood ranging from high to negligible.

Example with five terms:

- **High:** Event would be expected to occur
- **Moderate:** There is less than an even chance of the event occurring
- **Low:** Event would be unlikely to occur
- **Very low:** Event would rarely occur
- **Negligible:** Chance of event occurring is so small that it can be ignored in practical terms

How to use this matrix: To combine 2 likelihoods, find the likelihood of event 1 occurring in the top row and the likelihood of event 2 in the left column – the box where they intersect is their combined likelihood (for example: if the likelihood of event 1 is moderate and the likelihood of event 2 is high, their combined likelihood is moderate). This matrix is used for:

- combining likelihoods of completing steps along a pathway
- combining likelihood of release and likelihood of exposure

Blank scenario tree

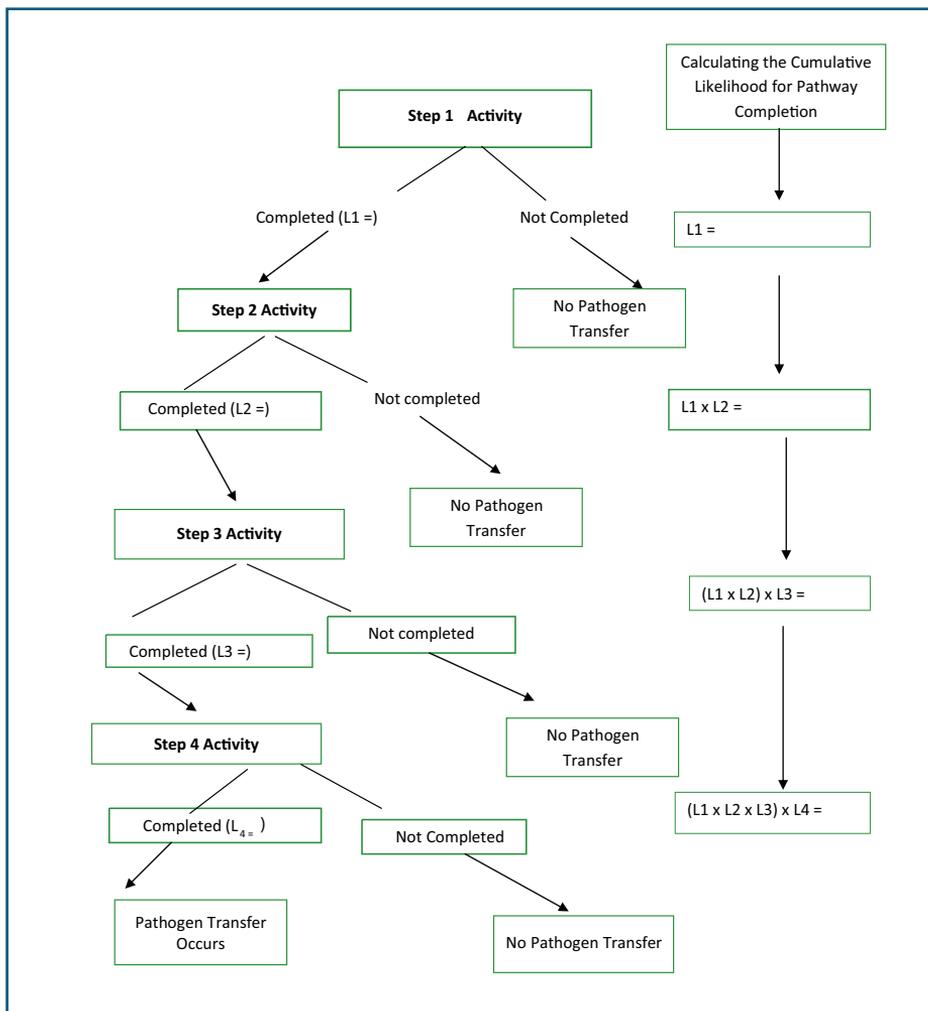
A scenario tree can have as many pathways as necessary to describe how release or exposure can take place (i.e. you can add as many branches (pathways) to the scenario tree as needed). In this instance, only one pathway is given.

To use the scenario tree:

- From the starting point (e.g. for release, the source population in the exporting country) identify each important pathway by which the pathogen could move to the end point (e.g. for release, the border of the importing country).
- For each pathway, identify each step in the pathway that must be successfully completed for the pathogen to complete the pathway (place the name of the step in the large box above each fork in the pathway)
- For each step in the pathway, estimate the likelihood of the step being completed using the definitions given in Document 5.2 (place the likelihood estimate for each step (L) in the small box for each step). Note that each step in the pathway has two choices (“yes” – completes the step and “no” – no pathogen transfer occurs)

Blank scenario tree

Simplified Scenario Tree with a single pathway having four steps. In this simplified example, the likelihood that infected animals will successfully complete the pathway can be expressed as $LC = (L_1 \times L_2 \times L_3 \times L_4)$. L_1 = likelihood of completing Step 1, etc.



Matrix for combining risk likelihoods

How to use this matrix: To combine 2 likelihoods, find the likelihood of event 1 occurring in the top row and the likelihood of event 2 in the left column – the box where they intersect is their combined likelihood (for example: if the likelihood of event 1 is moderate and the likelihood of event 2 is high, their combined likelihood is moderate). This matrix is used for:

- combining likelihoods of completing steps along a pathway
- combining likelihood of release and likelihood of exposure

		Estimated likelihood of event 1				
		Negligible	Very low	Low	Moderate	High
Estimated likelihood of event 2	High	Negligible	Very low	Low	Moderate	High
	Moderate	Negligible	Very low	Low	Low	
	Low	Negligible	Very low	Very low		
	Very low	Negligible	Negligible			
	Negligible	Negligible				

Matrix for adding likelihood pathways

When a scenario tree has more than one pathway, this matrix can be used to add the cumulative likelihoods obtained for each pathway to obtain an estimate of the overall Likelihood of release or exposure. Note that each pathway is an independent event and thus combining likelihoods across pathways is **additive**, while completing a given step in a single pathway is dependent upon first successfully completing the preceding steps and thus combining likelihoods within a pathway is **multiplicative**.

Example:

Estimates obtained for Pathways 1, 2 and 3 are very low, moderate and moderate, respectively.

Estimate for the entire scenario tree is:

- (1) very low + (2) moderate = (1 + 2) moderate;
- (1 + 2) moderate + (3) moderate = high

Estimated likelihood of pathway 1

	Negligible	Very low	Low	Moderate	High
High	High	High	High	High	High
Moderate	Moderate	Moderate	High	High	
Low	Low	Low	Moderate		
Very low	Very low	Very low			
Negligible	Negligible				

Estimated likelihood of pathway 2

Consequence assessment definitions of qualitative rankings

In this example a system of five levels of consequence is used:

- **Catastrophic:** Disease would significantly harm economic performance at an industry level and/or cause serious and irreversible environmental harm.
- **High:** Disease would have serious biological consequences (e.g. high mortality or morbidity) and would not be amenable to control or eradication. It could significantly harm economic performance at an industry level and/or cause serious environmental harm.
- **Moderate:** Diseases would have less pronounced biological consequences and may be amenable to control or eradication. It could harm economic performance at an industry level and/or cause some environmental effects, which would not be serious or irreversible.
- **Low:** Diseases would have mild biological consequences and would normally be amenable to control or eradication. Effects on economic performance and the environment would not be serious or irreversible.
- **Negligible:** Diseases would have no significant biological, ecological or economic consequences and would not require control or eradication.

Matrix for combining consequences

When a scenario tree has more than one pathway, this matrix can be used to add the cumulative likelihoods obtained for each pathway to obtain an estimate of the overall Likelihood of release or exposure. Note that each pathway is an independent event and thus combining likelihoods across pathways is **additive**, while completing a given step in a single pathway is dependent upon first successfully completing the preceding steps and thus combining likelihoods within a pathway is **multiplicative**.

Example:

Estimates obtained for Pathways 1, 2 and 3 are very low, moderate and moderate, respectively.

Estimate for the entire scenario tree is:

(1) very low + (2) moderate = (1 + 2) moderate;

(1+ 2) moderate + (3) moderate = high

		Estimated consequence 1				
		Negligible	Low	Moderate	High	Catastrophic
Estimated consequence 2	Catastrophic	Catastrophic	Catastrophic	Catastrophic	Catastrophic	Catastrophic
	High	High	High	High	Catastrophic	
	Moderate	Moderate	Moderate	High		
	Low	Low	Moderate			
	Negligible	Negligible				

Matrix for estimating total risk posed by a hazard

		Estimated consequence of release and exposure				
		Negligible	Low	Moderate	High	Catastrophic
Estimated likelihood of release and exposure	High	Negligible Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
	Moderate	Negligible Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
	Low	Negligible Risk	Very low Risk	Low Risk	Moderate Risk	High Risk
	Very low	Negligible Risk	Negligible Risk	Very low Risk	Low Risk	Moderate Risk
	Negligible	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk
		Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk

Matrix for use of ALOR in risk evaluation

The following example matrices show the division between Acceptable and Unacceptable risk for two ALOPs.

- (a) Matrix showing division between acceptable and unacceptable risk for a country having a very high ALOP (very low ALOR) – all outcomes with an estimated risk above “very low” are unacceptable. The ALOP is the dividing line between “green” (acceptable risk) and “red” (unacceptable risk).

		Estimated consequence of release and exposure					
		Negligible	Low	Moderate	High	Catastrophic	
Estimated likelihood of release and exposure	High	Negligible Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk	
	Moderate	Negligible Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk	
	Low	Negligible Risk	Very low Risk	Low Risk	Moderate Risk	High Risk	
	Very low	Negligible Risk	Negligible Risk	Very low Risk	Low Risk	Moderate Risk	
	Negligible	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	
		Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	

Matrix for use of ALOR in risk evaluation

(b) Matrix showing division between acceptable and unacceptable risk for a country having a moderate ALOP (moderate ALOR) – all outcomes with an estimated risk above “moderate” are unacceptable. The ALOP is the dividing line between “green” (acceptable risk) and “red” (unacceptable risk).

Estimated consequence of release and exposure

		Estimated consequence of release and exposure				
		Negligible	Low	Moderate	High	Catastrophic
Estimated likelihood of release and exposure	High	Negligible Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
	Moderate	Negligible Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
	Low	Negligible Risk	Very low Risk	Low Risk	Moderate Risk	High Risk
	Very low	Negligible Risk	Negligible Risk	Very low Risk	Low Risk	Moderate Risk
	Negligible	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk
	Negligible	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk

2.6 Risk management (option evaluation, implementation, monitoring and review) (Working Group Exercise 6)

2.1	Identifying issues and potential risks in proposals for species translocations for aquaculture development (WG Exercise 1)	44
2.2	Identifying current risk analysis frameworks and procedures (Working Group Exercise 2) Working Group Exercise 2	60
2.3	Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)	66
2.4	Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)	78
2.5	Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation) (Working Group Exercise 5)	86
	2.6 Risk management (option evaluation, implementation, monitoring and review) (Working Group Exercise 6)	104
2.6.1	Overview	105
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2.7	Implementing risk analysis: identification of needs and recommendations (Working Group Exercise 7)	112

2.6.1 Overview

Risk management (option evaluation, implementation, monitoring and review)

Learning objectives: This exercise completes the simplified pathogen risk analysis process. The participants learn how to conduct options evaluation by identifying risk management options and ranking them as to probable effectiveness and feasibility and calculating their likely effectiveness in reducing risk. They will also learn the basics of the implementation and monitoring and review of the risk analysis process.

Learning outcomes: Participants will gain a basic understanding of the risk management portion of a qualitative pathogen risk analysis. They will gain further experience in use of scenario trees and pathways analysis, the combining of risk likelihoods and the estimation of total risk. They will be introduced to evaluating risk management options and begin to consider how the selected option(s) might be implemented and their effectiveness monitored and reviewed.

Module duration: WG Exercise – 1 hour 40 minutes (1 hour 20 minutes preparation, 20 minutes presentation); lecture – 60 minutes (Supporting Lectures Part 9)

2.6.2 Summary of Working Group Exercise 6 and of supporting lecture material

Working Group Exercise

As with WG Exercise 5, WG Exercise 6 is rather demanding and its successful completion is critical to the participants' understanding of the risk analysis process. It continues to build understanding of the pathogen risk analysis process through completion of the risk management portion of the risk analysis. Continuing with the simplified risk analysis for their assigned commodities, the participants will conduct options evaluation by identifying risk management options and ranking them as to probable effectiveness and feasibility. Using the scenario tree/pathways approach, the WGs will identify at what points in the pathway(s) their risk management measures will be applied, estimate new likelihoods for these steps and calculate and evaluate new risk estimates. They will also consider the logistics of implementing and monitoring and review of the suggested risk management measures.

Supporting lecture material

Lecture materials supporting this exercise should include presentations on the options evaluation, monitoring, and monitoring and review portions of the risk management process (**Presentations 11-12**, in the Example Programme given in **Table 1** (see page 7)).

Working Group Exercise 6

Risk management (option evaluation, implementation, monitoring and review)

Time allotted: 1 hour 40 minutes (1 hour 20 minutes preparation, 20 minutes presentation)

Purpose: The exercise will assist participants in understanding the risk management portion of the pathogen risk analysis process and will cover (i) options evaluation, (ii) implementation, (iii) monitoring and review.

Methods: Participants will continue with the four WGs established during Exercise 1. WGs will elect a chairperson to lead their discussions, a rapporteur and a presenter. Each WG will further evaluate one of the hazards identified during Exercise 5 as having an unacceptable level of risk.

Materials: Each WG will use the information provided/developed during WG exercises 1-5 (proposal, commodity description, relevant guidance, information on aspects of pathogen biology, pathogenicity, host range, etc.) They will also consider the information presented in the relevant plenary lectures. WGs will also use the previously provided

- (i) Definitions of risk levels;
- (ii) Table for combining risk probabilities;
- (iii) Table for calculating overall risk, example of blank scenario tree, definitions of consequences, table for combining consequences.

Each WG will have access to a course resource person, who will play the roles of

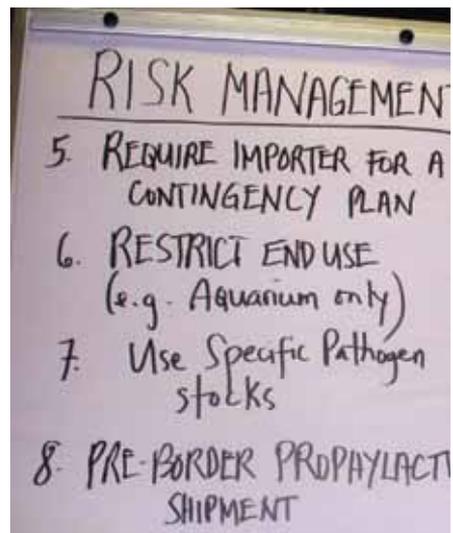
- (i) the “proponent” of the proposal and
- (ii) an expert on host and pathogen biology.

Working Group Exercise 6

Outputs: WGs will consider the following questions/activities and be prepared to justify their decisions. WGs should prepare a concise (5 min) summary for presentation to plenary.

1. Options Evaluation

- a. Prepare a list of five risk management options that might be effective in reducing the risk posed by the hazard.



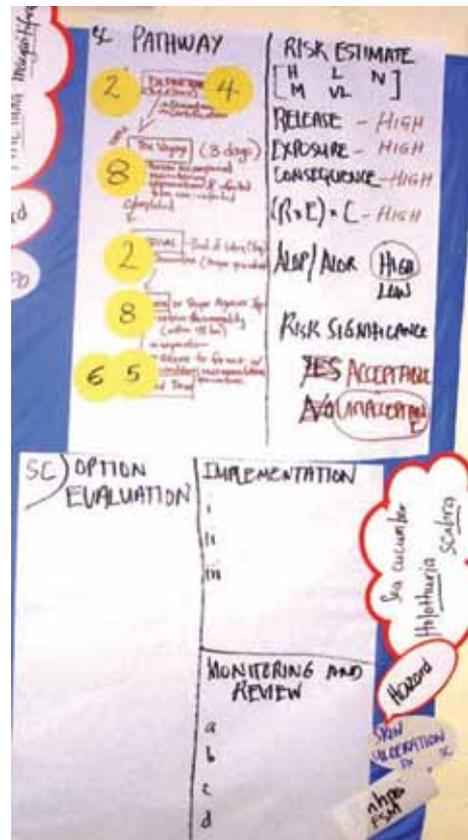
Working Group Exercise 6

- b. Using a table format, list estimates for the following parameters for each identified option (use the following ranking system : very high, high, medium, low, very low)
 - i. likely effectiveness
 - ii. likely feasibility for proponent and/or FSM to implement
- c. Now, based on the above, rank the options from 1 to 5 in order of their probable usefulness
- d. Are any of the options likely to be unacceptable to the proponent because of the cost or technical difficulty?
- e. Using the exposure and release scenario diagrams for the hazard that you prepared during Exercise 5, identify the step(s) in the pathway(s) where the risk management measure will affect the likelihood(s) of the step(s) being completed.
- f. Agree upon new likelihood estimates for completing these steps.
- g. Now recalculate the estimate of exposure &/or release using the methods from Exercise 5. Did the risk management measure change the estimate(s)?
- h. If yes, recalculate the total risk estimate (now the managed risk estimate) as per Exercise 5. Is the level of risk for the hazard now acceptable?
- i. If not, what would you do next?

Working Group Exercise 6

2. Implementation

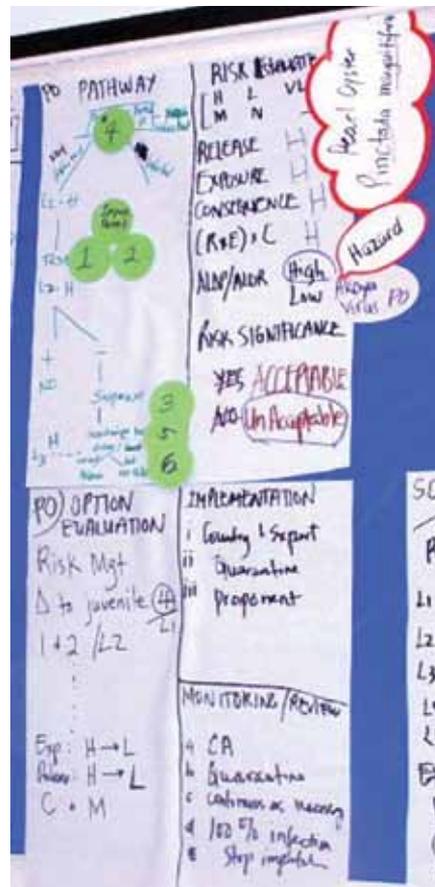
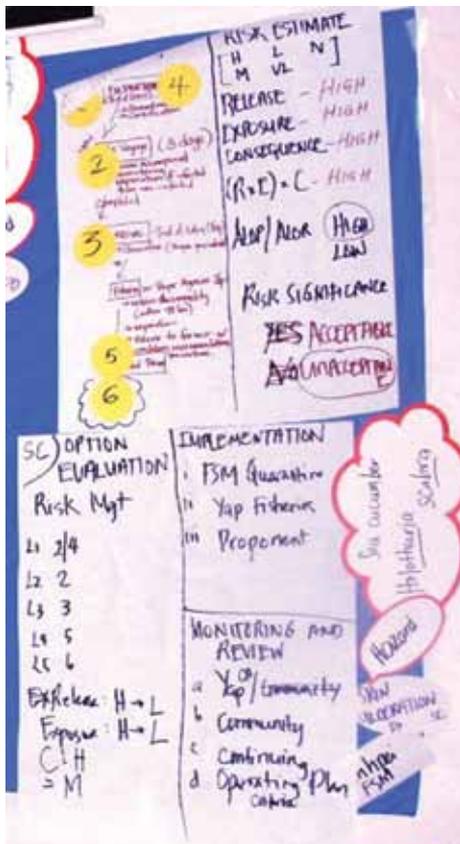
- a. Describe briefly how you would implement the risk management measure. Consider:
 - i. Who should set the standards?
 - ii. Who should implement it?
 - iii. Who should pay for it?



Working Group Exercise 6

3. Monitoring and review

- Who should set up the monitoring programme and standards?
- Who should do the actual monitoring?
- How long will the monitoring continue?
- What criteria would be used to decide if the importation process should be terminated and the stock destroyed?



2.7 Implementing risk analysis: identification of needs and recommendations (Working Group Exercise 7)

2.1	Identifying issues and potential risks in proposals for species translocations for aquaculture development (Working Group Exercise 1)	44
2.2	Identifying current risk analysis frameworks and procedures (Working Group Exercise 2)	60
2.3	Pathogen risk analysis – scoping to hazard identification (Working Group Exercise 3)	66
2.4	Determining an appropriate level of protection (ALOP) (Working Group Exercise 4)	78
2.5	Risk assessment (release, exposure and consequence assessment, risk estimation); risk management (risk evaluation) (Working Group Exercise 5)	86
2.6	Risk management (option evaluation, implementation, monitoring and review) (Working Group Exercise 6)	104
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2.7.1 Implementing risk analysis: identification of needs and recommendations

Overview

Learning objectives: In this short concluding WG Exercise which is conducted in plenary, the participants are asked to think critically about how risk analysis is currently conducted in their country and to identify areas that can be improved and make recommendations how this might be accomplished.

Learning outcomes: Using the knowledge and experience that they have gained during the workshop, participants will be able to apply new insight that will lead to the improvement of the risk analysis process as currently applied in their country.

Module duration: WG Exercise – 1 hour 40 minutes (1hour 20 minutes preparation, 20 minutes presentation); lecture – 60 minutes (Supporting Lectures Part 9)



2.7.2 Summary of Working Group Exercise 7 and of supporting lecture material

Working Group Exercise

This concluding exercise asks participants consider current risk analysis procedures and capacity in their country, identify areas that should be improved, and suggest ways to achieve the required expertise and capacity.

The outputs of the WGs can later be synthesized by the trainers into a list of recommendations to FAO and the national lead agency for future development of national risk analysis capacity.

Supporting lecture material

Lecture material supporting this exercise can include presentations prepared based on workshop outputs (i) summarizing the results of the risk analysis exercises and presenting the results of consultants case studies (e.g. **Presentations 12 and 13** in the Example Programme given in **Table 1**).

The results and recommendations of the WG Exercises are to be summarized in the workshop's concluding presentation (e.g. **Presentation 13**) and detailed in the Workshop Report for follow up by the national competent authorities and by FAO.

2.7.3 Working Group Exercise 7

Implementing risk analysis in FSM: identification of needs and recommendations

Time allotted: 1 hour 10 minutes (50 minutes preparation, 20 minutes presentation)

Purpose: In this exercise participants will consider current risk analysis procedures and capacity in FSM, identify areas that should be improved, and suggest ways to achieve the required expertise and capacity. The outputs of the four WGs will later be synthesized by the FAO team into a list of recommendations for future development of national risk analysis capacity.

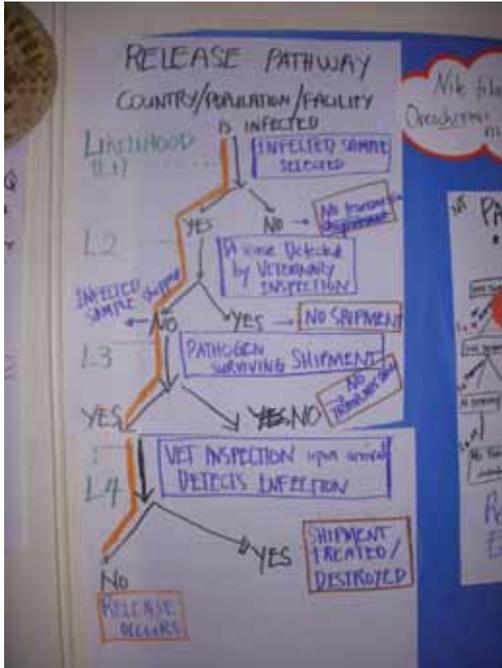
Methods: Participants will continue with the four WGs established during Exercise 1. WGs will elect a chairperson to lead their discussions, a rapporteur and a presenter. Following WG presentations, the outputs will be organized by the facilitators and presented to plenary for further discussion by a moderator chosen from among the participants.

Materials: Each WG will draw upon the experience and knowledge of its members and on knowledge and information gained during the workshop. WGs should be supplied with flip charts and post-its for use in their presentations and during plenary summary.

1. How important is understanding and applying risk analysis to managing introductions and transfers of aquatic species to/within FSM?
2. Rank the seven areas of risk analysis according to their importance to sustainable aquaculture development in FSM (financial, social, environmental, pathogen, food safety and hygiene, genetic, ecological (including pests and invasives))
3. What are the main problems/constraints to applying risk analysis in FSM (list from highest to lowest importance) (for example, consider the general areas of budget, infrastructure, legislation, knowledge, manpower, capacity, etc.)

Working Group Exercise 7

4. For each constraint, list some possible solutions (these should be practical and have a real possibility of being implemented in FSM, even if no external funding is obtained).
5. What other recommendations would the WG like to make to the competent authorities of FSM or to FAO?



What should FSM national ALDP be?

[Natural ecosystem/biodiversity]
[Social values]
[need for economic development]

???

WHO/SPC/FAO

explicit statement
Biosecurity
national awareness/
sensitization
(esp. business people, regulators)

References

3. Reference materials

3.1 References	119
3.2 Risk analysis references and resources	
Aquaculture risks (all sectors)	120
Ecological and environmental risk assessment	120
Food safety/human health risk analysis	120
Pathogen risk analysis	120
Molluscs	121
Finfish	122
Crustaceans	123
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*“Risk analysis is a discipline that is best shared by actual experience ...
it is an exercise that is learned by doing...”*



Example case study



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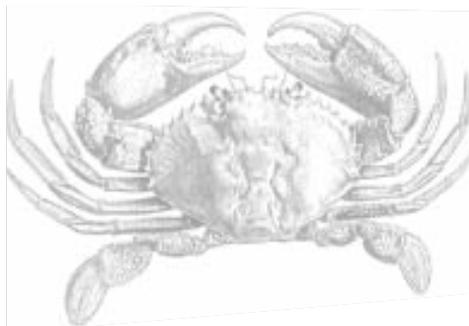
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Introduction

Example Case Study Mangrove crab (*Scylla serrata*) to Kosrae State, Federated States of Micronesia



This case study is prepared by the International Consultant for the Food and Agriculture Organization of the United Nations (FAO) under Project TCP/MIC/3201: Risk Assessment in Aquaculture Development in FSM, to assist in raising awareness and understanding on the application of risk analysis to aquaculture production. The case study is not a risk analysis, but rather provides a preliminary examination and assessment of the possible pathogen hazards and, to a lesser extent, ecological/pest/invasive species issues that may be involved in the translocation of mangrove crab (*Scylla serrata*) to Kosrae to support aquaculture development (mangrove crab “fattening”). It can thus form a starting point for conducting future pathogen, ecological and/or genetic risk analyses should the FAO or Government of the Federated States of Micronesia (FSM) chose to undertake such studies. It does not consider such issues as impacts on natural stocks by harvesting wild crab to support aquaculture development.

Background

The mangrove or mud crab (*Scylla serrata*) is distributed throughout the Indo-Pacific region from Hawaii, southern Japan, Taiwan POC and the Philippines, to Australia, the Red Sea and East and South Africa; it is thus native to Kosrae State, FSM

The Kosrae State Government has undertaken a feasibility study of mangrove crab farming with the aim of providing enough crabs for local subsistence and for export markets. In Kosrae, traditional extensive culture methods are used to grow-out or “fatten” mangrove crabs by the capture and holding of small numbers of locally caught, wild juveniles in pens constructed in mangrove areas. It is envisaged that using this enclosure grow system can develop the mangrove crab farming sector in Kosrae to meet the growing local and outside demands. The Kosrae State Government has invested some initial capital into this project and has approached the National Government for technical assistance and to solicit potential external assistance (source: FSM Country Report).

The Kosrae Fisheries Department set up a state-funded Mangrove Crab Pilot Project in 2002-2004 that includes construction of a mangrove crab hatchery at the FSM Aquaculture Center in Lelu. (Wortel, 2005; Ponia, 2006). The crab grow-out site comprises two large earthen ponds on a 10 ha site. Retaining walls have been built to reduce escapees. The crabs are fed trash tuna provided by transshipment boats in port. Exports of crabs to Guam for the restaurant trade have been taking place (Wortel, 2005).

Problems faced by the project have included competition for food from freshwater eels, the negative impacts on the mangrove forest of excavation and soil build-up around the site, and undetermined mortality rate for crabs within the pond. There has also been difficulty in obtaining small juvenile crabs from the mangrove forests of Kosrae for stocking into the ponds. As a result mangrove crabs of all sizes have been purchased by the state in order to stock the ponds. However, there is concern that this practice is not sustainable and will lead to depletion of local wild stocks (Wortel, 2005).

Species profile

- Taxonomy:
 - Kingdom: Animalia
 - Phylum: Arthropoda
 - Class: Crustacea
 - Order: Decapoda
 - Family: Portunidae
 - Genus: *Scylla*
 - Species: *Scylla serrata*

It is noteworthy that the genus *Scylla* contains four species, *S. serrata*, *S. tranquebarica*, *S. olivacea* and *S. paramamosan*. Thus the identity of crabs presently being cultured in FSM, as well as any stock that may be transferred or imported should be verified.

- **Geographic distribution**

The mangrove or mud crab (*Scylla serrata*) is distributed throughout the Indo-Pacific region from Hawaii, southern Japan, Taiwan POC and the Philippines, to Australia, the Red Sea and East and South Africa.

- **Aquaculture significance**

The mangrove crab is the most important crab for commercial culture in the Indo-West Pacific region and commands a high price in both the domestic and export markets. It is considered an excellent and sought-after delicacy in Asia and females with mature ovaries are particularly expensive. Mangrove crab is commercially harvested in areas where it has been introduced and populations have become established.

As interest in this species has grown so has pressure on the wild populations used for stocking, such that hatchery technology for large-scale production of juveniles has now been developed in the Philippines by SEAFDEC-AQD, as well as in Japan and India. However, although techniques for spawning and larval production have been developed (see Jithendran *et al.* 2009), these techniques are not widespread and are also still dependent on the capture of wild crabs for use as broodstock.

Species profile

- **Status in FSM**

Mangrove crab occurs throughout FSM and is thus native to Kosrae. Movements of this species, whether from other stocks in FSM or via importation of crabs from abroad would constitute species transfer.

- **Invasiveness**

There do not appear to be any reports of invasiveness or adverse ecological impacts resulting from translocations of mangrove crabs (e.g. Global Invasive Species Database, <http://www.issg.org/database/welcome/>). Ecological impact of introductions is unknown, but the species has been described as an active and aggressive⁵ As this species is native to Kosrae and has positive economic significance, invasiveness is not considered an issue in this proposed transfer.

- **Genetics**

The population structure of mangrove crab is not well known. The species is noted to have an extended larval phase, suggesting a high dispersal potential (USGSI. <http://nas.er.usgs.gov/queries/FactSheet.aspxPspeciesID=192>). A study of genetic differentiation in Indian Ocean populations, however, found reduced gene flow, even between geographically close sites. In contrast, the south-west region of Australia was colonized by large numbers of *S. serrata* from north-west Australia through a planktonic recruitment event enhanced by a strong 1999/2000 Leeuwin Current.

As noted by Uthicke and Purcell (2004), the release or escape of hatchery-produced aquatic species can present the risk of genetic harms to wild stocks via:

- (i) *Genetic introgression* that reduces the genetic differences among stocks. Reduction in frequency of native alleles via introgression of exogenous alleles can result from the use of imported or transferred broodstock of different genetic stock for hatchery production. This introgression may be caused either by interbreeding of animals

⁵ (<http://nas.er.usgs.gov/queries/FactSheet.aspxPspeciesID=192>).

Species profile

from the two stocks or by the introduced alleles outcompeting native alleles because of higher fitness of individuals carrying these introduced alleles.

- (ii) *Outbreeding depression* resulting from interbreeding of an introduced stock with a native stock, which can disturb potentially complex adaptations to the local environment that have evolved over time. Such hybridizations tend to have long-lasting effects that are disadvantageous to native stocks rather than beneficial through added genetic variation.

Therefore, unless the genetic structures of stocks at release and source sites are known, juveniles should be released only at native sites to preserve the genetic diversity of stocks.

- **Pathogens**

In general, the pathogens and parasites of mangrove crabs are poorly known. A wide range of “fouling organisms” and commensals (filamentous bacteria, algae, stalked protozoans, barnacles etc.) are common on crabs reared under suboptimal conditions. These are not considered further in this preliminary analysis; however, the Government should note their likely presence as “fellow travelers” on imported mangrove crabs. There are few studies on the diseases of larval stages and in hatchery production.

It is important to emphasize that there have been no studies of the diseases, pathogens or commensals of native mangrove crab stocks in FSM. Thus a precautionary approach would be to assume that local populations are free from infection until it is shown otherwise.

Summary of issues

The following appear to be the main issues surrounding the transfer of mangrove crab to Kosrae State for aquaculture development:

- *Genetic risks*: Possible loss of genetic integrity of local crab populations due to breeding of escapees with native populations.
- *Ecological risks*: Possible ecological risks due to the unintended translocation of “fellow travelers” (e.g. commensals and epiphytic organisms) with mangrove crab.
- *Pathogen risks*: Possible risk of introducing new diseases, parasites and pathogens due to unknown health status of transferred crabs, the unknown health status of local Kosrae stocks, the lack of SPF stocks, the generally poor state of knowledge of mangrove crab diseases and parasites, and the absence of diagnostics tests for some diseases.

Preliminary consideration of pathogen risks

Commodity description

1. Commodity description

TABLE 3

Commodity description: Mangrove crab

Species to be translocated:	<i>Scylla serrata</i>
Proposed date of importation:	not determined
Life cycle stage to be imported:	juvenile/adult
Importer:	Kosrae Fisheries Department
Exporter:	not determined
Source:	not determined (wild caught)
Proposed number of shipments:	not determined
Volume:	not determined
Proposed destination:	Kosrae. Stocking in project net pens and/or use as hatchery broodstock (not determined)

2 . Scoping considerations

Risk analysis should focus on *Scylla serrata*; however, the possibility that other species of *Scylla* will be included in domestic or international movements of crabs should be considered, as well as the possibility that new species or strains of pathogens may negatively impact other native *Scylla* spp. should be considered.

The risk analyses should include pathogen, genetic and ecological “fellow traveler” concerns.

Because of the absence of any pathogen data on local stocks of mangrove crabs and that source has not been determined, a generic approach should be taken that includes consideration of all diseases and pathogens of juvenile and adult *Scylla serrata* and other relevant *Scylla* spp. reported from any part of the world.

Hazard identification

3. Hazard identification

• **Criteria for initial listing**

- pathogen or parasite or a disease or syndrome likely to be caused by a biological agent; and
- reported from mangrove crab from any locality (global)

• **Consideration as a Potential Hazard:**

- pathogen is reported or likely to infect juvenile or adult mangrove crab
- pathogen is present or potentially present in the exporting country (if international source) or region (island) or State of FSM (if a domestic source is used). Due to the absence of contradictory data, all pathogens reported from mangrove crab are assumed to be potentially present in the source population.
- pathogen is absent from the importing country (if international movement) or state or local population (if a domestic movement), or, if present, it should be an OIE-listed disease or a disease subject to a program of eradication or control. Due to the absence of contradictory data, all pathogens are assumed to be absent from the aquatic fauna of Kosrae.
- pathogen causes significant disease in mangrove crab or in other species found in Kosrae.

A preliminary listing of pathogens and parasites reported globally from mangrove crab are summarized below in Table 1. Pathogens are separated into two broad categories (i) those listed by the World Organisation for Animal Health (OIE) and (ii) other, non-OIE listed pathogens. For each pathogen, the following information is presented: name, occurrence of reports from juvenile or adult crabs, importance as a pathogen, whether a pathogen that requires avoidance by Kosrae, references, and comments on geographic distribution, life cycle, pathogenicity, etc.

Based on this information, the following six pathogens/diseases (two virus, one protozoan, two rhizocephalan barnacles, and one disease of unknown cause) are considered to be of primary concern to Kosrae:

Preliminary recommendations

- **OIE-listed pathogens**
 - o Whitespot syndrome virus (WSSV)
- **Other serious pathogens**
 - o Mud crab reovirus (MCRV)
 - o Hematodinium sp.
 - o *Loxothylacus ihlei*
 - o *Sacculina granifera*
 - o “Orange crab disease”

(1) Only locally collected mangrove crabs should be used for aquaculture development

There appears to be only one real option for reducing the risk of introducing exotic pathogens, and that is to prohibit all importations of mangrove crabs and require that aquaculturists use only domestically (i.e. Kosrae) collected crabs. This is suggested due to the absence of any source of SPF stock or stock of known disease history that could be imported, and the high probability that imported crabs will be carrying serious diseases. Of these, WSSV is most problematic. Although the virus does not cause losses in crabs, they can act as carriers, posing a serious potential threat to the development of penaeid shrimp culture in Kosrae and to native shrimp populations. It should be noted that there are no effective treatments for WSSV. In the Philippines, where WSSV is common, it is recommended that crabs not be cultured in the vicinity of shrimp ponds due to the high risk of contamination (C.R. Lavilla-Pitogo, pers. comm.) The occurrence of at least five other diseases in crabs that are of potential concern also suggests that a highly conservative approach should be taken.

(2) Undertake baseline diagnostics studies on cultured and native *Scylla* spp. of Kosrae

A survey of the diseases of mangrove crabs in Kosrae could be undertaken to provide a basis for more in-depth risk analysis and to support aquaculture development. Such a study need not be overly expensive, basic diagnostics can be done in FSM, with support for

Preliminary recommendations

viral and bacterial analyses could be arranged with regional (e.g. SEAFDEC-AQD, Philippines, AAHRI, Bangkok) or international laboratories.

(3) Consider ecological, pathogen and genetic risk analyses

More comprehensive risk analyses could be completed to support the position that only locally collected mangrove crabs should be used for aquaculture development. However, it can be concluded that such studies would only support a decision not to allow importation of mangrove crabs from neighbouring countries or from other States within FSM.

(4) Support development of hatchery technology for breeding of mangrove crab

Given concerns about overharvesting of local mangrove crab stocks for aquaculture development and the recommendation that the use of imported crabs be prohibited, the only option to significantly expand Kosrae's crab culture production would appear to be the development of hatchery production, including the long-range goal of domesticated stocks.

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Table 4

TABLE 4
Pathogens and parasites of mangrove crab (*Scylla serrata*). (Y=Yes, N=No, P=Plausible, P=Uncertain)

Pathogen	Infects juvenile or adult	Causes significant disease	Further consideration required	References	Comments
Diseases Listed by the Office International des Épipizooties (OIE)					
Viruses					
White spot syndrome virus (WSSV)	Y	Y	Y	OIE database; Lavilla-Pitogo & de la Peña 2004; Jithendran et al. 2009	All stages of mangrove crab can carry this important pathogen of penaeid shrimp without signs of disease; global distribution; wide host range.
Other pathogens					
Viruses					
Mud crab reovirus (MCRV)	Y	Y	Y	Weng et al., 2007	Caused large losses of cultured mangrove crabs in southern China and "sleeping disease". The virus infects connective tissue cells of the hepatopancreas, gills and intestine, developing in the cytoplasm. 100% mortality observed in mud crab experimentally infected by intramuscular injection, bath inoculation and oral inoculation, while cohabitation infection caused 80% mortality. An RT-PCR detection method has been developed.
Muscle necrosis virus	Y	P	P	Song et al., 2003-04	Reported to cause a "sleeping disease" characterized by muscle necrosis in China.

Table 4

Pathogen	Infects juvenile or adult	Causes significant disease	Further consideration required	References	Comments
Scylla baculovirus (SIBV)	Y	N	N	Anderson & Prior 1992	No clinical disease noted; focal infections in hypertrophied hepatopancreatic epithelial cells; Australia.
Bacteria					
<i>Vibrio harveyi</i>	Y	Y	N	Lavilla-Pitogo & de la Peña 2004	Causes luminescent vibriosis, a devastating disease in crab larvae; mortalities can reach 100%; common in in-shore sea water; worldwide distribution.
<i>V. vulnificus</i> <i>V. parahaemolyticus</i> <i>V. splendidus</i> <i>V. orientalis</i> <i>Aeromonas</i> spp. <i>Pseudomonas</i> spp.	Y	Y	N	Lavilla-Pitogo & de la Peña 2004; Jithendran et al. 2009	Opportunistic bacteria causing shell disease and/ or systemic infections in mangrove crabs. Shell disease can affect 100% of tank-held crabs, but is seldom seen in wild populations.
Parasites					
<i>Hematodinium</i> sp.	Y	P	Y	Hudson & Lester 1994; Jithendran et al. 2009	Protozoan infecting the blood of mangrove crabs; Australia. Infections by members of this genus are highly pathogenic to other genera of crabs. Also in China and India.

Table 4

Pathogen	Infects juvenile or adult	Causes significant disease	Further consideration required	References	Comments
Epistylis, Vorticella, Zoothamnium	Y	P	N	Jithendran et al. 2009	Listed as infecting mangrove crabs in India. Ubiquitous free-living sessile ciliates that are fouling organisms on crustaceans. Includes fouling organisms (peritrich and suctorian ciliates, and internal infections (microsporidians, gregarines) not noted to cause disease.
Amyloodinium sp.	Y	P	N	Jithendran et al. 2009	Flagellated protozoan listed as infecting mangrove crabs in India. Genus includes common parasite of the gills of fishes with pathogenic significance in aquaria.
Nematopsis sp.	Y	N	N	Jithendran et al. 2009	Gregarine protozoan listed as infecting mangrove crabs in India. Genus is common in other crustaceans; unlikely to be pathogenic.
Acineta, Ephelota	Y	N	N	Jithendran et al. 2009	Suctorian ciliates listed as infecting mangrove crabs in India. Ubiquitous genera, fouling organisms.
Polypocephalus sp. metacestode	Y	P	N	Hudson & Lester 1994	Larval cestode
Digenea metacercaria	Y	P	N	Jithendran et al. 2009	Unidentified metacercariae listed as occurring in crabs in India. Unlikely to cause significant pathology but may have zoonotic significance.

Table 4

Pathogen	Infects juvenile or adult	Causes significant disease	Further consideration required	References	Comments
Nematodes	Y	P	N	Jithendran et al. 2009	Unidentified nematodes listed as occurring in crabs in India. Probably larval stages.
Crustacea					
<i>Loxothylacus illeis</i>	Y	Y	Y	Knuckley et al. 2005	Rhizocephalan barnacle; causes parasitic castration; infected crabs noted to be smaller than uninfected; recorded distribution includes Australia and Indonesia.
<i>Sacculina granifera</i>	Y	Y	Y	Lavilla-Pitogo & de la Peña 2004	Parasitic barnacle causing sterility and altered meat flavour; distribution includes Australia.
Fungi					
<i>Atkinsiella hamaensis</i>	Y	N	N	Bian and Egusa 1980; Lavilla-Pitogo & de la Peña 2004; Jithendran et al. 2009	Ubiquitous; can destroy eggs and larvae.
<i>Lagenidium</i> spp. <i>Sirolpidium</i> spp. <i>Halocrusticida</i> spp. <i>Haliphthoros</i> spp. <i>Fusarium</i> sp.					
<i>Thelohania</i> . sp.	Y	NP	N	Jithendran et al. 2009	Microsporean listed as infecting mangrove crabs in India. Genus includes species pathogenic to other crustaceans.
Diseases of unknown etiology					

Table 4

Pathogen	Infects juvenile or adult	Causes significant disease	Further consideration required	References	Comments
“Orange crab disease”	Y	Y	Y	Lavilla-Pitogo & de la Peña 2004	Septicemic disease of unknown etiology causing losses of crabs held in floating cages in Singapore.

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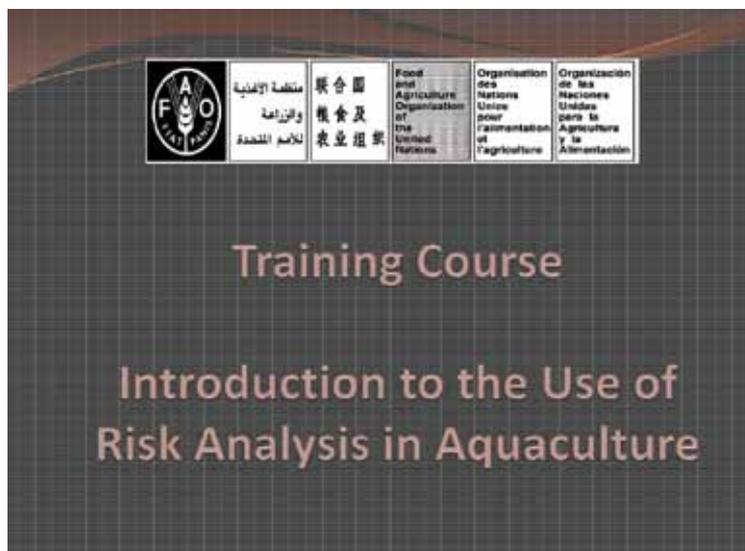
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Part 1

Part I – Course introduction: Information on course resource personnel, course goals and limitations, course overview and course outline. (14 Slides)

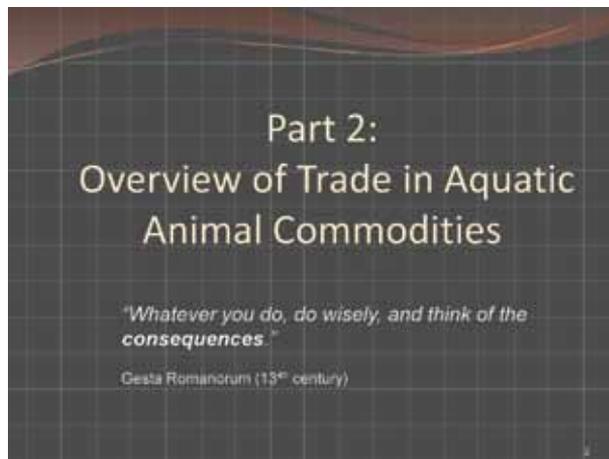
Slide 1



Part 2

Part 2 – Overview of trade in aquatic animal commodities: Why trade is “risky”, the global growth of aquaculture and trade in aquatic products and the driving forces, and the nature of the trade **(20 Slides)**.

Slide 1



Slide 9



International Trade in Live Aquatic
Animals and their Products

- Characterized by a **diverse range of species traded**:
 - fish
 - crustaceans
 - molluscs
 - other invertebrates
 - aquatic plants
 - amphibians
 - aquatic reptiles, birds & mammals



Part 2

Slide 12

International Trade in Live Aquatic Animals and their Products

- Diverse range of life-cycle stages traded
 - live aquatic animals
 - broodstock
 - juveniles
 - fry
 - postlarvae
 - nauplii
 - fertilized eggs



12

Slide 15

International Trade in Live Aquatic Animals & their Products

- Examples:
 - Malaysia alone produced some 338 million freshwater ornamentals in 2001, including 293 million freshwater fish belonging to > 90 species.
 - Australia imports 8-10 million ornamental every year

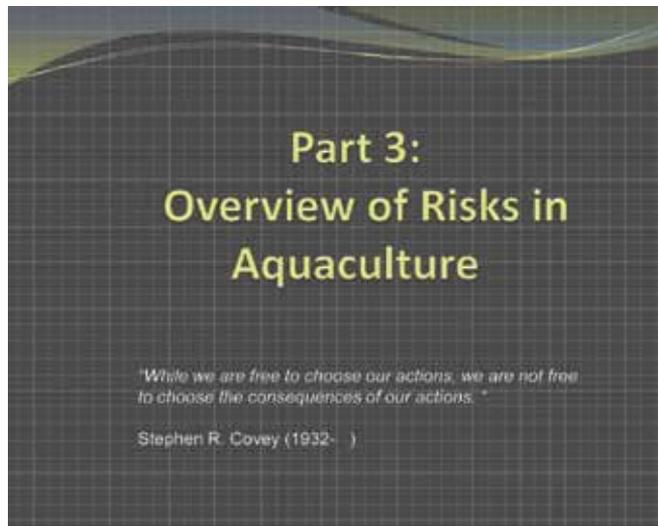


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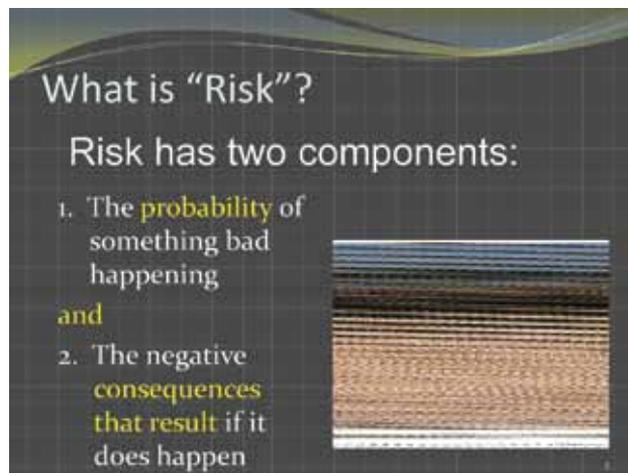
Part 3

Part 3 – Overview of risks in aquaculture: The nature of risk and the types of risk inherent in aquaculture development, the seven risk sectors, the invasive species problem, overview of genetic risks, balancing the risks and benefits of aquaculture (**37 Slides**).

Slide 1

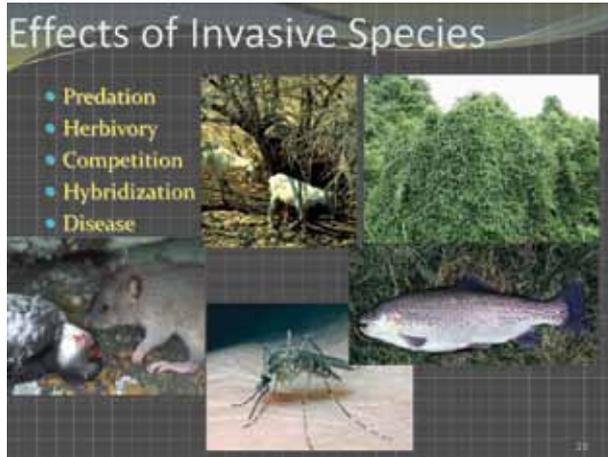


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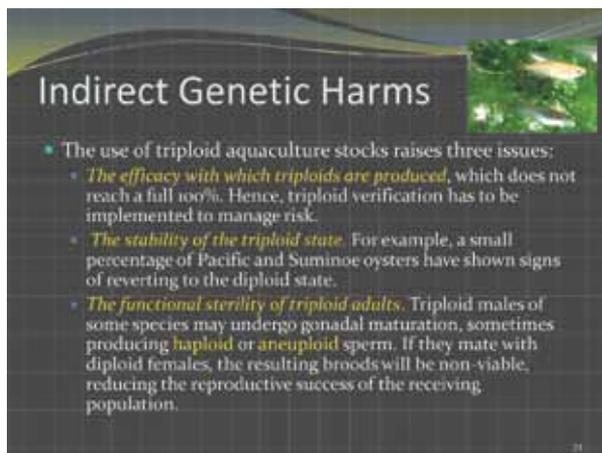


Part 3

Slide 20



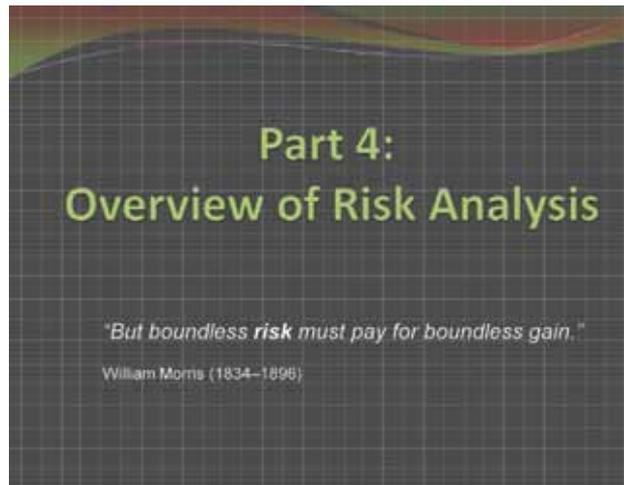
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Part 4

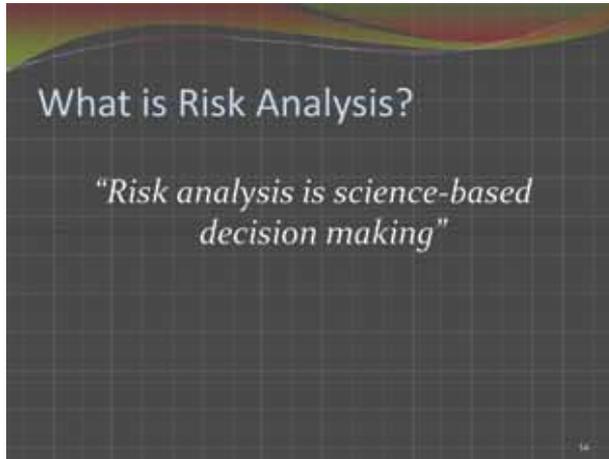
Part 4 – Overview of risk analysis: What is risk?, important terms, protection vs. free trade; What is risk analysis?; Who uses risk analysis?; Relation of risk analysis and national biosecurity; National biosecurity actions; Why do countries need to be able to conduct risk analysis?; Two sides of the coin – risks to and from aquaculture; The four risk analysis questions; Approaches to risk analysis; Simplified risk analysis process; The World Organisation for Animal Health (OIE) framework (risk communication, hazard identification and the concept of hazard, risk assessment, risk management); Examples of risk analysis frameworks for various risk sectors; Simplified process for pathogen risk analysis **(60 Slides)**.

Slide 1

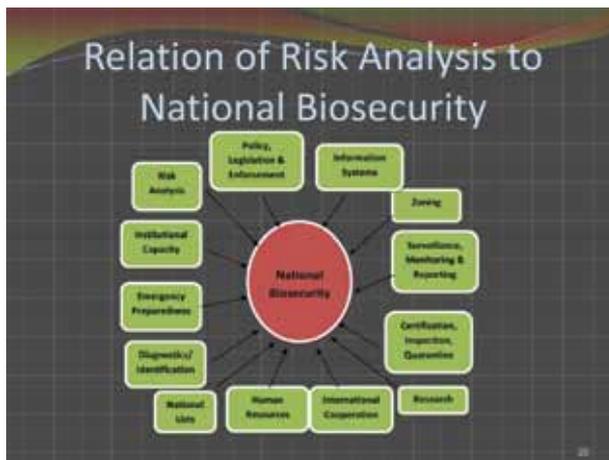


Part 4

Slide 14

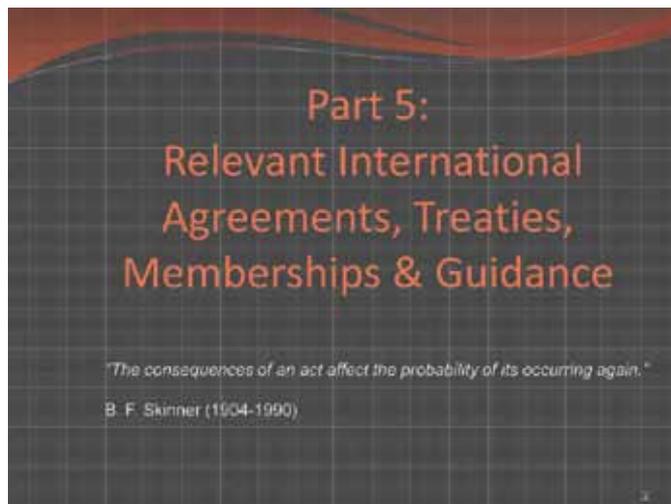


Slide 20



Part 5 – Relevant international treaties, agreements and guidance: Key treaties and agreements; World Trade Organization Sanitary and Phytosanitary (WTO SPS) Agreement main regulatory instruments; Key guidance (voluntary guidelines, guidance manuals, completed pathogen risk analyses, global and farm-level guidelines); Online resources. **(21 Slides)**

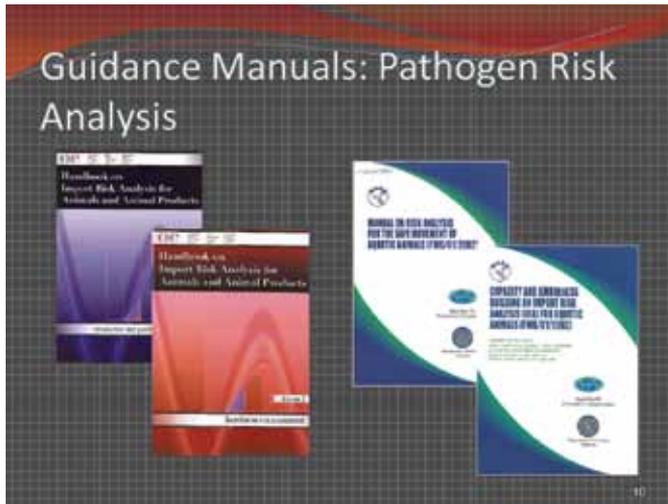
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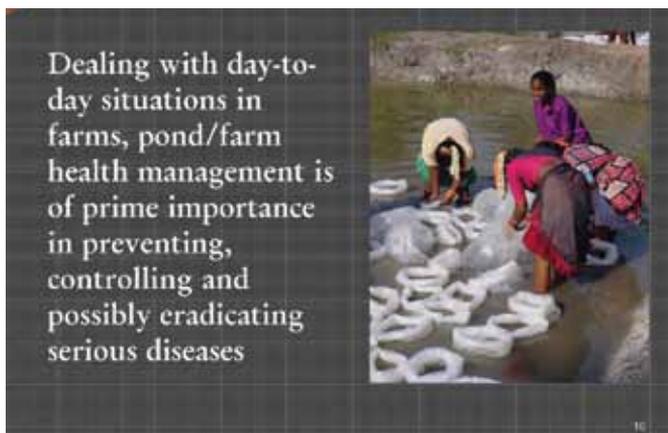
Examples of PowerPoint presentation

Part 5

Slide 10

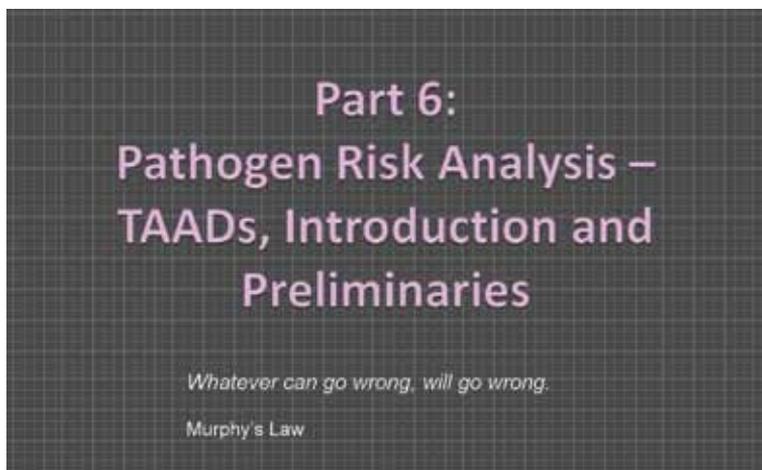


Slide 16



Part 6 – Pathogen risk analysis – Transboundary aquatic animal diseases (TAADs), introduction and preliminaries: Examples of TAADs: koi herpesvirus, white spot syndrome virus, epizootic ulcerative syndrome; Estimates of losses due to disease; What is pathogen risk analysis?; What is import risk analysis?; Historical aspects; Summary of completed formal risk analyses; Major risk factors; The risk analysis process; The risk analysis team and its duties; How risk analyses are initiated; The proposal to import; The risk analysis working group; Scoping a risk analysis (including an example from an actual risk analysis); Special issues and problems **(59 Slides)**.

Slide 1



Part 6

Slide 4

Scoping the Risk Analysis

- Field visit to Rarotonga, Cook Islands
 - visit proponent, proposed receiving site in Cook Islands, veterinary services & other stakeholders



The slide features three photographs. The leftmost photo shows a view of a coastline with mountains and a body of water. The middle and right photos show a grassy field with a prominent red area, likely a field visit site.

Slide 6

WTO SPS Agreement – Animal Health

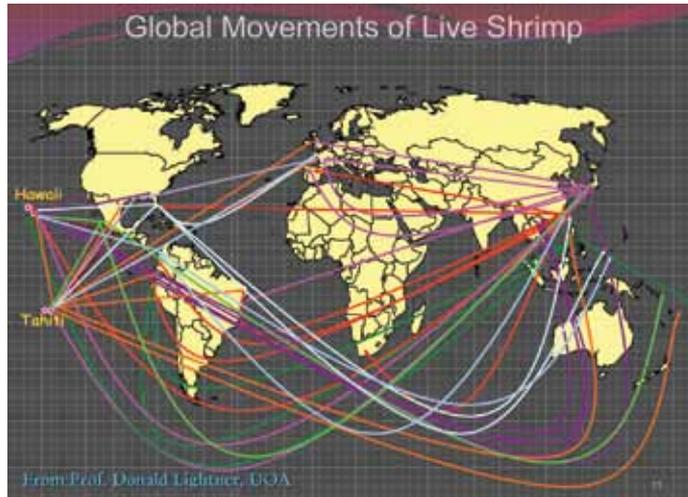
- World Organisation for Animal Health (OIE, formerly the Office International des Epizooties)
 - OIE *Aquatic Animal Health Code*
 - OIE *Diagnostic Tests for Aquatic Animal Diseases*
 - OIE Aquatic Animal Health Commission
 - OIE Reference Laboratories



The slide displays two book covers. The left cover is titled 'Aquatic Animal Health Code' and the right cover is titled 'Manual of Diagnostic Tests for Aquatic Animals'. Both covers feature the OIE logo and a blue background with images of aquatic animals.

Part 6

Slide 11



Slide 15



Part 6

Slide 20

What is Pathogen Risk Analysis?

For aquatic animal movements, it is:



- A standardized, systematic & defensible method of assessing the risk associated with the movement (importation) of a **commodity**
- A mechanism for an importing country to separate the important (unacceptable) risks from the unimportant (acceptable) risks. (i.e. a coping mechanism)

Slide 31

Major Risk Factors, In Practical Terms:

Risk =

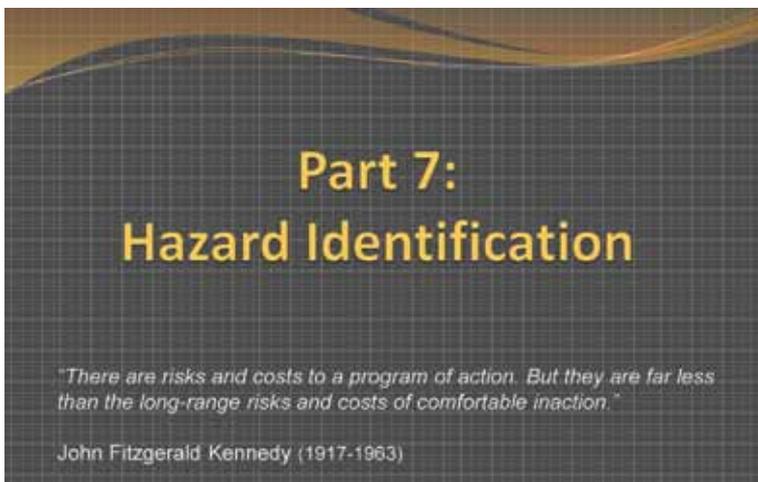
	Commodity	x	Source	x	Destination	x	Volume
	Live Adult		Wild		Direct Release		Billions
Higher							
	↓		↓		↓		↓
Lower							
	Processed Product		SPF		Immediate Consumption		One Animal

Examples of PowerPoint presentation

Part 7

Part 7 – Pathogen risk analysis – Hazard identification: Screening criteria; Summary of procedure; Summary of hazards identified from completed risk analyses, giant river prawn as an example **(18 Slides)**.

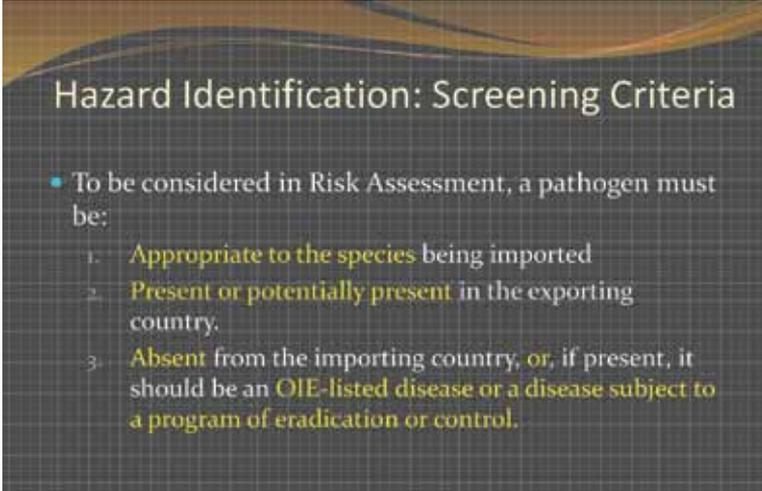
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Examples of PowerPoint presentation

Part 7

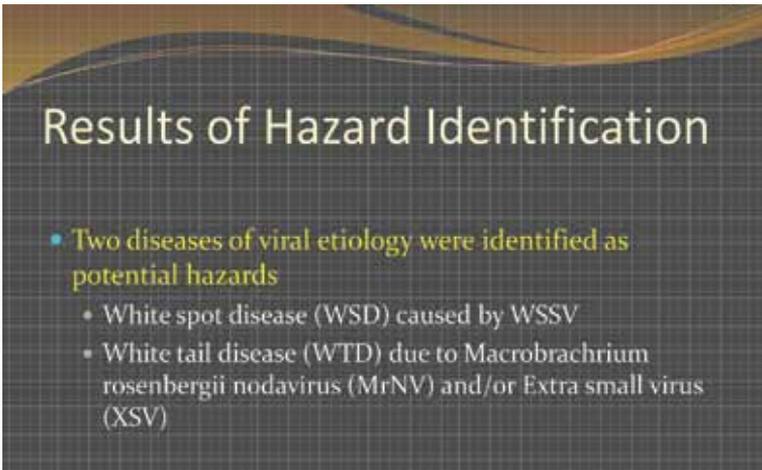
Slide 6



Hazard Identification: Screening Criteria

- To be considered in Risk Assessment, a pathogen must be:
 1. **Appropriate to the species** being imported
 2. **Present or potentially present** in the exporting country.
 3. **Absent** from the importing country, **or**, if present, it should be an **OIE-listed disease** or a disease subject to a program of eradication or control.

Slide 15

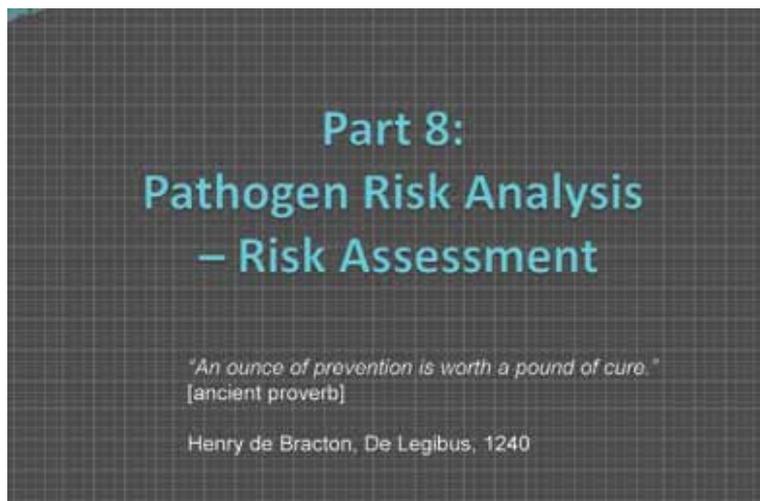


Results of Hazard Identification

- **Two diseases of viral etiology were identified as potential hazards**
 - White spot disease (WSD) caused by WSSV
 - White tail disease (WTD) due to Macrobrachium rosenbergii nodavirus (MrNV) and/or Extra small virus (XSV)

Part 8 – Pathogen risk analysis – Risk assessment: Overview; Qualitative versus. quantitative methods; Use of scenario trees and pathways analysis; Release assessment; Exposure assessment; Consequence assessment; Risk estimation; Practical example using giant river prawn **(36 Slides)**.

Slide 2



Slide 3

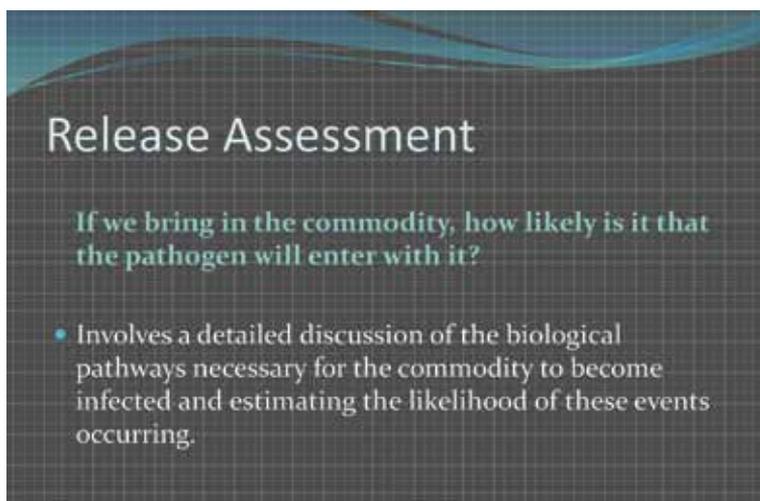


Risk Assessment

“How likely is it to go wrong?”

- The process of evaluating the **likelihood** that a “potential hazard” will gain entry into the importing country and
- Estimating the **biological and economic consequences** of its entry, establishment and/or spread.

Slide 10



Release Assessment

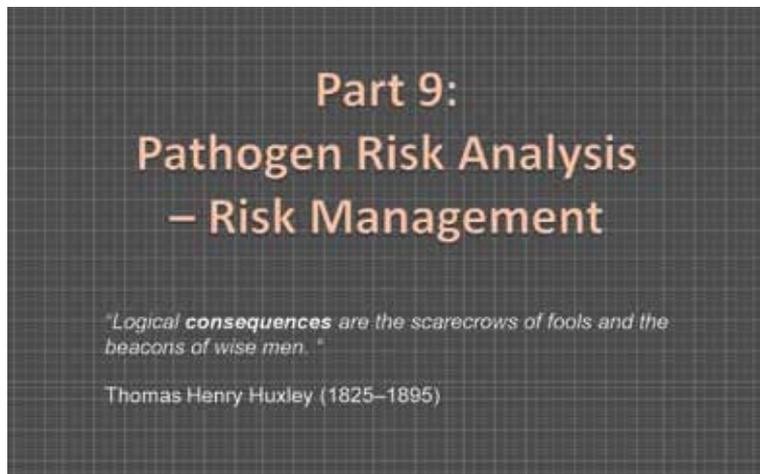
If we bring in the commodity, how likely is it that the pathogen will enter with it?

- Involves a detailed discussion of the biological pathways necessary for the commodity to become infected and estimating the likelihood of these events occurring.

Part 9

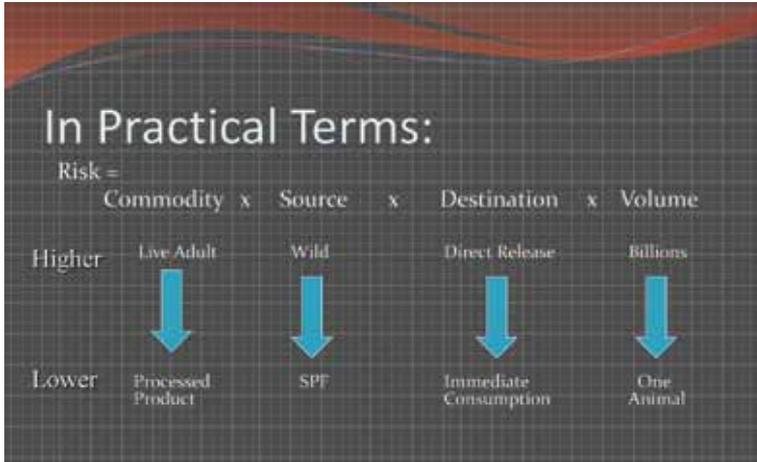
Part 9 – Pathogen risk analysis – Risk management: Overview; Risk evaluation; ALOP/ALOR; Practical example using giant river prawn; Possible outcomes of risk evaluation; Summary of results from completed risk analyses; Options evaluation; Summary of risk management measures from completed risk analyses; The precautionary principle and its application to pathogen risk analysis; Practical example using giant river prawn; Implementation; Monitoring and review; Reporting and report preparation **(44 Slides)**

Slide 1



Part 9

Slide 5



Slide 8

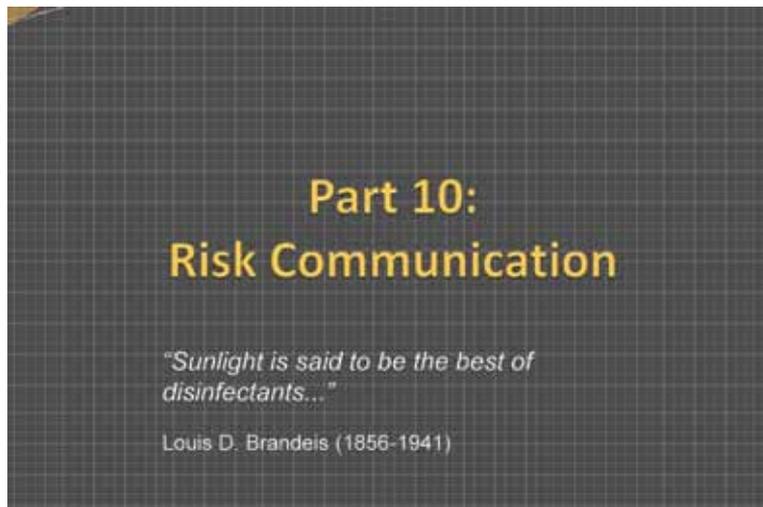
Risk Evaluation

- Compares the estimated risk with the **Appropriate Level of Protection (ALOP)** to determine if the risk posed by the hazard is acceptable to the importing country

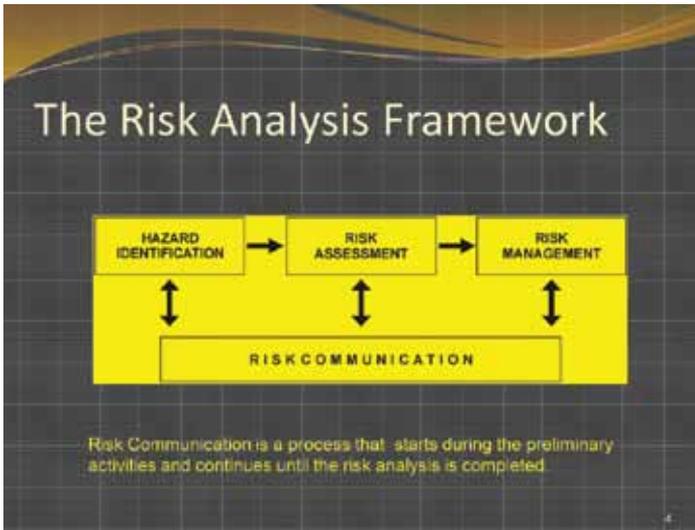
Part 10

Part 10 – Risk communication: Overview; Purpose; Strategies; Identifying stakeholders; Risk communication methods; The risk analysis report **(15 slides)**

Slide 1



Slide 4



Slide 15



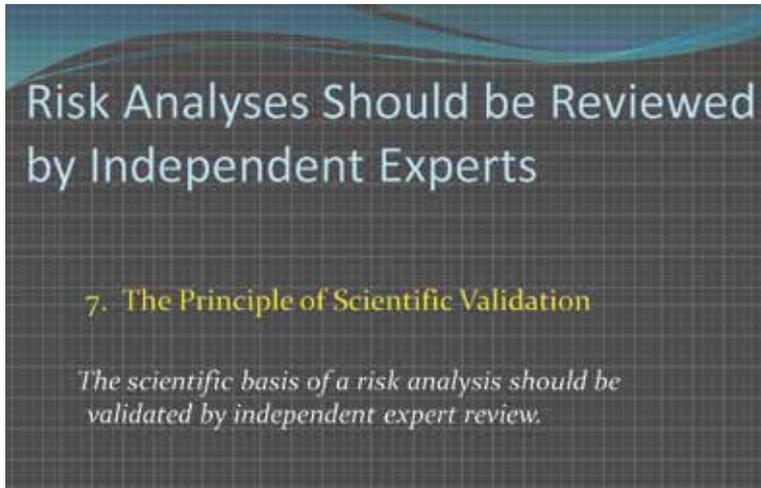
Part 11 – Concluding session: Some universal principles of risk analysis; What is needed to implement risk analysis?; Risk analysis and developing countries; Characteristics of risk analysis that support good governance; Regional approaches; Constraints; Evaluating your country's current situation **(26 Slides)**.

Slide 1



Part 11

Slide 11



Risk Analyses Should be Reviewed
by Independent Experts

7. The Principle of Scientific Validation

The scientific basis of a risk analysis should be validated by independent expert review.

Slide 21



Characteristics of Risk Analysis that
Support Good Governance

- Concept of appropriate level of protection (ALOP) (which is the same across all types of commodities)
- Separation of science-based and political decisions and
- Concept of unacceptable risk