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# Understanding and applying risk analysis in aquaculture

A manual for decision-makers



**Cover photographs:**

*Left column, top to bottom:* fish farmers administering antibiotic treatment to a suspected viral infection of fish (courtesy of M.B. Reantas).

*Middle column, top:* Suminoe oyster (*Crassostrea ariakensis*) (courtesy of E. Hallerman); *bottom:* mortalities of common carp in Indonesia due to koi herpes virus (courtesy of A. Sunarto).

*Right column:* women sorting post-larvae shrimp at an Indian shrimp nursery (courtesy of M.J. Phillips).

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by

**James Richard Arthur**

FAO Consultant

Barriere, British Columbia, Canada

**Melba G. Bondad-Reantaso**

Fishery Resources Officer (Aquaculture)

Aquaculture Management and Conservation Service

FAO Fisheries and Aquaculture Department

Rome, Italy

**Marnie L. Campbell**

Associate Professor

Australian Maritime College

University of Tasmania

Launceston, Tasmania, Australia

**Chad L. Hewitt**

Professor

Australian Maritime College

University of Tasmania

Launceston, Tasmania, Australia

**Michael J. Phillips**

Senior Scientist

WorldFish Center

Penang, Malaysia

**Rohana P. Subasinghe**

Senior Fishery Resources Officer (Aquaculture)

Aquaculture Management and Conservation Service

FAO Fisheries and Aquaculture Department

Rome, Italy

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# Preparation of this document

The need for a manual for decision-makers on understanding and applying risk analysis in aquaculture was discussed and guidance on its approach and contents formulated by the participants at the FAO/NACA Expert Workshop on Understanding and Applying Risk Analysis in Aquaculture, held from 8 to 11 June 2007 in Rayong, Thailand. The experts attending the Rayong workshop recognized that the aquaculture sector, which is characterized by a high diversity in operating systems, environments and species cultured, faced a wide range of biological, physical, chemical, economic and social risks to its successful and sustainable development. As a consequence, this document was prepared to provide policy-makers and senior managers who must deal with the rapid development of their national aquaculture sectors with a concise overview of risk analysis methodology as applied in seven key risk categories (pathogen, food safety and human health, genetic, environmental, ecological [pests and invasives], financial and social risks) and advice on the application of risk analysis at the national and farm levels can lead to a more sustainable aquaculture industry.

This document will also be of relevance to aquaculture operators, industry organizations, non-governmental organizations (NGOs) and other groups interested in understanding risk analysis and its influences on national aquaculture policy, industry regulation and the management of aquatic resources.

This manual was developed under the technical supervision of Dr Melba B. Reantaso, Fishery Resources Officer, Aquaculture Management and Conservation Service, Fisheries and Aquaculture Management Division, FAO Fisheries and Aquaculture Department. The manual draws heavily on the proceedings of the Rayong workshop (FAO Fisheries and Aquaculture Technical Paper No. 519) and particularly on the review papers of M.G. Bondad-Reantaso and J.R. Arthur (pathogen risks), M.L. Campbell and C.L. Hewitt (environmental pest risks), I. Karunasagar (food safety and public health risks), E. Hallerman (genetic risks), M.J. Phillips and R.P. Subasinghe (environmental risks), K.M.Y. Leung and D. Dudgeon (ecological risks), L.E. Kam and P. Leung (financial risks) and P.B. Bueno (social risks).

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# Abstract

Aquaculture is a rapidly expanding sector of the global economy with an average growth rate of 8.8 percent per annum since 1970. This consistent increase in production is a result of expansion of markets, globalization of market access and an increasing market demand for seafood products during a period in which most capture fisheries are stagnating or in decline. Aquaculture is expected to continue to increase its contribution to the world's production of aquatic food and will further strengthen its role in food security and food safety, while also offering opportunities to alleviate poverty, increase employment and community development and reduce overexploitation of natural aquatic resources, thus creating social and generational equity, particularly in developing countries.

This rapid development of the industry under various national and regional jurisdictions has resulted in a diversity of regulatory frameworks. Thus, FAO Members have requested guidance on the application of risk analysis with respect to aquaculture production. The purpose of this manual is to provide an overview of the risk analysis process as applied to aquaculture production and to demonstrate the variety of ways in which risk can manifest in aquaculture operations and management. The intention of this manual is to promote wider understanding and acceptance of the applications and benefits of risk analysis in aquaculture production and management.

This manual is directed towards decisions-makers and senior aquaculture managers in FAO Members States. It includes an introduction to the methodology used to assess the risks posed by aquaculture operations to the environment, socio-political and economic well-being and cultural values, as well as the risks to aquaculture from outside influences, including potential environmental, socio-political, economic and cultural impacts. The manual contains six sections. Section 1 provides a background to the aquaculture sector and an introduction to the concepts of risk analysis. Section 2 presents the operating environment for risk analysis for the aquaculture sector by briefly reviewing the relevant international frameworks applicable to each risk category. Section 3 discusses a general risk analysis process for aquaculture. Section 4 provides brief overviews of the risk analysis process as applied in each of the seven risk categories. Section 5 briefly summarizes actions that need to be taken by FAO Members to promote the wider use of risk analysis for aquaculture development. Finally, Section 6 discusses future challenges to aquaculture and the role risk analysis might play in addressing them.

**Arthur, J.R.; Bondad-Reantaso, M.G.; Campbell, M.L.; Hewitt, C.L.; Phillips, M.J.; Subasinghe, R.P.**

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# Abbreviations and acronyms

<b>ALARA</b>	as low as reasonably achieved (approach)
<b>ALOP</b>	appropriate level of protection
<b>ALOR</b>	acceptable level of risk
<b>ANP</b>	analytic network process
<b>APEC</b>	Asia-Pacific Economic Cooperation
<b>ASEAN</b>	Association of Southeast Asian Nations
<b>BMPs</b>	best management practices
<b>CAC</b>	Codex Alimentarius Commission
<b>CBD</b>	Convention on Biological Diversity
<b>CCRF</b>	Code of Conduct for Responsible Fisheries
<b>CSR</b>	corporate social responsibility
<b>EIA</b>	environmental impact assessment
<b>EIFAC</b>	European Inland Fisheries Advisory Commission (of the FAO)
<b>ERA</b>	ecological risk assessment; environmental risk assessment
<b>EU</b>	European Union
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>FSO</b>	food safety objective
<b>GAP</b>	good aquaculture practices
<b>GESAMP</b>	IMO/FAO/UNESCO-LOC/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
<b>GISD</b>	Global Invasive Species Database
<b>GMO</b>	genetically modified organism
<b>HABs</b>	harmful algal blooms
<b>HACCP</b>	Hazard Analysis And Critical Control Point Analysis
<b>ICES</b>	International Council for the Exploration of the Sea
<b>ICPM</b>	Interim Commission on Phytosanitary Measures (of the IPPC)
<b>IPPC</b>	International Plant Protection Convention
<b>IRA</b>	import risk analysis
<b>IRR</b>	internal rate of return
<b>ISO</b>	International Standards Organisation
<b>ISPM</b>	International Standards for Phytosanitary Measures
<b>ISR</b>	International Sanitary Regulations
<b>IUCN</b>	World Conservation Union
<b>LIFDCs</b>	low-income food-deficit countries
<b>MCMD</b>	multicriteria decision-making
<b>MPEDA</b>	Marine Products Export Development Authority ( India)
<b>MOTAD</b>	minimization of total absolute deviations
<b>NACA</b>	Network of Aquaculture Centres in Asia and the Pacific

<b>NaCSA</b>	National Centre for Sustainable Aquaculture (India)
<b>NEMESIS</b>	National Exotic Marine and Estuarine Species Information System
<b>NIMPIS</b>	National Introduced Marine Pest Information System
<b>NGO</b>	Non-governmental organization
<b>NPPOs</b>	National Plant Protection Organizations
<b>OIE</b>	World Organisation for Animal Health
<b>ORP</b>	organism risk potential
<b>PAHO</b>	Pan American Health Organization
<b>PRP</b>	pathway risk potential
<b>ROI</b>	return on investment
<b>PRA</b>	pathogen risk analysis
<b>RPPOs</b>	Regional Plant Protection Organizations (of the IPPC)
<b>SEAFDEC</b>	South East Asian Fisheries Development Center
<b>SOPs</b>	standard operating procedures
<b>SPS</b>	Sanitary and Phytosanitary (Agreement) (of the WTO)
<b>SRM</b>	social risk management
<b>TAADs</b>	transboundary aquatic animal diseases
<b>TBT</b>	Agreement on Technical Barriers to Trade (TBT Agreement)
<b>UN</b>	United Nations
<b>UNICLOS</b>	United Nations Convention on the Law of the Sea
<b>USEPA</b>	United States Environmental Protection Agency
<b>WGITMO</b>	Working Group on Introductions and Transfers of Marine Organisms (of ICES)
<b>WHO</b>	World Health Organization
<b>WSD</b>	whitespot syndrome disease
<b>WSSV</b>	whitespot syndrome virus
<b>WTO</b>	World Trade Organization

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# Glossary

<b>Appropriate level of protection (ALOP)</b>	The level of protection deemed appropriate by a country establishing a sanitary or phytosanitary measure to protect identified or assessed values
<b>Acceptable level of risk (ALOR)</b>	The level of risk a country establishing a sanitary or phytosanitary measure is willing to assume to protect identified or assessed values
<b>Biosecurity</b>	A strategic and integrated approach that encompasses both policy and regulatory frameworks aimed at analyzing and managing the risks of the sectors dealing with food safety, animal life and health, plant life and health and the environment
<b>Consequence</b>	The evaluated impact an event may have on assessed values (environmental, economic, socio-political, cultural)
<b>Consequence assessment</b>	The process of evaluating the impact of an event.
<b>Cultural value</b>	Those aspects of the aquatic environment that represent an iconic or spiritual value, including those that create a sense of local, regional or national identity
<b>Delphi process</b>	A semi-quantitative method from the social sciences that is used to capture stakeholder and/or expert opinions and beliefs
<b>Economic value</b>	Components within an ecosystem that provide a current or potential economic gain or loss
<b>Environmental value</b>	Everything from the biological to physical characteristics of an ecosystem being assessed, excluding extractive (economic) use and aesthetic value
<b>Exposure assessment</b>	The process of describing the mechanism or pathway(s) necessary for an adverse event to occur and estimating the likelihood of that event occurring
<b>Food safety</b>	The process of ensuring that products for human consumption meet or exceed standards of quality to ensure that human consumption will not result in morbidity or mortality

<b>Food security</b>	The protection and management of biological resources for safe and sustainable human consumption
<b>Genetically modified organism (GMO)</b>	An organism in which the genetic material has been altered by human intervention, generally through use of recombinant DNA technologies
<b>Hazard</b>	An organism, action or event that can produce adverse consequences relative to the assessment endpoint
<b>Hazard identification</b>	The process of identifying events, actions or objects that can potentially cause adverse consequences to values
<b>Impact</b>	The alteration or change in value caused by a hazard
<b>Introduction</b>	The intentional or accidental transport and release by humans of any species into an environment outside its present range
<b>Invasive species</b>	An organism that causes negative impact to economic, environmental, socio-political or cultural values due to prolific growth and unmanaged population
<b>Likelihood</b>	Probability of an event occurring, ranging from rare events to likely or frequent events
<b>Non-indigenous species</b>	An organism that has been transferred to a location in which it did not evolve or in which it was not present in its historic range
<b>Pathogen</b>	An infectious agent capable of causing disease
<b>Pest</b>	An organism that causes harm to economic, environmental, socio-political or cultural values
<b>Precautionary approach</b>	An approach to risk management that takes into account the precautionary principle
<b>Precautionary principle</b>	The axiom that “a lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation” (CBD, 1992)
<b>Quarantine</b>	The isolation of a region, area or group of organisms to contain the spread or prevent the entry of something considered dangerous or likely to cause harm (e.g. a pest or pathogen)
<b>Release assessment</b>	The process of describing the pathway by which a hazard is “released” into the operating environment of the risk analysis and estimating the likelihood of this occurring

<b>Risk</b>	The potential occurrence of unwanted, adverse consequences associated with some action over a specified time period
<b>Risk analysis</b>	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 in order to minimize the risk
<b>Risk assessment</b>	The process of assessing the likelihood and consequence of an event
<b>Risk communication</b>	The act or process of exchanging information concerning risk
<b>Risk management</b>	The pragmatic decision-making process concerned with what to do about risk
<b>Risk mitigation</b>	Actions or controls that, when put in place, will alter, reduce or prevent either the likelihood or the consequence of an event, thus acting to reduce the risk of an event
<b>Socio-political value</b>	The value placed on a location in relation to human use for pleasure, aesthetic or generational values. This value may also include human health and politics. Examples include tourism, family outings, learning and aesthetics
<b>Transfer</b>	The intentional or accidental transport and release of any species within its present range

