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Understanding and applying risk analysis in aquaculture

Cover photos:
Left column, top to bottom: Fish farmers administering antibiotic treatment
to a suspected viral infection of fish, courtesy of M.B. Reantaso.
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 shrimp post-larvae at an Indian shrimp nursery, courtesy of M.J. Phillips.

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Preparation of this document

A project "Application of risk analysis to aquaculture production" was undertaken in 2007 through a desk study and an expert workshop held in Rayong, Thailand, from 7 to 11 June 2007. The project culminated in the publication of this document, which is presented in two parts.

Part 1 contains 12 technical papers presented during the expert workshop, contributed by 23 specialists and peer-reviewed by nine experts. These include seven commissioned sectoral review papers addressing the seven identified major risk sectors of aquaculture production: pathogen risks, food safety and public health risks, genetic risks, ecological risk assessment and management of exotic organisms, environmental risks, financial risks and social risks, as well as an additional five contributed papers addressing the following topics: general principles of risk analysis, introduced marine species risk assessment, guidelines for ecological risk assessment of marine fish aquaculture, the aquaculture insurance industry risk analysis process and risk analysis experiences from small-scale shrimp farmers in India. Part 2 of this document contains the highlights of the FAO/NACA Expert Workshop on Understanding and Applying Risk Analysis in Aquaculture, with 42 experts participating.

The commissioned review papers and expert workshop were technically supervised by Dr Melba B. Reantaso, Fishery Resources Officer and Dr Rohana P. Subasinghe, Senior Fishery Resources Officer of the Aquaculture Management and Conservation Service, Fisheries and Aquaculture Management Division of the FAO Fisheries and Aquaculture Department.

The study, workshop and publication were made possible with financial assistance through the Programme Cooperation Agreement of Norway under B.1 and D.1 objectives administered through the FishCode Programme of the FAO Fisheries and Aquaculture Department and the Nutrition and Consumer Protection Division of the FAO Agriculture and Consumer Protection Department, respectively.

Abstract

As a food-producing sector, aquaculture has surpassed both capture fisheries and the terrestrial farmed meat production systems in terms of average annual growth rate. However, it has a number of *biosecurity concerns* that pose risks and hazards to both its development and management, and to the aquatic environment and society. Aquaculture faces risks similar to those of the agriculture sector. However, as aquaculture is very diverse (in terms of species, environments, systems and practices), the range of hazards and the perceived risks are complex. Multiple objectives are driving the application of risk analysis to aquaculture. Foremost is for *resource protection* (human, animal and plant health; aquaculture; wild fisheries and the general environment) as embodied in international agreements and responsibilities. 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.

The expert workshop, using a series of seven review papers commissioned by the desk study, focused on the importance and application of risk analysis to seven major risk sectors of aquaculture production: pathogen risks, food safety and public health risks, ecological (pests) risks, genetic risks, environmental risks, financial risks and social risks. Part 1 of the document consists of 12 peer-reviewed technical papers relative to the application of risk analysis to aquaculture that were prepared by 23 specialists papers on: general principles of risk analysis, food safety and public health risks associated with products of aquaculture, pathogen risk analysis, application of risk analysis to genetic issues in aquaculture ecological risk assessment and management of exotic organisms, introduced marine species risk assessment, guidelines for ecological risk assessment of marine fish aquaculture, the aquaculture insurance industry risk analysis process and risk analysis experiences from small-scale shrimp farmers in India. Part 2 contains the detailed outcomes of the deliberations of 42 experts who developed the contents of a Manual on the Application of Risk Analysis to Aquaculture, discussed in great length the seven risk sectors and reached general conclusions and specific recommendations to enhance the application of the risk analysis process to aquaculture production.

Risk analysis methods as applied to the seven risk sectors have many commonalities but also many differences. An overriding feature is a firm foundation in drawing upon the results of scientific studies, the use of logic or deductive reasoning and the application of common sense in assessing risk and applying risk management measures. General principles that apply to risk analysis for aquaculture include application of the precautionary approach when dealing with uncertainty, transparency of the process, consistency in methodolody, use of stakeholder consultation, application of high level of stringency, use of minimal risk management interventions needed to achieve an acceptable level of risk, the concept of unacceptable risk and recognition that some "risky" actions cannot be managed and therefore should not be permitted under any circumstance, and the concept of equivalence where alternative risk management measures achieving the required level of protection are equally acceptable.

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Contents

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Acronyms and abbreviations

AAPQIS	Aquatic Animal Pathogen and Quarantine Information System
ADB	Asian Development Bank
ADCP	acoustic doppler current profiler
AHP	analytic hierarchy process
AIDS	Auto-immune deficiency syndrome
ALARA	as low as reasonably achieved
ALOP	appropriate level of protection
ALOR	acceptable level of risk
APEC	Asia-Pacific Economic Cooperation
ANP	Analytic Network Process
ANS	Aquatic Nuisance Species
AQIS	Australian Quarantine Inspection Service
ASFA	Aquatic Science and Fisheries Abstracts
ASP	amnesic shellfish poisoning
BDNs	Bayesian decision networks
BMPs	better management practices
BP	*Baculovirus penaei*
CAB	Commonwealth Agricultural Bureau
CAC	Codex Alimentarius Commission
CART	categorical and regression tree analysis
CBD	Convention on Biological Diversity
CCFH	Codex Committee on Food Hygiene
CCRF	Code of Conduct for Responsible Fisheries
CDFs	cumulative distributions functions
CE	consequence of establishment
CRS	corporate social responsibility
DAFF	Department of Agriculture, Fisheries and Forestry
DFA	discriminant function analysis
DIAS	Database on Introductions of Aquatic Species
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DSP	diarrhetic shellfish poisoning
DTs	decision trees
Eh	redox potential
EIA	environmental impact assessment
EIFAC	European Inland Fisheries Advisory Commission
ER	economic rent
ERA	ecological risk assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCR	food conversion ratio
FCS	frozen commodity shrimp
FEAP	Federation of European Aquaculture Producers
FSO	Food Safety Objective
GAP	good aquaculture practices
GATT	General Agreement on Tariffs and Trade

GESAMP	Group of Experts on the Scientific Aspects of Marine Environmental Protection
GIS	geographic information system
GMOs	genetically modified organisms
HACCP	Hazard Analysis and Critical Control Point
HPV	hepatopancreatic parvo-like virus
HSNO	hazardous substances and new organisms
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organization
ICES	International Council for the Exploration of the Sea
IHHNV	infectious hypodermal and haematopoietic necrosis virus
IMO	International Maritime Organization
IRA	import risk analysis
IRR	internal rate of return
ISI	Institute for Science Information
ISSG	Invasive Species Specialist Group
IUCN	International Union for the Conservation of Nature
KSh	Keynan shillings
LOVV	lymphoid organ vacuolization virus
LP	linear program
MCDM	multicriteria decision making
MFF	Ministry of Fisheries and Forestry (Fiji)
MOP	multiple objective programming
MOTAD	minimization of total absolute deviations
MPEDA	Marine Products Export Development Authority
MrNV	*Macrobrachium rosenbergii* nodavirus
NAAHP	National Aquatic Animal Health Programme
NACA	Network of Aquaculture Centres in Asia and the Pacific
NaCSA	National Center for Sustainable Aquaculture
NBCR	net benefit-cost ratio
NGO	non-governmental organization
NHP	necrotising hepatopancreatitis
NOAA	National Oceanic and Atmospheric Administration
NPV	net present value
NRC	National Research Council
OIA	organism impact assessment
OIE	World Organisation for Animal Health (formerly Office international des epizooties)
ORP	organism risk potential
PCBs	polychlorinated biphenyls
PCR	polymerase chain reaction
PE	Probability of Establishment
PICTs	Pacific Island Countries and Territories
PL	postlarvae
PRA	pathogen risk analysis
PRP	pathway risk potential
PSP	paralytic shellfish poisoning
RA	risk analysis
RAS	recirculating aquaculture systems
RPS	rhabdovirus of penaeid shrimp
SEAFDEC	Southeast Asian Fisheries Development Center
SGS	sediment grain size
SPC	Secretariat of the Pacific Community

SPF	specific pathogen free
SPS Agreement	Agreement on the Application of Sanitary and Phytosanitary Measures
STDF	Standards and Trade Development Facility
TCP	Technical Cooperation Project
TDH	thermostable direct hemolysin
TMDL	total maximum daily loads
TOTALPOLL	total pollution
TRH	TDH-related hemolysin
TSV	Taura syndrome virus
TVS	total volatile solids
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO-IOC	United Nations Educational, Scientific and Cultural Organization-Intergovernmental Oceanographic Commission
USA	United States of America
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VOI	value of information
YHV	yellow head virus
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organization
WSD	white spot disease
WSSV	white spot syndrome virus
WTD	white tail disease
WTO	World Trade Organization
XG	foreign exchange earnings
XSV	extra small virus