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**Final Draft Code of Practice
for
Trans-boundary Movement of
Aquatic Organisms in the
Lower Mekong Basin**



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Preface

The demand for fisheries and aquaculture products is continuously increasing while natural aquatic resources continue to decline due to over-exploitation, environmental degradation and other problems (e.g. diseases). As such, the aquaculture sector will further intensify and develop, and this will be heavily based on the movement of live aquatic animals and their products from one country to another. Trade is important and will continue because it is a necessity for aquaculture development at both the subsistence and commercial scales. This is especially true along the Mekong River system where fisheries and aquaculture activities are highly active and often unregulated. Trading and movements (both legal and unregulated) of live aquatic organisms within the Mekong River system may also pose significant problems in terms of spread of trans-boundary aquatic animal diseases, introduction of unwanted species, and loss of genetic diversity. Unregulated industry operations may also bring about pollution and contamination along the Mekong River which may have negative implications on food safety and quality of aquaculture and fishery products. Although related regional and international guidelines and other documents on responsible movement of live aquatic animals are already available, a Code of Practice specific to the nature and condition of the Mekong River system/environment is currently lacking. Thus, it is high time that this Code is developed for implementation in the LMB.

This Code of Practice is prepared to promote or ensure compliance to World Trade Organisation-Sanitary and Phytosanitary (WTO-SPS) measures for the movement of live aquatic organisms in the Lower Mekong Basin (LMB). The long-term goals of the Code are to achieve environmental protection and management, biodiversity conservation as well as prevention of spread of disease epizootics. Most of the important

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points listed in this Code are based on the inputs of MRC Member Countries through national reviews on the Impacts of Exotic Species on Natural Environment and Aquaculture.

This Code requires MRC Member Countries to take responsibility in determining what aspects of the different activities related to trans-boundary movement of aquatic animals in the LMB that may bring significant risks to the environment, biodiversity as well as to the aquaculture and fishery industries in the region. The Code further requires members to formulate, develop and implement necessary actions to mitigate the negative impacts of aquatic animal species introductions, especially exotics, into the LMB.

The Code is approved by the Technical Advisory Body on Fisheries Management in the LMB (TAB). The approved Code will be guidance for LMB countries to consider developing and formulating their national codes accordingly to mitigate the negative impacts from unregulated movement within and across national boundaries and for economic, social and development purposes in the LMB.

Acronyms and Definition of Terms

AAQF	Aquatic animals quarantine facility
AHPND	Acute hepatopancreatic necrosis disease
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CGRFA	Commission on Genetic Resources for Food and Agriculture
DNA	Deoxyribonucleic acid
EUS	Epizootic ulcerative syndrome (Infection with <i>Aphanomyces invadans</i>)
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical information system
GR	Genetic resources
GRFA	Genetic resources for food and agriculture
IPR	Intellectual property rights
KHV	Koi herpesvirus
LMB	Lower Mekong Basin
MTA	Material Transfer Agreement
MRC	Mekong River Commission
NACA	Network of Aquaculture Centres in Asia-Pacific
OIE	Office International des Epizooties (World Organization for Animal Health)
TRIPs	Trade related aspects of intellectual property rights
TSV	Taura syndrome virus
WTO	World Trade Organization
WSSV	White spot syndrome virus

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Access	Acquisition (right to use) of biological resources and/ or knowledge associated thereof, and of their derivatives or, as applicable, intangible components, for purposes of research, conservation, biological prospecting and industrial application or commercial use, among others.
Accession	A distinct, uniquely identifiable sample of fish, blood, tissue of fish representing a species, stock, breeding line or a population, which is maintained in a genebank for conservation and use.
Accession number	A unique identifier assigned to an accession, when it is registered with a genebank. This number is never assigned again to another accession even after loss of the accession.
Agrobiodiversity	A subset of biodiversity that is used for food and agriculture and include animals gathered from hunting.
Benefit sharing	Sharing of benefits arising from use of biological resources and associated knowledge based on prior informed consent and mutually agreed terms, with contracting party providing such resources.
Biological diversity	The variability among living organisms from all sources including, <i>inter alia</i> , terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems.
Conspecifics	Members of the same species.
Competent authority (on Aquatic Animal Health)	National Authority with the officially approved responsibility and competency and who is responsible to ensure and supervise the implementation of live aquatic animal health management and quarantine measures.
Country of origin (of a consignment of fish)	Country where the fish was collected or cultured.

Distribution	The process of supplying samples of germplasm accessions to breeders, researchers, curators and other <i>bonafide</i> users.
DNA barcode	A small fragment of mitochondrial DNA (mtDNA) which has species discriminating signals.
Domestication	Domestication is the process by which fishes, plants, animals or microbes selected from the wild adapt to a special habitat created for them by humans, bringing a wild species under human management. In a genetic context, the process in which changes in gene frequencies and performance arise from a new set of selection pressures exerted on a population (http://cmsdata.iucn.org).
Donor	An institution or individual responsible for donating germplasm.
Ecosystem	A dynamic complex of plant, animal and microorganism communities and their abiotic environment interacting as a functional unit.
Effluent	Liquid waste or sewage discharged into a river, sea or any natural bodies of water.
Endangered	When used in the context of the IUCN Red List, a taxon is classified as 'Endangered' when there is very high risk of extinction in the wild in the immediate future (IUCN 2001).
Endemic	Native to, and restricted to, a particular geographical region. Highly endemic species, those with very restricted natural ranges, are especially vulnerable to extinction if their natural habitat is eliminated or significantly disturbed.
Epizootic	Denoting a disease that is temporarily prevalent and widespread in an animal population.
Evaluation	The recording of quantitative traits whose expression is often influenced by environmental factors; it provides an assessment of the potential of germplasm for use in

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	breeding/research.
Ex situ	Outside the original habitat of the organism.
Exotic species	Populations introduced of their native habitat in a new area for propagation.
Ferral populations	Populations derived from domesticated / introduced populations and naturalized in wild.
Fisherfolks	People associated with fishing or fish farming activities.
Fomites	any object or substance capable of carrying infectious organisms, such as germs or parasites, and hence transferring them from one individual to another.
Genebank	Is a facility where genetic resources (genetic material) are conserved under suitable conditions to prolong their lives.
Genepool	The sum total of all the genes and combinations of the genes that occur in a population of organisms of the same species.
Genetic conservation	The collection, maintenance, storage and sustainable management of genetic resources aimed at ensuring their continued existence, evolution and availability for future generations. Also referred as 'gene conservation' and 'genepool conservation'.
Genetic diversity	The genetic variability (variety of genetic traits) within a population or a species, arising due to number and relative abundance of alleles. It can be assessed at three levels: (a) diversity within breeding populations, (b) diversity between breeding populations; and (c) diversity within the species. Genetic diversity occurs at gene level (the molecular level), the individual level, the population level, the species level, and the ecosystem level.
Genetic material	Any material of plant, animal, microbial or other origin containing functional units of heredity.

Genetic resources	Genetic material of actual or potential economic, scientific or societal value contained within and among species. In a domesticated species, it is the sum of all the genetic combinations produced in the process of evolution. The term includes species, genetic stocks; wild relatives of domesticated species; and genetic variants of wild species.
Genetic stock	Reproductively isolated group of individuals of the same species.
Germplasm	The genetic material which can be used for propagation or breeding programmes.
Germplasm exchange	Mutual give and take of germplasm or genetic resources from all available sources.
Habitat	Part of an ecosystem with conditions in which an organism naturally occurs or can establish.
Health certificate	A certificate issued by the Competent Authority of the exporting country attesting to the health status of a consignment of live aquatic animals.
<i>In situ</i>	In the original habitat of the organism.
Indigenous	A species that is assumed to be intrinsically part of the ecosystem of ones country owing to having developed there having arrived in the area long before record of such matters was kept having arrived by natural means (unaided by human action) etc.
Impact risk assessment	The process of assessing the probabilities and consequences of risk events if they are realized.
Intellectual property rights (IPR)	Intellectual Property Rights (IPR) are legal right that are conferred to the owner of an intellectual creation. The IPR are granted by means of protection through appropriate legislation based on the type of creation that generally include patents copyright trademark industrial designs

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geographical indications trade secrets protection of layout design of integrated circuits and protection of new plant varieties. The Intellectual Property Right protection entitles the owner of the Intellectual Property or his assignee the exclusive right to fully utilize the invention/creation for commercial gain generally for a fixed period of time.

Material transfer agreement (MTA)	A contractual arrangement (can be legally binding) in commercial and academic research partnerships involving the transfer of tangible biological materials (such as germplasm, microorganisms and cell cultures) from a provider to a recipient. The MTA sets conditions for use, commercialization and sharing of benefits derived from the use of the materials provided.
Passport data/information	Basic information about the origin of an accession, such as details recorded at the collecting site, pedigree or other relevant information that assists in the identification of an accession.
Pathogen	A living microorganism such as a virus, bacterium or fungus that causes disease in another organism.
Quarantine	Official confinement of regulated articles (introduced germplasm) for observation and research or for further inspection, testing or treatment to ensure that it does not carry diseases or pests injurious to the importing country.
Quarantine officers	A technically competent person (e.g. from the fish inspection office) authorized by the Competent Authority for the purposes of inspecting and certifying compliance with the health requirements of the Competent Authority concerning the import and export of live aquatic animals.
Trans-boundary disease	A disease that is highly contagious or transmissible, with the potential for rapid spread irrespective of national borders and that cause significant socio-economic, and possibly public health consequences.

Acknowledgement

The Code of Practice for Trans-boundary Movement of Live Aquatic Organisms in the LMB has been developed based on national reviews on impacts of exotic species on natural environment and aquaculture related issues of the MRC Member Countries and the regional and international codes of practice and their requirements.

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Introduction

The Lower Mekong Basin (LMB) is a highly productive and diverse environment that supports surrounding community of around 6 million inhabitants in terms of livelihood, which is mostly from fisheries and aquaculture. There is a standing concern of the fast development of aquaculture sector in the LMB that heavily depends on the use of exotic species will lead to the risks of habitat alteration, feed competition, and predation to the indigenous species. These risks may pose threats in form of loss of diversity of endemic indigenous wild fish stocks, genetic interference and extinction of indigenous population. In this regard, the trans-boundary movements of live aquatic organisms within the Mekong Rivers system by trading or trafficking are of concerns.

Aquatic animal importations or exportations without intensive inspection or health certification may pose significant risks in terms of trans-boundary aquatic animal diseases as well as introduction of unwanted species or invasive exotic species. Unregulated aquaculture industrial operators, that are using gene technology, may lead to a genetic alteration of the indigenous species along the Mekong River. This uncontrolled genetic alteration in aquatic animals may have negative implications on food security, food safety and/or quality of aquaculture and fishery products.

For aquaculture, in particular, the introduction and use of exotic species is highly significant, mainly for the purpose of increased production to meet the increasing demand for fish protein in the region and beyond (Hewitt et al., 2006). Exotic species have been introduced to the Member Countries of Mekong River Commission (MRC) since the early years. Some of these exotic species have been well adapted to the environment

and widely used for aquaculture production in the region (e.g. Nile tilapia, Chinese carps, Indian carps, white leg shrimp, etc.). Other exotic species were also able to establish populations in the wild which have somehow affected the biodiversity as well as genetics of indigenous species. Some exotic aquatic species that have established population in the MRC region are as follows (from national review of MRC Member Countries on impacts of exotic species, environment and aquaculture): Nile tilapia (*Oreochromis niloticus*) which was reported in most MRC countries; and, sucker mouth catfish (*Pterygoplichthys disjunctivus*; *Hypostomus punctatus*) and peacock bass (*Cichla ocellaris*) reported in Viet Nam. Genetic introgression in wild native catfish *Clarias macrocephalus* due to escape of exotic African catfish *Clarias gariepinus* was reported in Thailand (Senanan et al., 2004).

In general, Cambodia reported 13 exotic species of aquatic animals that are already found in natural water bodies, out of the 43 exotic species that were introduced into the country. In addition, 21 exotic ornamental species were also introduced. In Lao PDR, a total of 22 species in the Mekong Basin were identified as exotic, 15 of which were introduced locally while 9 were from other countries/region.

Thailand reported 12 exotic species that are already invasive in the country, and 13 more species that have the potential to be likely invasive. Viet Nam recorded the highest number of introduced exotic species including 40 freshwater species, 1 marine fish, 78 freshwater ornamental fish, 4 crustaceans, 2 amphibians, 2 reptiles and 7 molluscs.

With the lack of established regulations at a regional level for the introduction of exotic species in the LMB and the unregulated movements of aquatic animals across borders of MRC Member Countries, problems associated with invasive exotic species as well as spread of trans-boundary aquatic animal diseases will continue. This warrants the

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development and implementation of this Code, in order to prevent if not minimize these negative impacts of movement of live aquatic organisms within the LMB. This is necessary in order to maintain aquatic biodiversity, minimize disease outbreaks and spread, and sustain the environmental integrity of the basin.

1. Nature and Scope of the Code

- 1.1. The Code is suggestive in nature and supports MRC Member Countries to formulate, develop, and implement necessary actions to mitigate the negative impacts of aquatic animal species introductions, especially exotics, into and within the LMB, and to properly manage exotic species that were already introduced in the MRC Member Countries.
- 1.2. This Code aims to provide standard operating procedures for the development of agreements among MRC Member Countries that could be mandatory and legally binding, and in compliance to national laws. Such agreements can be regularly updated by means of technical regional consultations and progress assessments, to reflect recent developments in terms of technology, protocols and the overall industrial and environmental scenarios in the LMB and other surrounding areas/countries.
- 1.3. The Code has been developed in close collaboration with the fisheries line agencies of the MRC Member Countries and is mainly meant for their use. The Code is also applicable to all individuals, cooperatives, private companies and other sectors that are engaged in fisheries, aquaculture and other related activities in the LMB, either independently or collectively.
- 1.4. The Code is applicable to LMB nations but with global outlook with respect to the introduction of alien species in the region.
- 1.5. This Code addresses the responsibility of MRC Member Countries for the management of aquatic resources, fisheries and aquaculture operations, community and environment in the LMB.
- 1.6. This Code is in line with existing international and regional guidelines related to responsible movement of live aquatic animals (e.g. FAO, OIE, NACA, and WTO).

2. Objectives of the Code

This Code of Practice was prepared to:

- 2.1. Ensure compliance to important guidelines and standards on responsible movement of live aquatic organisms in the LMB for long-term environmental protection and management, biodiversity conservation and prevention of spread of disease epizootics;
- 2.2. Guide the implementation of effective awareness programs on the status and impacts of introduced (exotic) species on spread of diseases, biodiversity and genetics of indigenous species, and overall environmental management;
- 2.3. Enhance consultation and collaboration with relevant authorities in their respective countries and in the region for the development and implementation of policies, regulations and responsible practices on live movement of aquatic animals in the LMB. These policies and regulations should assist in attaining sustainability of the LMB environment as well as aquaculture and fisheries production and socio-economic status of the communities;
- 2.4. Facilitate consultation and cooperation among all sectors involved in aquaculture, fisheries, environmental management and community development for the development and agreement of common standards and objectives for the overall management of the LMB;
- 2.5. Assist in the planning and management of existing and developing aquaculture and fisheries activities to minimize their impacts on the LMB ecosystem;
- 2.6. Support the formulation of necessary preventive measures to avoid outbreaks of aquatic animal diseases (OIE-listed and other

diseases of regional importance) and implement appropriate containment and control measures. Technical consultation with Competent Authorities and relevant stakeholders on aquatic animal health and risk assessments should be done prior to the implementation of any preventive, control and containment measures;

- 2.7. Inform the formulation of proper government regulations for disposal of wastewater, chemicals and industrial/agricultural effluents that may pose hazards to the environment and to human health;
- 2.8. Facilitate cooperation with sectors involved in research and development, and training programs for capacity building, towards social and economic improvements and resource management in the LMB;
- 2.9. Guide the formulation of projects for the improvement of fisheries management in the LMB, provided that such projects are economically feasible and can assist in the sustainability of all related activities in the LMB.

3. Legal Frameworks

Implementation of this Code of Practice can also be referred to the following international and regional treaties that deal with responsible movement of live aquatic animals for trade and aquaculture, as well as science-based risk analysis:

1. ***Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy, 2000***, FAO Fisheries Technical Paper No. 402, Food and Agriculture Organization of the United Nations, Rome, Italy, and Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand. This document provides background material and detailed technical procedures to assist countries and territories in the Asia Region in implementing the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals.
(<http://www.fao.org/docrep/005/X8485E/X8485E00.HTM>)
2. ***FAO Code of Conduct for Responsible Fisheries (CCRF)***. The Code sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The Code recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interests of all those concerned with the fishery sector. The Code takes into account the biological characteristics of the resources and their environment and the interests of consumers and other users
(<http://www.fao.org/fishery/topic/18133/en>)

3. ***The Cartagena Protocol on Biosafety to the Convention on Biological Diversity***. An international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) which are resulting from use of modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health. It was adopted on 29 January 2000 and entered into force on 11 September 2003.
(<http://bch.cbd.int/protocol>).
4. ***Convention on Biological Diversity*** (CBD). This is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and microorganisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live
(<http://www.cbd.int/convention/>)
5. ***The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity***. This is an international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components
(<http://www.cbd.int/abs/>)

6. ***Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)***. This is an international agreement between governments which aim to ensure that international trade in specimens of wild animals and plants does not threaten their survival. (<http://www.cites.org/>)

7. ***Commission of Genetic Resources for Food and Agriculture***. The Commission provides the only permanent forum for governments to discuss and negotiate matters specifically relevant to biological diversity for food and agriculture. The Commission aims to reach international consensus on policies for the sustainable use and conservation of genetic resources for food and agriculture and the fair and equitable sharing of benefits derived from their use. (<http://www.fao.org/nr/cgrfa/cgrfa-home/en/>)

8. ***OIE Aquatic Animal Health Code, 17th Edition, 2014***. The OIE Aquatic Animal Health Code (the Aquatic Code) sets out standards for the improvement of aquatic animal health and welfare and veterinary public health worldwide, including through standards for safe international trade in aquatic animals (amphibians, crustaceans, fish and molluscs) and their products. The health measures in the Aquatic Code should be used by the veterinary authorities of importing and exporting countries to provide for early detection, reporting and control of agents pathogenic to aquatic animals and, in the case of zoonotic diseases, for humans, and to prevent their transfer via international trade in aquatic animals and aquatic animal products, while avoiding unjustified sanitary barriers to trade. (<http://www.oie.int/international-standard-setting/aquatic-code/access-online/>)

9. ***OIE Manual of Diagnostic Tests for Aquatic Animals, 2014.*** This manual provides a uniform approach to the detection of the diseases listed in the *OIE Aquatic Animal Health Code*, so that the requirements for health certification in connection with trade in aquatic animals and aquatic animal products can be met. It includes bibliographical references and a list of the OIE Reference Laboratories for amphibian, crustacean, fish and mollusc diseases.
(<http://www.oie.int/international-standard-setting/aquatic-manual/access-online/>)

10. ***Understanding Risk Assessment in Aquaculture, 2008.*** (Eds. MB Reantaso, JR Arthurs and RP Subasinghe), FAO Fisheries and Aquaculture Technical Paper No. 519, FAO, Rome, Italy. This document 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.
(<http://www.fao.org/docrep/011/i0490e/i0490e00.htm>)

11. ***Understanding and Applying Risk Analysis in Aquaculture: A Manual for Decision-makers, 2009.*** (JR Arthur, MB Reantaso, ML Campbell, CL Hewitt, MJ Phillips and RP Subasinghe). FAO Fisheries and Aquaculture Technical Paper 519/1, FAO, Rome, Italy. This manual is directed towards decision-makers and senior aquaculture managers. This is also of relevance to aquaculture operators, industry organizations, non-governmental organizations and other groups interested in understanding risk analysis and its influence on national aquaculture policy, industry regulation and the management of aquatic resources.
(<http://www.fao.org/docrep/012/i1136e/i1136e.pdf>)

12. ***Manual on Risk Analysis for the Safe Movement of Aquatic Animals, 2004.*** (JR Arthur, MB Reantaso, FC Baldock, CJ Rogers and BF Edgerton). FWG/01/2002; APEC/DoF/NACA/FAO. This manual provides a simplified overview of the risk analysis process to assist responsible individuals in developing countries to begin formulating national policies and approaches to conducting risk analyses. This manual is useful to Competent Authorities, senior policy and management staff, and member of the private sectors involved in regulating or conducting international and domestic trade in live aquatic animals and their products.
(http://www.enaca.org/modules/library/publication.php?publication_id=448)

13. ***Handbook on Import Risk Analysis for Animals and Animal Products: Introduction and Qualitative Analysis (Volume 1); Quantitative Risk Assessment (Volume 2), 2004.*** World Organisation for Animal Health (OIE), Paris, France. These two volumes of the Handbook introduce the concepts of import risk analysis and discuss qualitative and quantitative risk analysis. It also explains key issues within the frameworks provided by WTO SPS Agreement and the Chapters in both Codes on Risk Analysis.

4. The LMB Environment

The Mekong's floodplain underpins the most productive and arguably most complex ecosystem services regime in the world, producing fish that sustains the majority of the protein and fatty oil needs of 60 million natural resource-dependent mostly rural inhabitants in the Lower Mekong Basin of Laos, Thailand, Cambodia and Viet Nam (www.mrcmekong.org). The Mekong Basin hoists one of the world's largest and most productive inland fisheries. An estimated 2 million tonnes of fish are landed each year, in addition to almost 500,000 tonnes of other aquatic animals (Hortle, 2007). Aquaculture, on the other hand, yields about 2 million tonnes of fish a year (MRC, 2010a). Hence, the LMB yields a total of about 4.5 million tonnes of fish and aquatic products annually. The total economic value of the fishery is between USD 3.9 to USD 7 billion a year (MRC, 2010b). Wild capture fisheries alone have been valued at USD 2 billion a year (Baran and Ratner, 2007).

With the diverse resources and high potential of the LMB in supporting livelihoods of the mainly rural communities, all sectors including fisheries, aquaculture, and environmental management should work together with other relevant agencies in the MRC Member Countries to ensure equitable, responsible and sustainable use of the LMB environment and resources:

- 4.1. Responsible use of the water resources should be promoted. Urban and rural communities and industries should minimize discharge of wastewater and other pollutants that have adverse effect on the LMB environment and resources;
- 4.2. For aquaculture operations within the LMB, zonal management should be implemented by defining appropriate zones for selected exotic/introduced species under special regulation that will benefit the industry (both for fish food and ornamentals);

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- 4.3. Escape of farmed fish into the natural environment should be minimized, if not prevented. Farmers and community members will, in event of escapes, cooperate and inform respective authorities, so that appropriate actions can be implemented;
- 4.4. Relevant authorities should have special control measures formulated and implemented for registration and tracing of movement of exotic species that are introduced into the LMB which have high risk to alter aquatic biodiversity or spread new disease epizootics.

5. Socio-economics

Aquaculture and capture fisheries in the LMB play an important role in bridging the gap between supply and demand of aquatic animal products, both for domestic and international markets. Considerations for social and economic aspects of production are one of the requirements for the development of standards in aquaculture products for facilitation of international trade. As such, policy makers, aquaculture operators and fishers must:

- 5.1. Become aware of the social contribution required of their respective activities and ensure integration/collaboration in local and regional community development and planning;
- 5.2. Ensure the safety of all operators/workers involved in all and related activities including proper handling of equipment, use of chemicals, and disposal of waste materials. All health hazards associated with aquaculture and fisheries operations should be taken in full consideration;
- 5.3. Acknowledge their responsibility towards the local society by providing safe and stable workplace;
- 5.4. Undertake capacity building activities related to proper marketing and processing of aquatic animal products to improve their marketability in both local and domestic markets. Such activities should ensure equal employment opportunities and access for men and women workers in the community;
- 5.5. Take social responsibility in providing nutritious and high quality aquatic animal products for the consumers;
- 5.6. Endeavour to ensure both short- and long-term balance between supply and demand, for sustainable economic stability of the aquaculture and fisheries industries.

6. Aquatic Animal Health

The spread of new aquatic animal disease is one of the important risks that can result from the movement of live aquatic animals, especially if proper quarantine measures are not implemented prior to its use and release. There have been many documented outbreaks of trans-boundary aquatic animal diseases (both OIE- and non OIE-listed diseases) resulting from trading/movement of aquatic animals mainly for aquaculture or ornamental uses. These include parasitic diseases (e.g. *Hexamita*, *Tetrahymena*, *Oodinium*), viral diseases (white spot disease, infection with koi herpesvirus, taura syndrome virus), fungal disease (infection with *Aphanomyces invadans* or EUS), and bacterial diseases (acute hepatopancreatic necrosis disease or AHPND; edwardsiellosis). Some of these diseases have caused significant economic losses in the overall aquaculture production of MRC Member Countries.

It is, therefore, recommended that MRC Member Countries should develop national as well as regional aquatic animal health strategies to deal with important aquatic animal diseases, especially trans-boundary diseases that can spread and cause epizootics in the LMB. The aquatic animal health strategies should include optimisation of general health of aquatic animals, as well as disease diagnosis, prevention and control as follows:

- 6.1. Improved capacities for diagnostic, surveillance and monitoring of important aquatic animal diseases in the region;
- 6.2. Avoidance of the introduction of diseases. Aquatic animals to be introduced into the system and the LMB environment should be of good health and come from a certified origin. Adequate and proper precautionary measures should be undertaken to avoid inter-farm contamination or spread of the disease in the wild;
- 6.3. Formulate a list of requirements for movement of live aquatic animals which might carry pathogens that are (1) common in the

- region, and (2) exotic in the region with potential to infect indigenous as well as cultured aquatic animal species;
- 6.4. Develop and implement mitigating measures and emergency response when new disease outbreak occurs;
 - 6.5. Develop standard protocols on handling, cleaning and disinfection of fomites used in the transport of live aquatic animals into and within the LMB;
 - 6.6. Promote awareness programmes on proper containment of the disease, as well as eradication and disposal of infected organisms in case of disease outbreaks. This is to prevent further spread of the disease and to protect the LMB environment in general.

7. Genetics and Biodiversity

7.1. Conservation of Aquatic Biodiversity

The decision and management plans for transboundary movement of live aquatic animal must be based on scientific information and consider both beneficial and negative impacts resulting from transfer of germplasm. Aquatic biodiversity in LMB is very rich and diverse, and supports livelihoods of fisherfolks. Being a fragile and vulnerable ecosystem, conservation measures are of high importance. Alien species are considered one of the major threats to conservation efforts and containment of their spread to natural ecosystems needs strategies related to activities as follows:

- 7.1.1. Commissioning of comprehensive exploratory surveys to document spread and establishment of exotic fish species in the LMB and assess the likely impact on native germplasm;
- 7.1.2. Unintentional germplasm exchange should be discouraged; any introduction should be based on a proactive assessment decision making process and robust risk assessment analysis with the approval of authority followed by germplasm transfer;
- 7.1.3. The non-native germplasm, species or differentiated population of a native species, should not be considered for open water stocking in rivers and reservoirs but only for confined water aquaculture (with no risk of escape);
- 7.1.4. The flood prone areas should not be used for aquaculture of exotic species or specific guidelines should be prepared for culture in these areas;
- 7.1.5. For native species of a country, transfer of its non-native germplasm should be permitted within domesticated and managed populations to capture large genetic diversity for culture. The introduction of such germplasm in wild should not be

encouraged to avoid risk of genetic mixing and conserve within-species diversity;

- 7.1.6. The species which are protected by law or endemic to a protected location in a LMB member country should not be collected in the wild for export to a third country for commercial use. Export can only be allowed for specimens of hatchery bred progeny;
- 7.1.7. LMB nations importing germplasm from a third country for aquaculture and trade will inform MRC/LMB member countries and share passport details of the species for future preparedness of fellow nations against spread and disease risks;
- 7.1.8. A predator fish that might be commercially attractive and with high market value should not be imported unless it is justified following preceding ecological risk assessments and strict adherence of safe commercial and appropriate culture and biosecurity guidelines that should be in place;
- 7.1.9. Awareness programmes to contain spread and culture of existing invasive /undesirable species and adherence to guidelines by the culturists regarding import and culture of exotic fish species;
- 7.1.10. Appropriate Material Transfer Agreements (MTA) should be developed and used for any transfer between LMB or out of LMB nation. The MTA should consider appropriate provisions of access and benefit sharing (wherever applicable) to protect the sovereign rights of native communities on genetic resources; developing a MTA document, which is common to all LMB nations, can be considered. Appropriate access and benefit sharing guidelines applicable to transfer of germplasm among LMB nations and transfer to a third country, should be commissioned with MTA to protect the rights of native communities.

7.2. Transfer of Aquatic Germplasm

The germplasm transfers and exchange between LMB Member Countries can occur for the purpose of culture or domestication for future propagation in importing country. Under this fish may be farmed species, improved varieties or wild stocks. Even feral populations of the exotic species can be in demand for their adaptive traits, developed during naturalization process in the new environment, for use in genetic improvement programmes. Since the domestication level in the fish is low, many of the germplasm exchange will need harvesting from natural resources, which can harm biodiversity. Academic institutes also undertake germplasm exchange for research purposes. Type of material can include developing eggs, specimens at various stages of life history, cryopreserved gametes. Regulatory mechanisms and appropriate guidelines, necessary for sustainable propagation of exotic fish, while avoiding or minimizing impact on biodiversity and protecting intellectual property rights (IPR) on natural genetic resources, shall include the following:

- 7.2.1. Genetic considerations prior to introduction should be taken into account to avoid negative founder effect and inbreeding concerns which can impact aquaculture sustainability of exotic fish;
- 7.2.2. Decision on import of germplasm for commercial aquaculture should be based on pilot-scale performance assessment at least at three different locations (multi locational trials). Assessment Performance framework should be formulated to cover biology, culture performance, disease profile and commercial feasibility;
- 7.2.3. Best management practices, dissemination and aquaculture plan, biosecurity requirements, possibilities of opportunities of cluster farming, potential for gender empowerment should be planned during the preintroduction assessment process to harness the multiple benefits from germplasm transfer;
- 7.2.4. The importing country should generate marker based profile of genetic variability out of a appropriate sample from import

consignment for aquaculture to ensure future monitoring of risks due to inbreeding and genetic erosion;

- 7.2.5. Transfer of germplasm should be done through MTA supported by passport detail on specified format (to be developed for LMB). The MTA should detail specific clauses that the species allowed for import are only for aquaculture/specified use and will not be used for any other research on improvement, commercial product development without knowledge of exporting country;
- 7.2.6. MRC Member Countries should consider establishing a common Germplasm Repository, with legal standing to house samples of the consignment transferred and appropriate guidelines for deposition including species DNA barcode should be formulated for IPR protection. The repository should consider storing disease and pathogenic profiles to aid traceability during disease outbreak; identify potential institutional arrangements within the Member Countries to establish this germplasm repository; MRC can just help to facilitate or serve as a platform in the establishment of such Repository (if possible).

8. Trans-boundary Movement of Live Aquatic Animals

Aquaculture and capture fisheries are the two highly important sectors in the LMB, providing major sources of livelihoods for most of the rural communities. Not surprisingly, trade of live aquatic animals within and across national boundaries is widely practiced given the economic, social and development incentives it provides. It is a fact that both legal and illegal (unregulated) trans-boundary movements of aquatic animals, particularly seeds and broodstock for aquaculture, are common in the LMB. Despite the existence of several regional and international standards and guidelines for movement of live aquatic animals, their proper implementation to minimize risks associated with trans-boundary movement is lacking in the LMB.

The following practices are recommended to be undertaken for movement and introduction of live aquatic animals in the LMB:

- 8.1. National and regional policies should be formulated or refined/harmonized and implemented for the responsible movement and introduction of live aquatic animals, especially exotic species, in the LMB;
- 8.2. Environmental risk assessment should be performed for new (exotic) species to be introduced in the LMB, either for aquaculture or ornamental purposes. This is to assess their possible effect(s) on aquatic biodiversity, genetic make-up of the local population, and possible spread of new disease epizootics in the LMB environment;
- 8.3. Border-gate management strategies should be formulated by the MRC Member Countries, to avoid or minimize unregulated movements of live aquatic animals within and beyond the LMB;

- 8.4. Strict regulations on quarantine measures should be formulated and implemented to prevent or minimize entry of potential pathogens that may affect other cultured species or may spread new disease epizootics for both cultured and wild populations. Proper import/export permits and health certificates should be required for all aquatic animals that will be moved/traded within the LMB region;
- 8.5. Promote awareness on the impacts of introduced/exotic species as well as on conservation and protection of indigenous species, through appropriate local, national and regional media, including academic curricula;
- 8.6. Update national list of exotic aquatic animal species and develop a regional list for the LMB region;
- 8.7. Promote programmes to encourage local fishers and other traders to properly report to relevant authorities on the presence of exotic species (if found) in fish catches, natural river systems and other water bodies.

9. Risk Analysis

Risk analysis is a structured process for analysing the potential impacts (e.g. disease, environmental) associated with movements, both across international borders and domestically, of living organisms and their products (Arthur et al., 2004). For trading live aquatic animals, the risk analysis approach provides objective, repeatable and documented methods for identifying, assessing and considering management options for the associated risks. Risk analysis process (e.g. for aquaculture) include the following components (Arthur et al., 2009):

- Determining the scope of risk analysis;
- Hazard identification
- Risk assessment
- Risk management
- Risk communication

For risk on the spread of aquatic animal diseases, analysis should also establish lists of pathogens of national concern and use standard risk analysis procedures to determine the appropriate level of protection (ALOP). This relates to the potential risks of spread of trans-boundary aquatic animal diseases that can lead to spread in the MRC Member Countries.

Genetic risks, on the other hand, can arise from the escape of the non-native fish specimens in aquaculture. Such non-native germplasm can be of a species that is found in natural waters of receiving country, or an exotic species or genetically modified or improved fish. Genetic consequences can be adverse to the receiving population, happening over generations through chain of events after genetic mixing of escapees with reproductively compatible species populations under favourable conditions in the receiving environment. The risk is due to

genetic harm which can be direct or indirect. Direct genetic harms will happen through interbreeding and subsequent introgression. These include loss of adaptation capacity in natural populations, introgression of new genetic material into species' gene pools, which can lead to loss of locally adapted populations. Indirect harm can be due to invasive nature of the introduced species, creating direct competition or impact environment which reduces the effective population size of the native species. The details of genetic risk assessment are given by Hallerman (2008). While possibilities of genetic hazards are accepted, the associated risks are not well quantified. Genetic risk assessments are still subjective and are of recent concerns; therefore the non-availability of baseline data will be a major impediment (Hallerman, 2008).

It is, therefore, necessary that a robust and science-based risk analysis (using published international handbooks and manuals, e.g. OIE; FAO; see reference list for details) be done prior to importation or introduction of aquatic animal species for the LMB system:

- 9.1. Identify the potential risk(s)/hazard(s) associated with aquatic organisms to be introduced in terms of diseases/pathogens, environmental impacts, and genetics;
- 9.2. Conduct risk assessment studies following established guidelines, to assess the animal's potential to cause disease epidemics, negative environmental impacts, and threat to genetic diversity in the LMB environment;
- 9.3. For cases of past and future introductions, formulate proper risk management procedures to avoid or at least minimize its possible effect on the environment and to the genetic diversity of the local fish populations;
- 9.4. Apply appropriate quarantine and containment measures for aquatic species that were allowed to be imported/introduced into the MRC Member Countries;

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- 9.5. Disseminate risk analysis results to all concerned stakeholders to properly dispose or monitor introduced species, including those that were not properly recorded (unregulated movements);
- 9.6. Encourage reporting of escapees, improper disposal of dead fish, and disease outbreaks caused by introduced species to the proper authorities for immediate action.

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