Food and Agriculture Organization of the United Nations

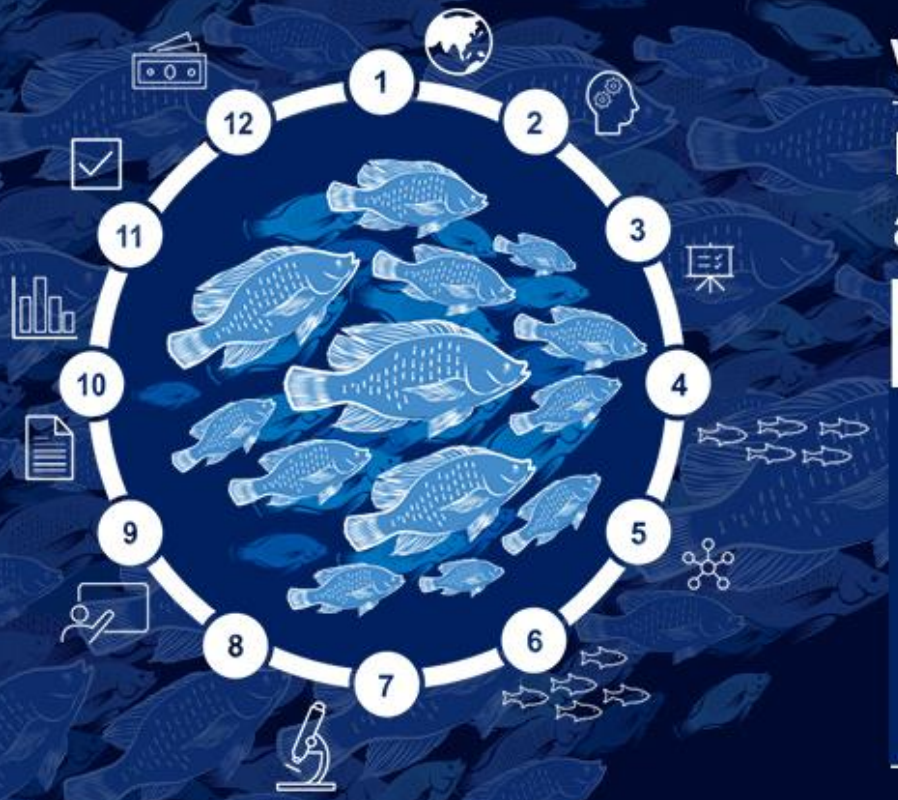
SUSTAINABLE DEVELOPMENT GOALS

VIRTUAL COURSE

26 March to 15 April 2021

Design of an Active Surveillance for Tilapia Lake Virus (TILV) Disease and Its Implementation

TCP/INT/3707: Strengthening biosecurity (policy and farm level) governance to deal with Tilapia lake virus



VIRTUAL COURSE

Design of an Active Surveillance for Tilapia Lake Virus (TILV) Disease and Its Implementation

INTRODUCTION

26 March 2021

Aquatic health management and aquaculture biosecurity

Epidemiology, surveillance

Tilapia sector in the Philippines

Tilapia sector in Viet Nam

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

INTRODUCTION

25 March 2021

Aquatic animal health management and aquaculture biosecurity

Melba G. Bondad-Reantaso

Melba.Reantaso@fao.org

TCP/INT/3707: Strengthening biosecurity (policy and farm level) governance to deal with Tilapia lake virus

Health management of aquatic animals

In its broadest sense, encompassing

- pre-border (exporter), border and post-border (importer) activities
- relevant national and regional capacity-building requirements (infrastructure and specialised expertise) for addressing health management activities, and
- implementation of required effective national and regional policies and regulatory frameworks

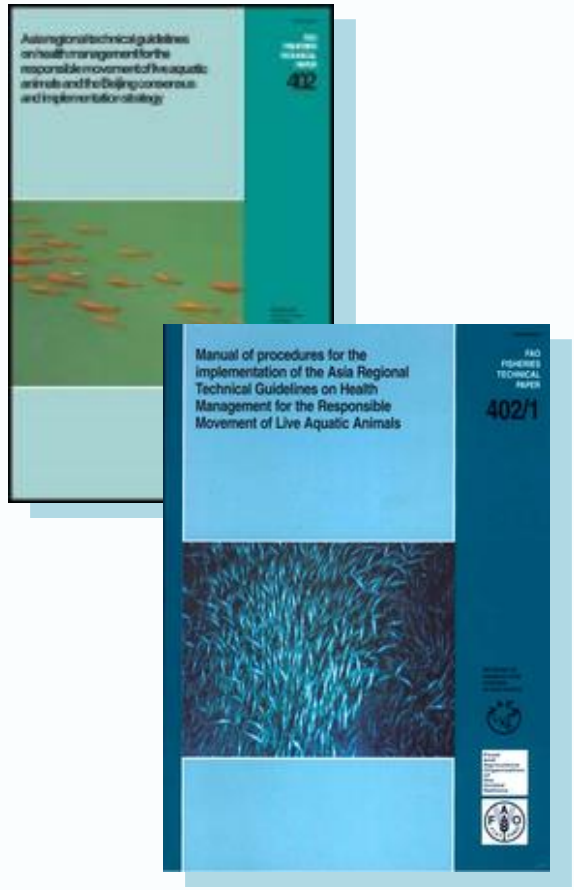
FAO/NACA. 2000
http://www.fao.org/tempref/docrep/fao/005/x8485e/x8485e00.pdf

Health management of aquatic animals

In its broadest sense, encompassing

- **the reduction of the risk of disease spread through movement (intra- and international) of live aquatic animals.**

- **the reduction of risks arising from the potential entry, establishment or spread of pathogens and the diseases they cause.**

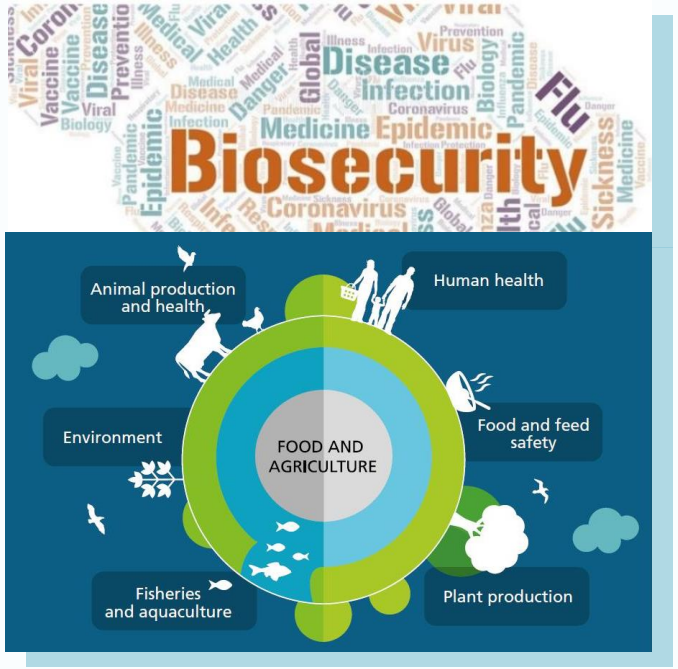


FAO/NACA. 2001
http://www.fao.org/fi/oldsite/eims_search/1_dett.asp?calling=simple_s_result&lang=en&pub_id=72234

biosecurity = minimise risks = exposure to danger, harm or loss

"Strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) that analyse and manage risks in the sectors of food safety, animal (including aquatic) life and health, and plant life and health, including associated environmental risks." (FAO, 2007)

http://www.fao.org/3/a1140e/a1140e00.htm



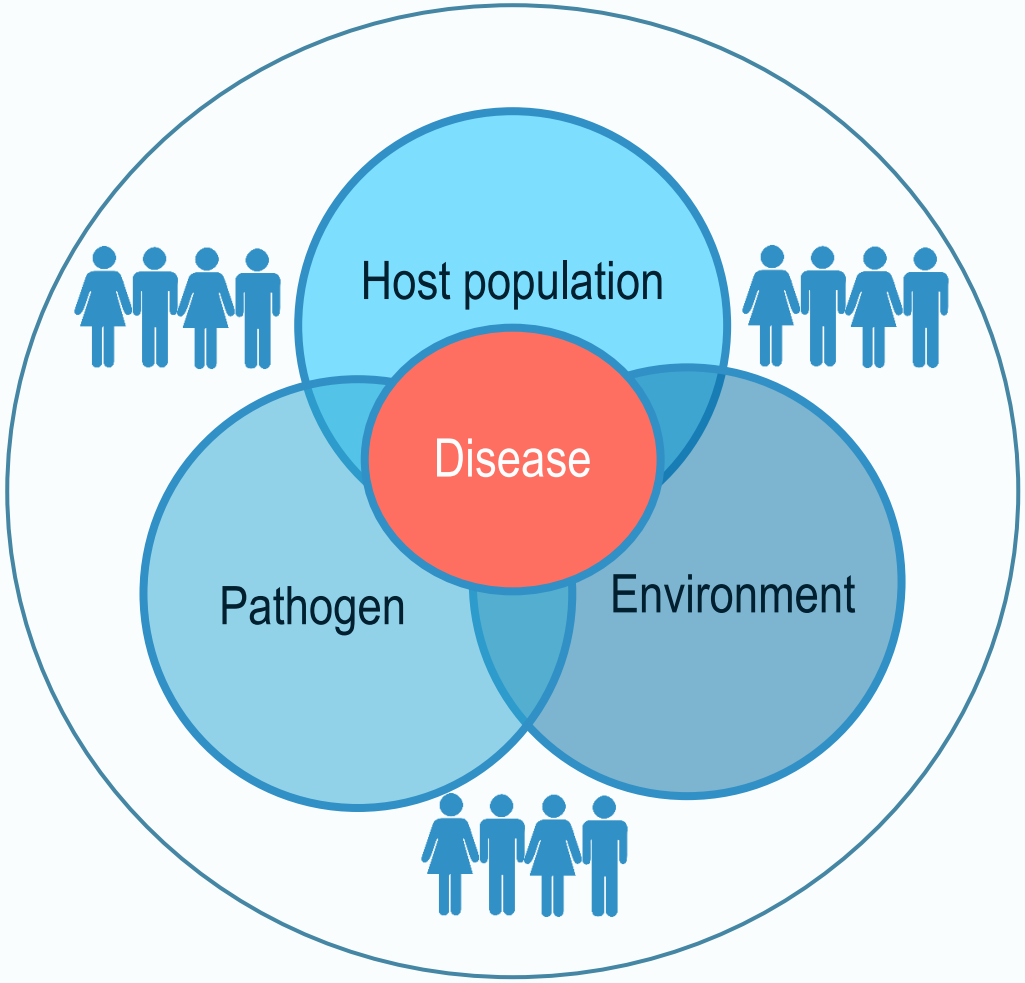
Biosecurity: most important aquaculture sustainability challenge

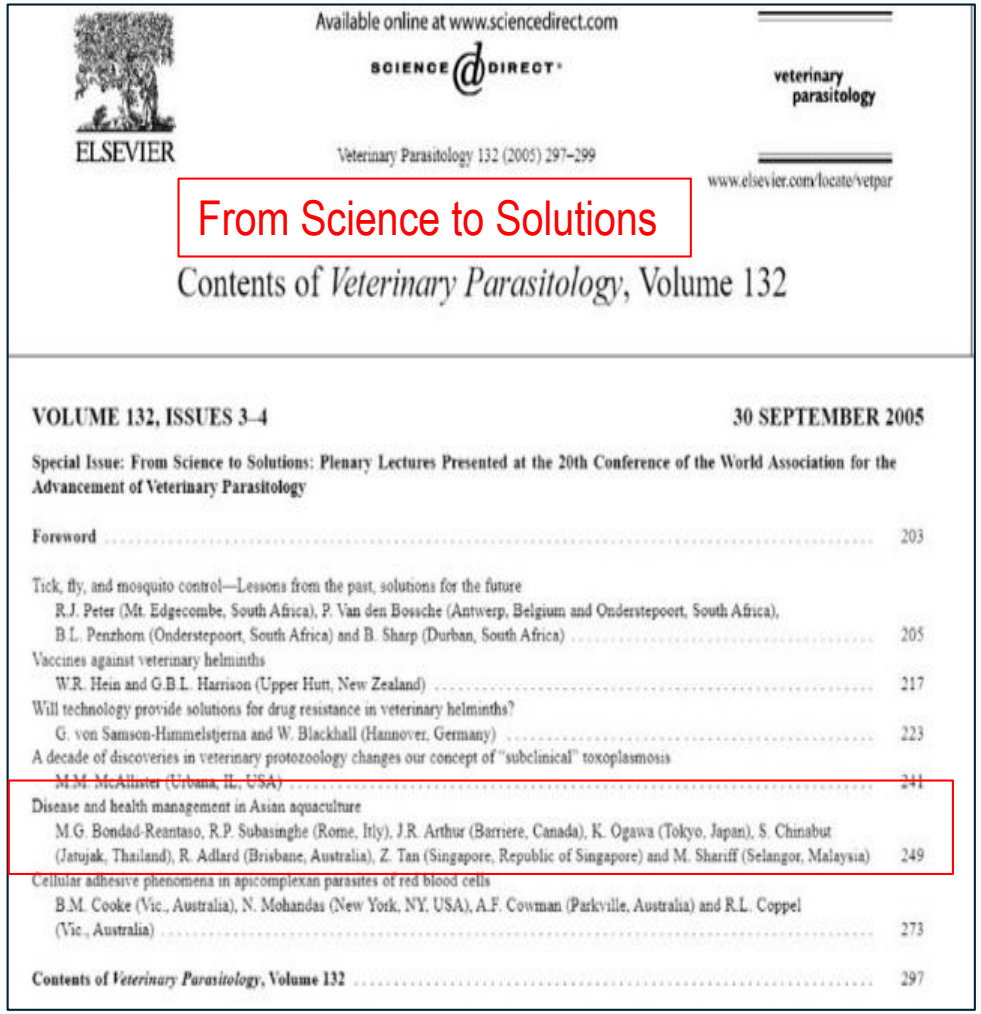
- **Under-the-water animal health**
- Not readily visible
- Complex and dynamic aquatic environment
  Interaction between a pathogen and susceptible population in a suitable environment that allows transmission of the pathogen and development of disease in the population
- The pathogen must be present for disease to occur, but its presence may not always result in disease.
- Biosecurity activities and ‘risk mindset”should be an everyday practice.

Biosecurity: most important aquaculture sustainability challenge

Disease spread from farmed to wild population & vice-versa: conditions/criteria (Olivier, 2002) are essential:

- presence of pathogen in both fish and water source;
- presence of susceptible host;
- viability, in terms of number and longevity, of pathogen in the environment;
- viable infection route.





Available online at www.sciencedirect.com
SCIENCE DIRECT
veterinary parasitology
ELSEVIER
Veterinary Parasitology 132 (2005) 297–299
www.elsevier.com/locate/vetpar

From Science to Solutions

Contents of *Veterinary Parasitology*, Volume 132

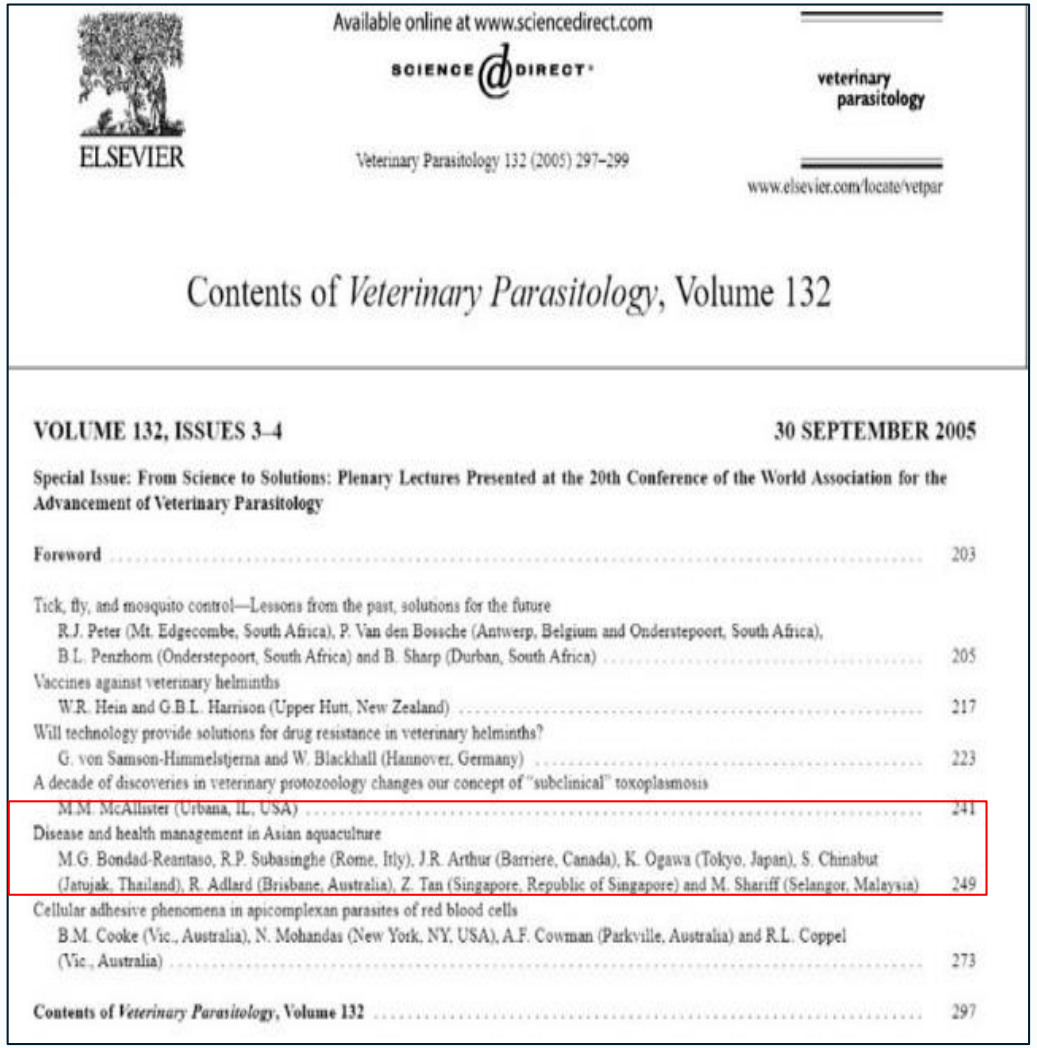
VOLUME 132, ISSUES 3–4 30 SEPTEMBER 2005

Special Issue: From Science to Solutions: Plenary Lectures Presented at the 20th Conference of the World Association for the Advancement of Veterinary Parasitology

Diversity of the sector: species, systems, environment, management, scale of operation, etc.
TAADs – transboundary aquatic animal diseases
Impacts of TAADs
Economics: investments and opportunities

- increased trade in live aquatic animals and their products;
- intensification of aquaculture through the translocation of broodstock, postlarvae, fry and fingerlings;
- development and expansion of the ornamental fish trade
- enhancement of marine and coastal areas through stocking aquatic animals raised in hatcheries
- misunderstanding and misuse of specific pathogen free (SPF) stocks (e.g. shrimps);
- unanticipated negative interactions between cultured and wild fish populations;
- poor or lack of effective biosecurity measures; slow awareness on emerging diseases;
- climate change; all other human mediated movements of aquaculture commodities.

Bondad-Reantaso *et al*. 2005
https://www.researchgate.net/publication/7660129_Disease_and_health_management_in_Asian_Aquaculture



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https://www.researchgate.net/publication/7660129_Disease_and_health_management_in_Asian_Aquaculture

- International standards, regional guidelines
- National strategies on AAH
- Diagnostics, therapy and information technology
- Biosecurity
- Surveillance and reporting
- Research
- Institutional strengthening and manpower
- development (education, training and extension,
- diagnostic services)
- Emergency response to disease epizootics
- Opportunities for fishery biologists and veterinariians

Fish/Vet Dialogue: Exploring opportunities for collaboration

Virtual event: 7-9 June 2021

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

Pathogens

TCP/INT/3707: Strengthening biosecurity (policy and farm level) governance to deal with Tilapia lake virus

Seaweed

PyroV1
Aspergillus sp.,
Alternatia sp.,
Pythium spp.,
Olpidiopsis spp.

Shrimp

EHP

Vibriosis: *Vibrio (harveyi, damsela, alginolyticus, vulnificus, penaecida),*
AHPND, NHP

HPV, IHHNV, LSNV, WSSV, BP, IMNV, YHV MoV ,CMNV, TSV,

Molluscs

Haplosporidium

Candidatus *Xenohaliotis californiensis*

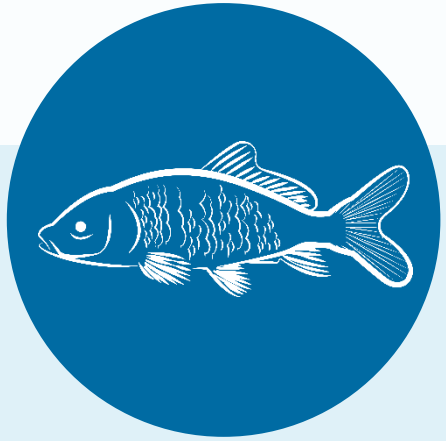
VirusOstreid Herpesvirus type 1

Abalone Haliotid herpesvirus

Tilapia

Trichodina, Amyloodinium
Flavobacterium columnare,
Streptococcus spp,
Edwardsiella spp.,
Francisella spp.,

TiLV, Indovirus,VER/VNN,
Saprolegnia,
Branchyomyces, EUS



Carp

Sphaerospora spp.,
Flavobacterium columnare,
Strepococcus spp., Edwardsiella spp., Mycobacterium spp.,
A. hydrophilia,
Aeromonas salmonicida,
Pseudomonas fl ourescens
KHV,SVC,
Saprolegnia spp.,

Pathogen/Disease Emergence in Aquaculture

Legend: Parasites Bacteria Virus Fungi

1970s

Gyrodactylus (salmon)

MBV (shrimp)

LCDV (tilapia)

EUS (many finfish)

1980s

Sea lice (salmon)

NHP (shrimp)

ISA (salmon)

IPNV (tilapia)

WSSV, HPV, IHHNV, BP (shrimp)

1990s

Vibriosis: *Vibrio (harveyi, damsela, alginolyticus, vulnificus, penaeicida* (shrimp)

YHV, TSV (shrimp)

KHV (carps/koi carp)

2000s

EHP *Enterocytozoon hepatopenaei* (shrimp)

MoV, IMNV, CMNV, LSNV (shrimp)

AHPND (shrimp)

TiLV (tilapia)

VNN (tilapia and marine finfish)

Future

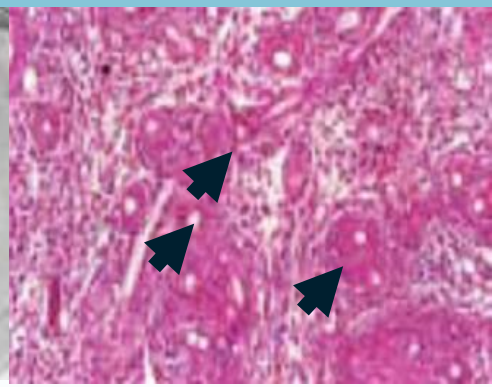
We expect more diseases (exotic, endemic, emerging) if no biosecurity actions are taken

These pathogens affect all phases of production (hatchery, nursery, grow-out).

Diseases in Aquaculture

EUS: fungi/ many finfish species





1970s — Disease (observation in the field)

1980s — Diagnosis

1995 — Adopted in OIE AAH Code

? — Containment (vaccine, treatment, husbandry)

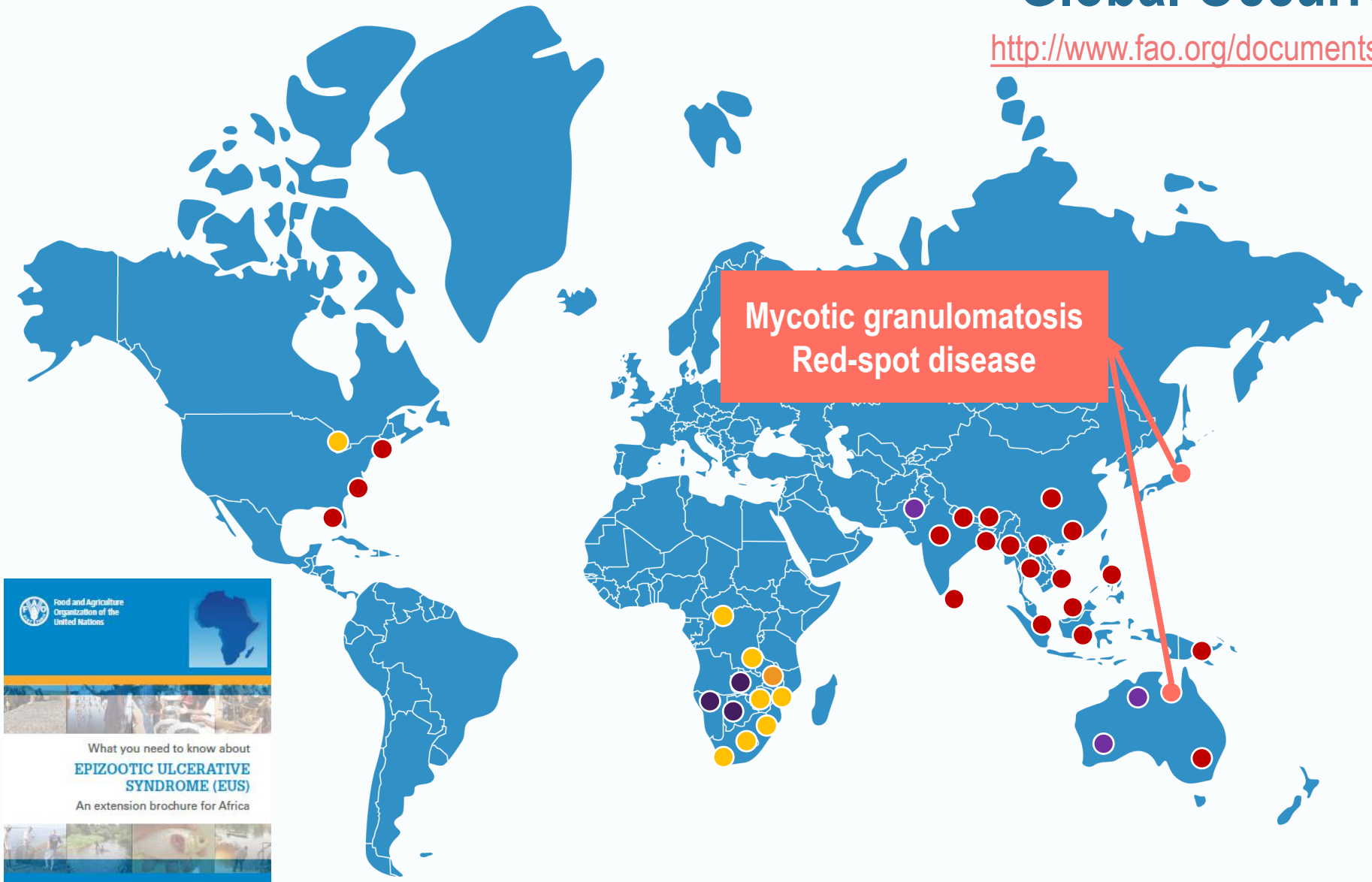
? — Management (cost effective)

? — Disease Freedom

? — National and international confidence to the sector

Global Occurrence of EUS

http://www.fao.org/documents/card/en/c/cb1645en/



1970-1979
Japan, Australia

1980-1989
Papua New Guinea, Indonesia, Malaysia, Thailand, Cambodia, Viet Nam, China, Philippines, Sri Lanka, Bangladesh, India, Bhutan, Nepal, United States of America

1990-1999
Pakistan

2000-2009
Botswana, Namibia, Zambia

2010-2019
Canada, Zimbabwe, South Africa, DRC

2020 - present
Malawi

Diseases in Aquaculture

WSSV: virus/shrimp


Photo credit: Dr D Lightner

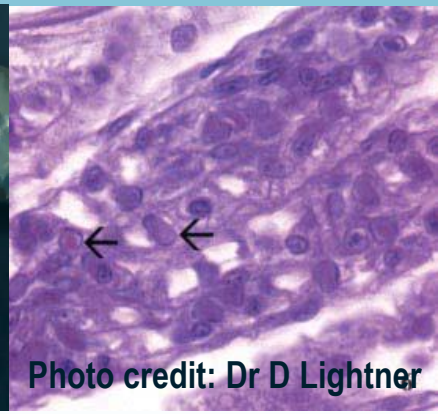


Photo credit: Dr D Lightner

1980s — Disease (observation in the field)

Mid-1990's — Diagnosis

1997 — Adopted in OIE AAH Code

? — Containment (vaccine, treatment, husbandry)

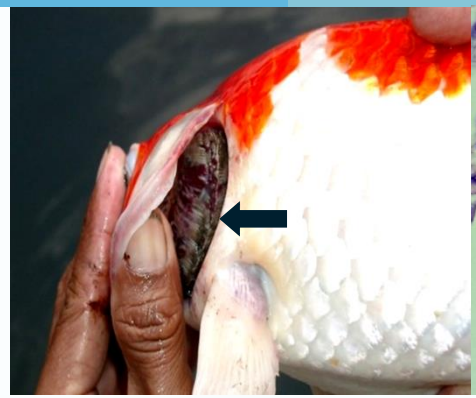
? — Management (cost effective)

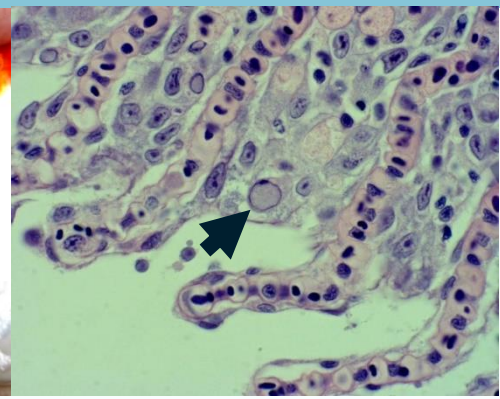
? — Disease Freedom

? — National and international confidence to the sector

Diseases in Aquaculture

KHV: virus/carp & koi carp





1990s — Disease (observation in the field)

Mid 2000s — Diagnosis

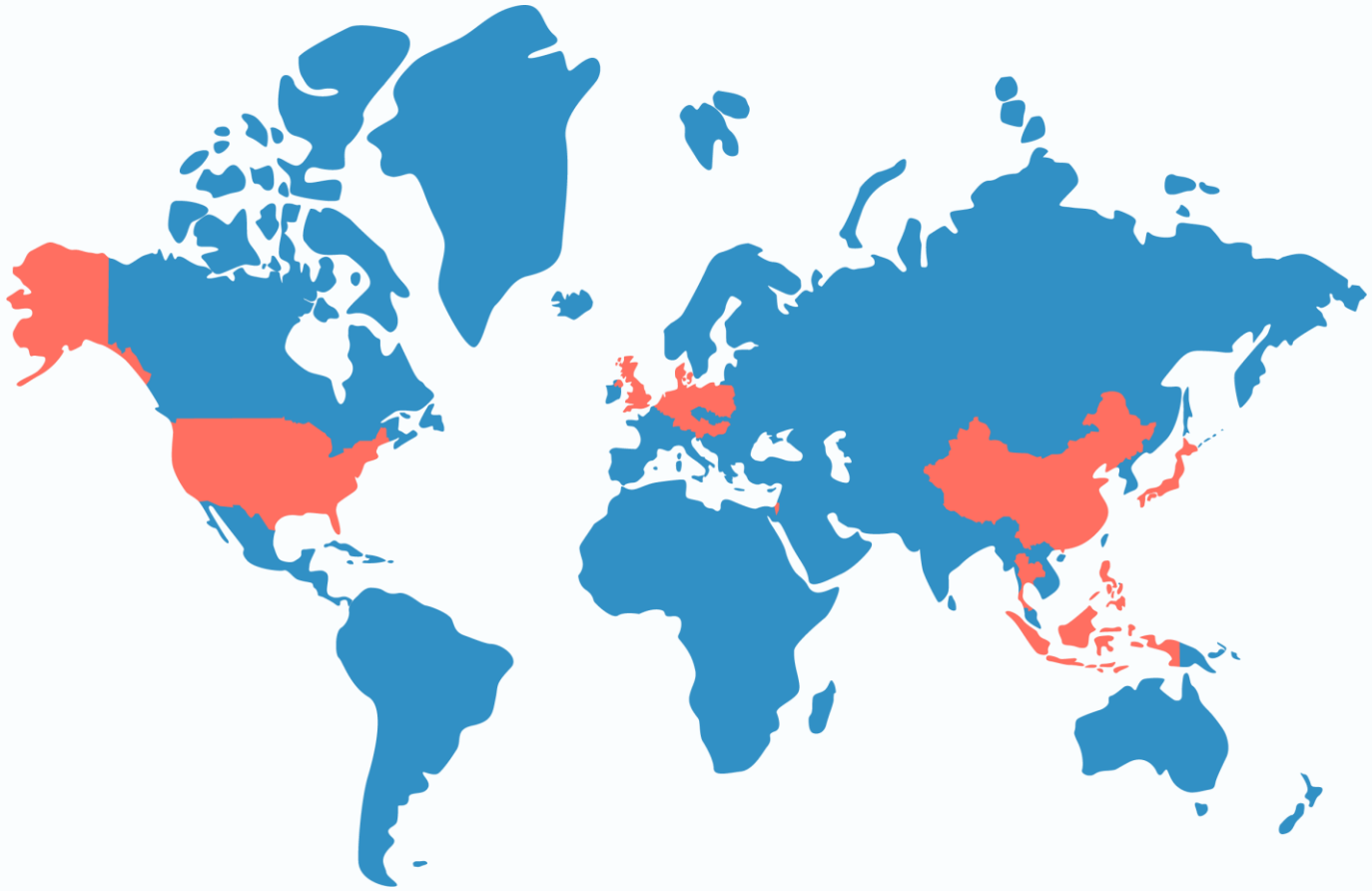
2007 — Adopted in OIE AAH Code

2018/2019 — Containment (vaccine, treatment, husbandry)

? — Management (cost effective)

? — Disease Freedom

? — National and international confidence to the sector



Current distribution of koi herpesvirus (KHV)

Affects important food fish (carp) and high value ornamental (koi carp)

Africa: 1; Asia: 7; Europe: 8; Middle East:1; North America: 1

Latest incursion: Iraq

MARCH 6, 2019

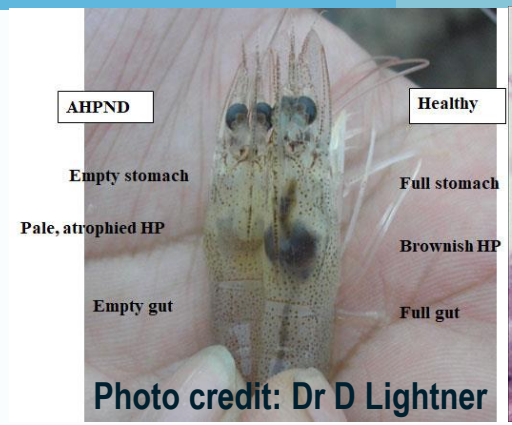
UN finds herpes killed millions of Iraqi carp

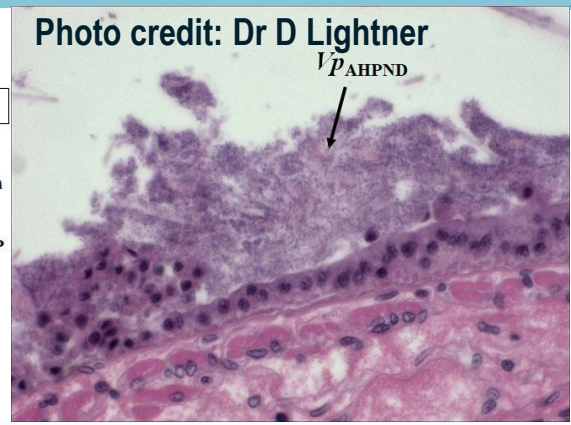
Rumours swirled over whether the fish used to prepare Iraq's signature dish masgoof were sick or the E...

The sudden death last year of millions of Iraqi carp, used in the country's signature dish, was caused by a strain of herpes harmless to humans, the United Nations said Wednesday.

Diseases in Aquaculture

AHPND: bacteria/shrimp





2009 — Disease (observation in the field)

2013 — Diagnosis

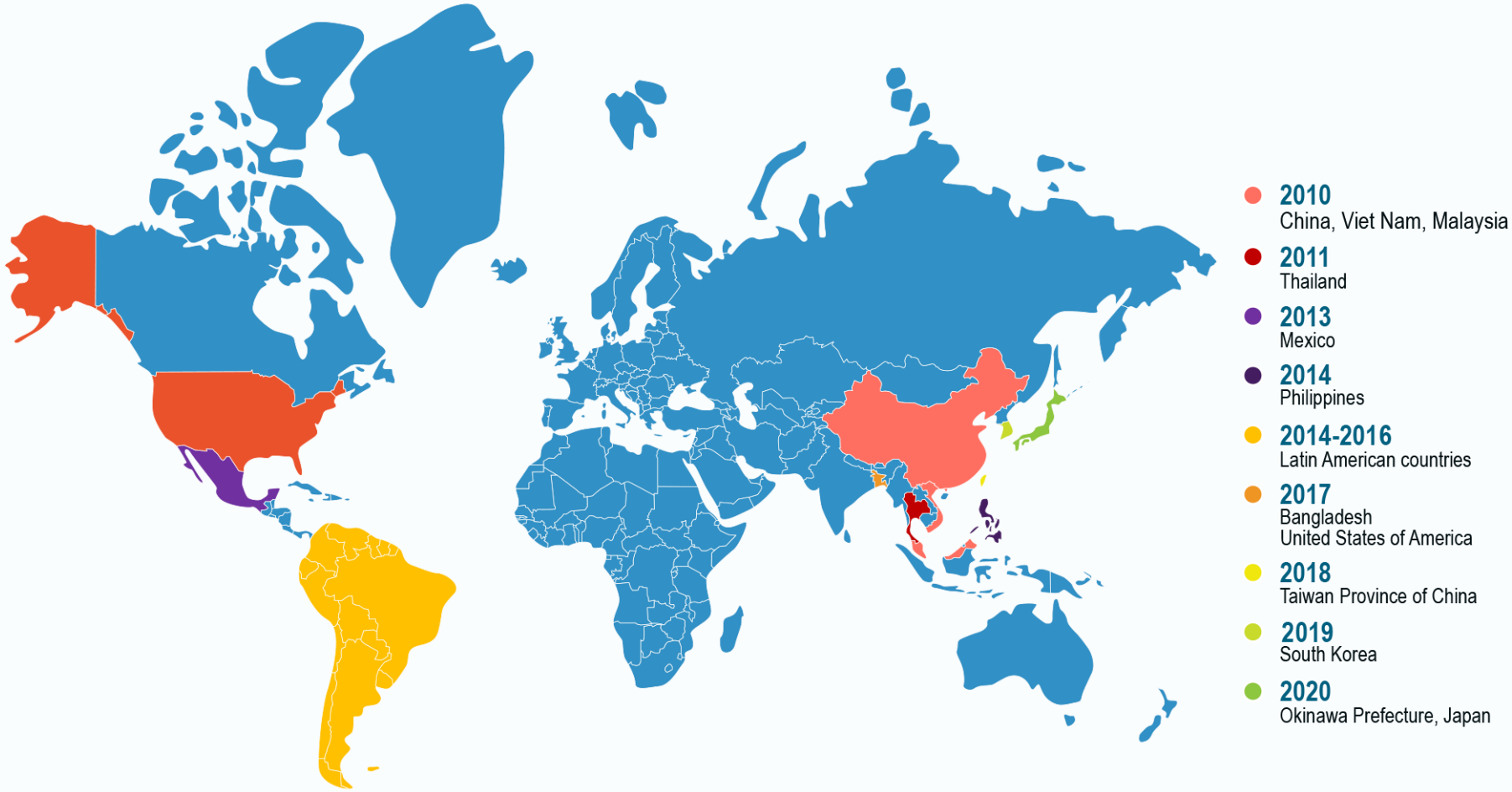
2017 — Adopted in OIE AAH Code

? — Containment (vaccine, treatment, husbandry)

? — Management (cost effective)

? — Disease Freedom

? — National and international confidence to the sector



AHPND: bacteria/shrimp

Diseases in Aquaculture

TiLV: virus/tilapia

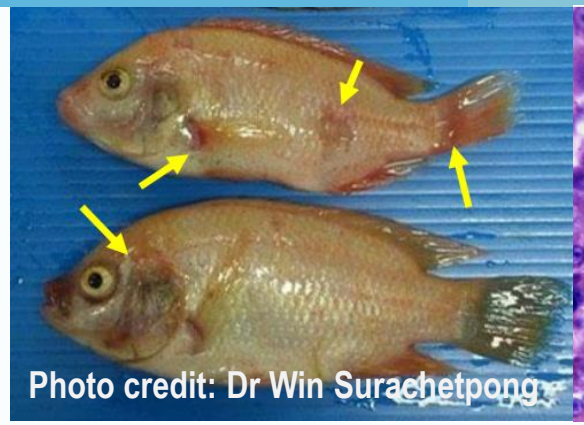


Photo credit: Dr Win Surachetpong

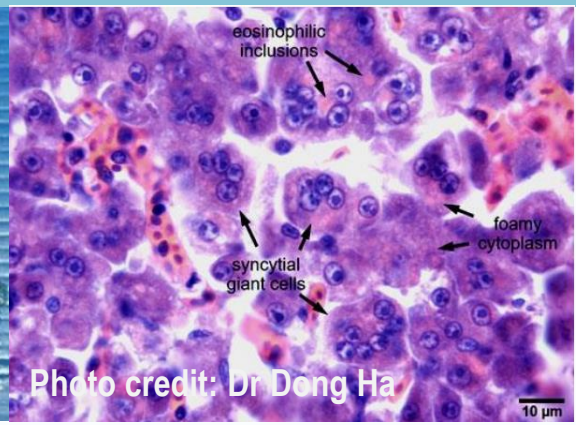


Photo credit: Dr Dong Ha

2009 — Disease (observation in the field)

2014 — Diagnosis

Still being Assessed — Adopted in OIE AAH Code

2019? — Containment (vaccine, treatment, husbandry)

? — Management (cost effective)

? — Disease Freedom

? — National and international confidence to the sector

Diseases in Aquaculture

EUS: fungi/many finfish species

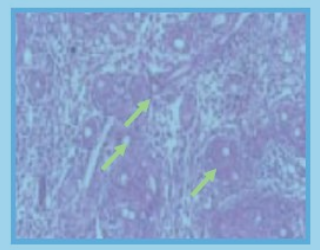
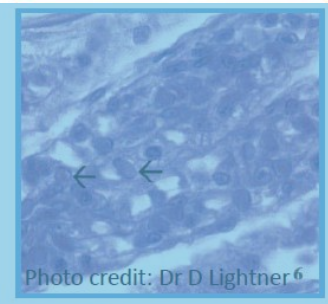


Photo credit: Dr D Lightner

Diseases in Aquaculture

WSSV: virus/shrimp



1970s

1995

? ? ?

1980s

Mid-

1997

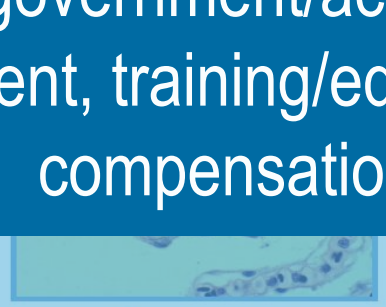
? ? ?

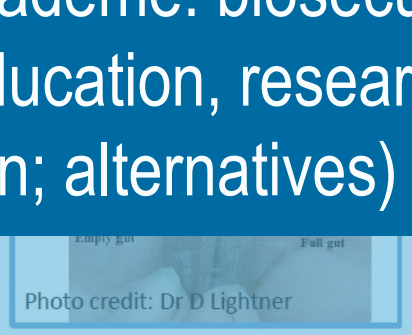
Disease (observation in the field)

National and international confidence to the sector

$$$$ losses: production, market = livelihoods, export earnings, food supply = socio-economic and environmental impacts

$$$ spent: producers/government/academe: biosecurity (policies, diagnosis, surveillance, containment, training/education, research, trade disputes, etc); compensation; alternatives)





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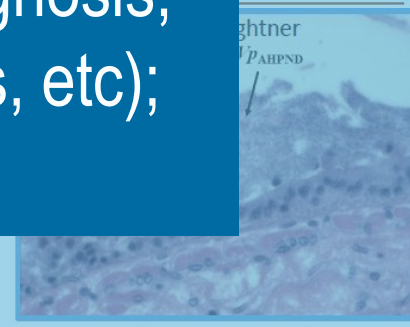


1990s

Mid 2000s

2007

2018//2019

? ? ?

Disease (observation in the field)

Diagnosis

25 March 2021

Adopted in OIE AAH Code

Containment (vaccine, treatment, husbandry)

Management (cost effective)

Disease Freedom

National and international confidence to the sector

2009

2013

2017

? ? ? ? ?

Disease (observation in the field)

Diagnosis

Adopted in OIE AAH Code

Containment (vaccine, treatment, husbandry)

Management (cost effective)

Disease Freedom

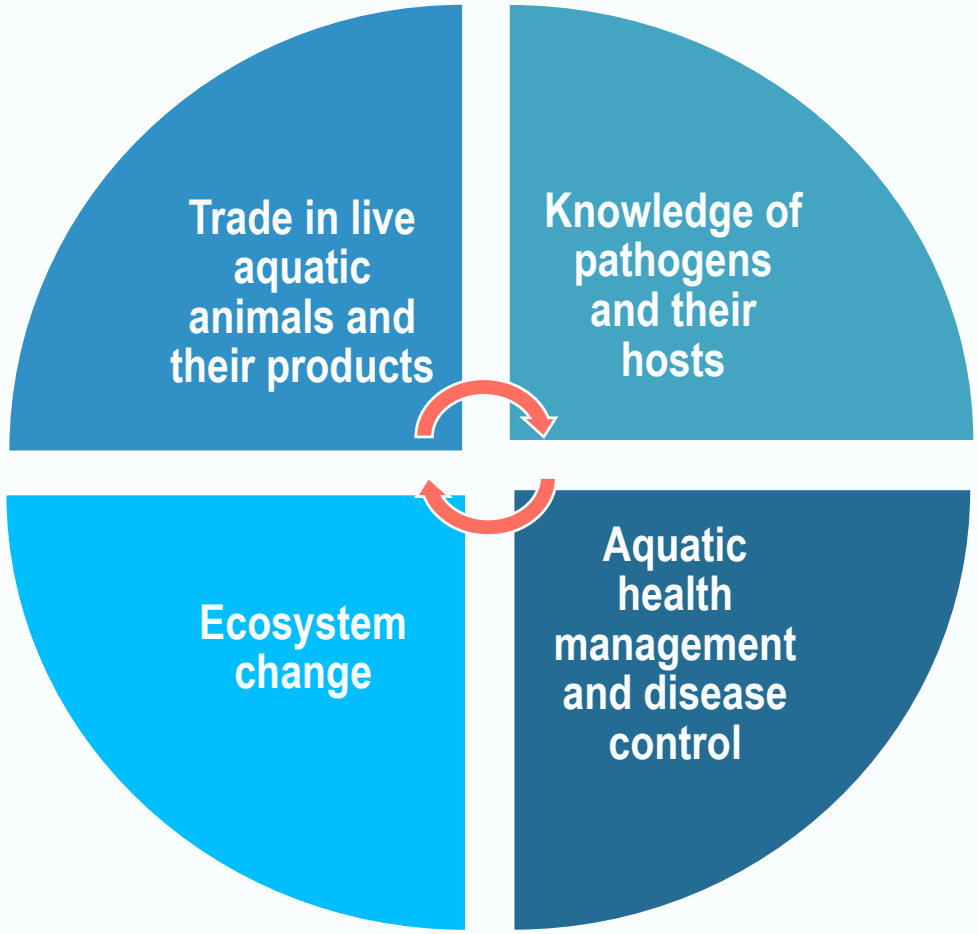
National and international confidence to the sector

Period	Species	Disease	Losses (USD)
1987-1994	Shrimp	Several pathogens	3 019 million[1]
1998-1999	Salmon	ISA	39 million[2]
2010-2017	Shrimp	AHPND	12 billion[3]
2015	Shrimp	AHPND	>26 million[3]
2017	Tilapia	Several pathogens	450 million[4]
2017	Shrimp	Several pathogens	1.6 billion[4]
2017	Oysters	Several pathogens	540 million[4]
2017	Seaweed	Several pathogens	190 million[4]

[1]Israngkura and Sae-Hae, 2002
[2]Hastings *et al*., 1999
[3]Shinn *et al*., 2018;
[4]Annual Report on Aquatic Animal Health in China, 2017

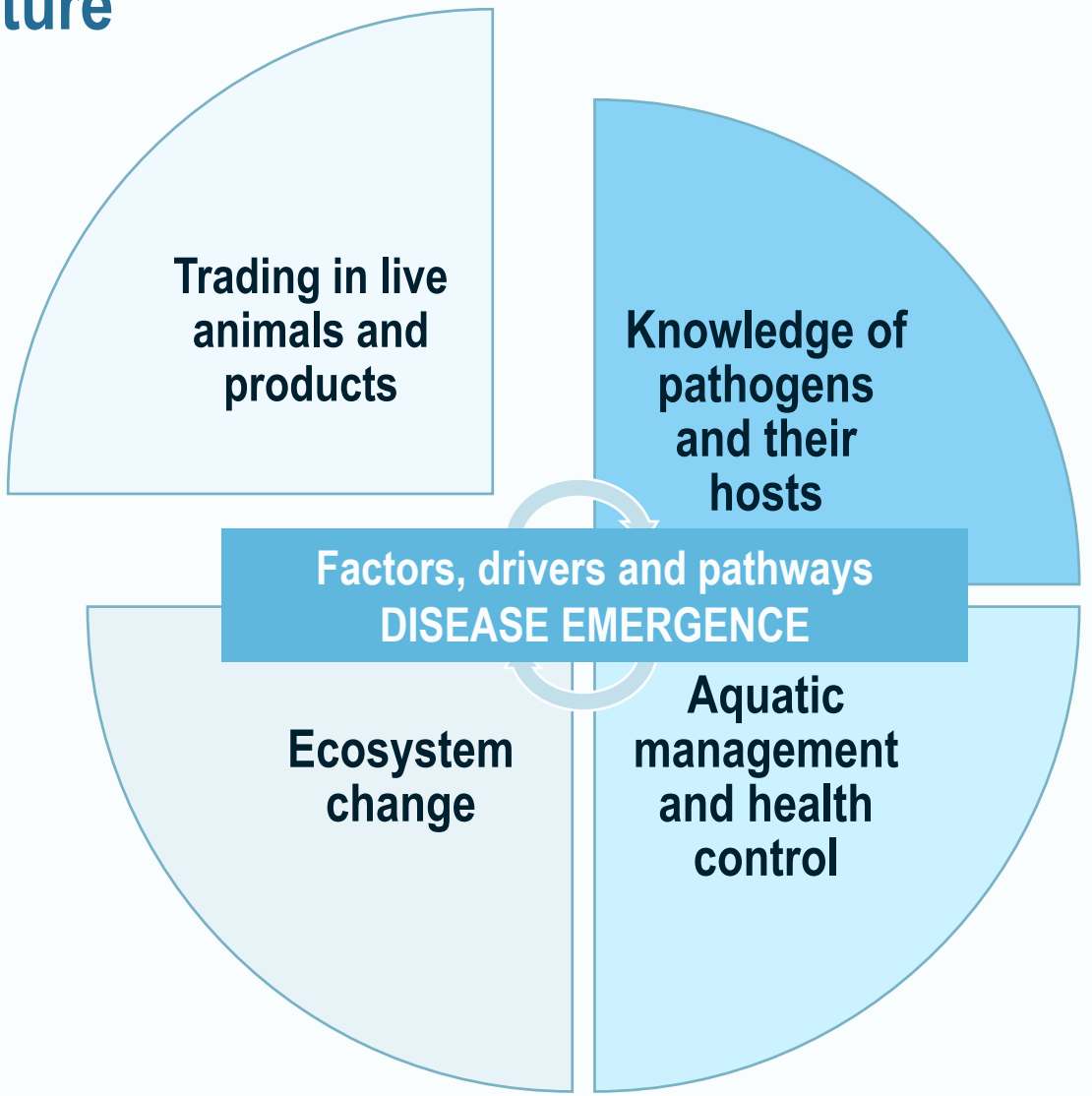
- Numerous **unmanaged disease outbreaks** with high economic losses reflect an **immature aquaculture industry**
- A **maturing aquaculture** industry requires a focus on disease prevention supported by:
  - Improved **governance**
  - Understanding **disease impacts (burdens and investments)**
- The **current approach** to disease challenges needs to be supplemented with an **economic dimension** for improved responses and more efficient resource allocation
- **Aquatic sector now engaged with the Global Burden of Animal Diseases**

Aquaculture Disease Emergence Pathways/ Drivers

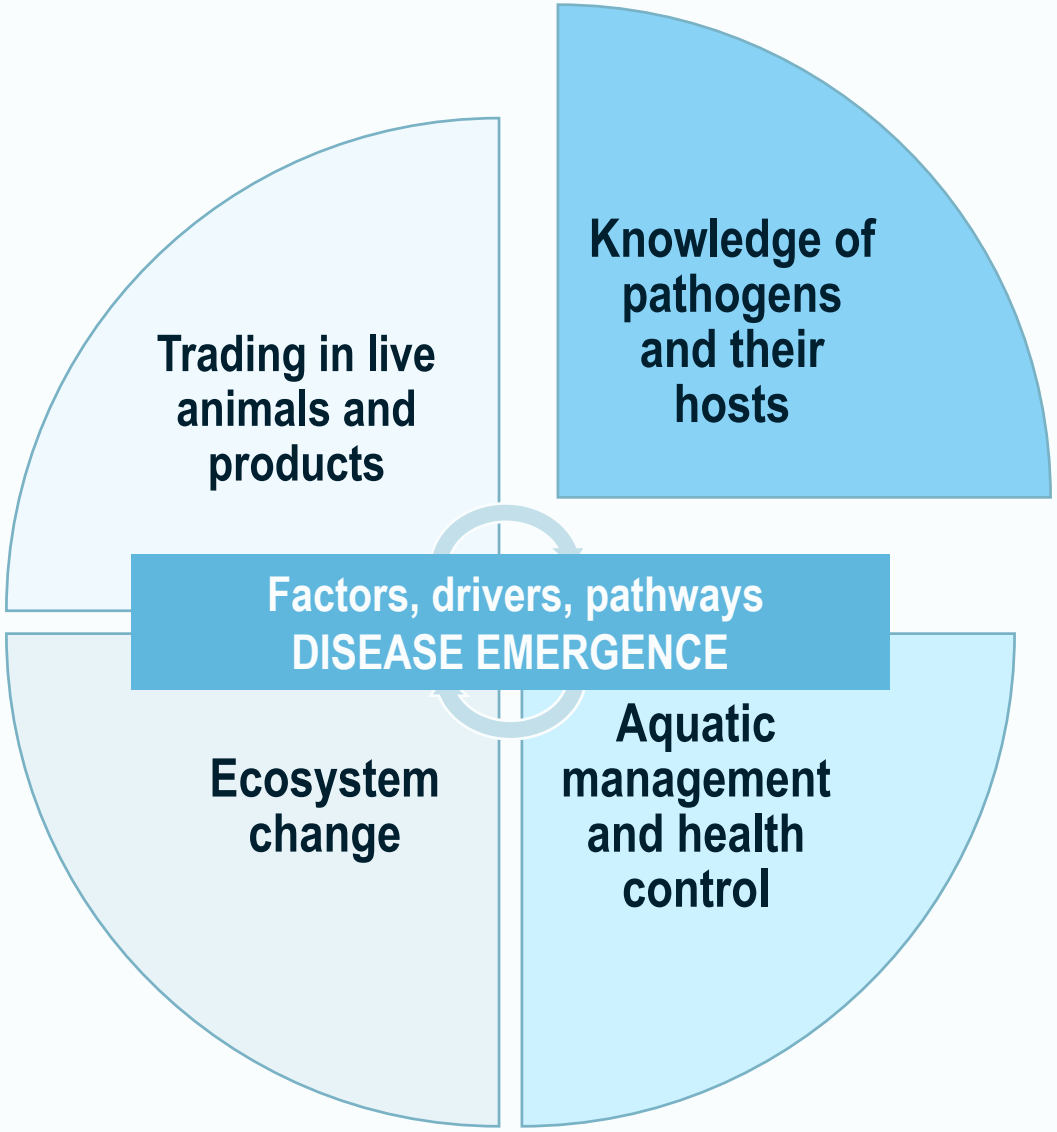


Factors, drivers and pathways to aquatic animal disease emergence in aquaculture

- Highly traded commodity (70% exposed to international trade)
- Hyper-diverse species range (>500) farmed compared to terrestrial systems
- Live animals (larvae, fry, adults) and their products (live, fresh, frozen) traded internationally
- Many species farmed outside of native range
- Invasive animals and pathogens can be traded with primary host
- Ornamental aquaculture trade is large and growing
- Some diversion to unintended usage (e.g. angling baits)

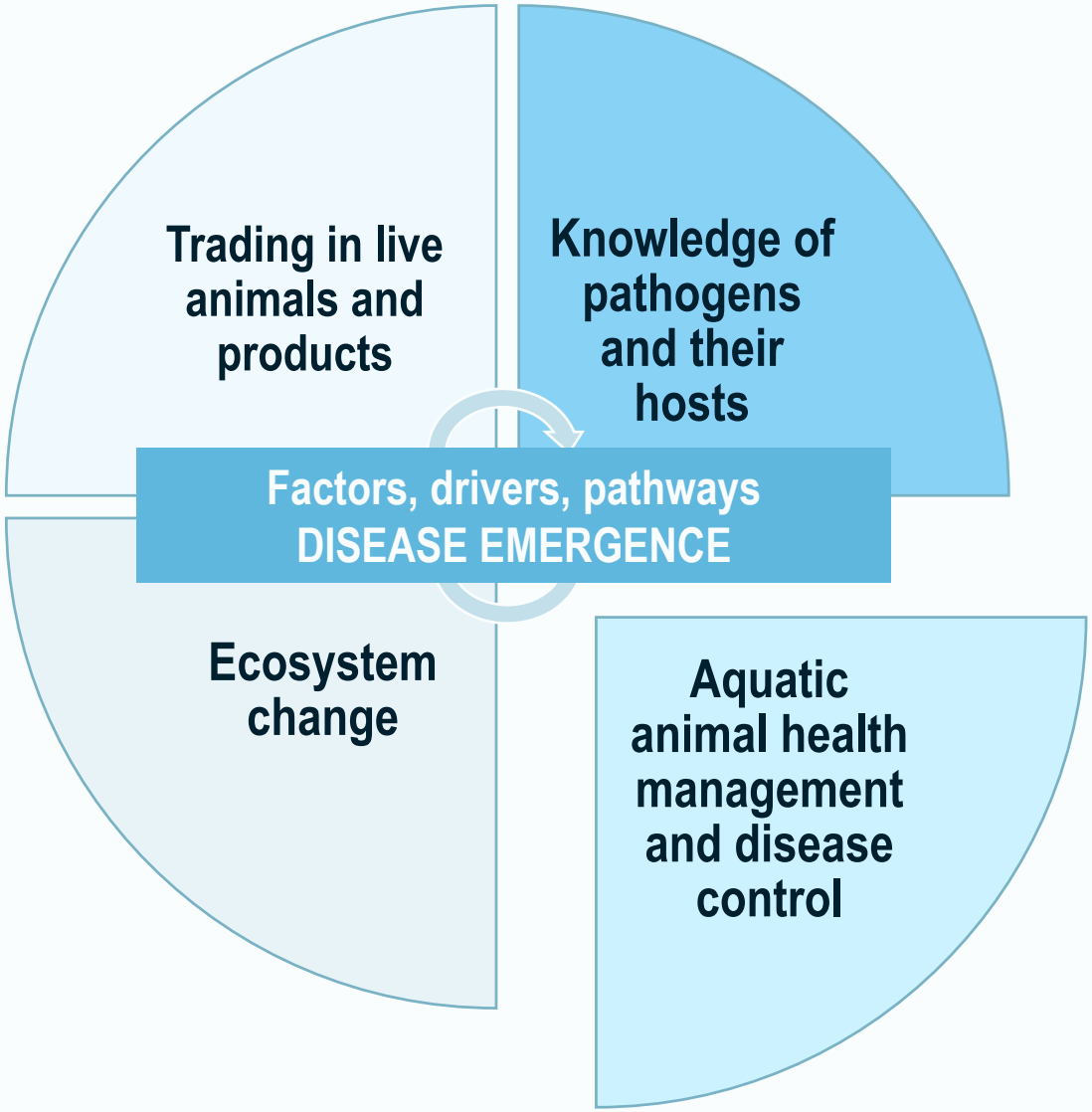


Factors, drivers and pathways to aquatic animal disease emergence in aquaculture



- The unique aquatic medium
- Slow collective awareness of new threats
- Lack of basic pathogen data (e.g. transmission)
- Lack of basic host data (e.g. immunity, genetics)
- Diagnostics focussed on known/listed diseases
- Breeding strategies not in place for many species (e.g. SPF, SPT, SPR, selective breeding)
- Misuse of stock (e.g. SPF) in some cases
- Limited availability of vaccines (fish) and other credible control options (invertebrates)

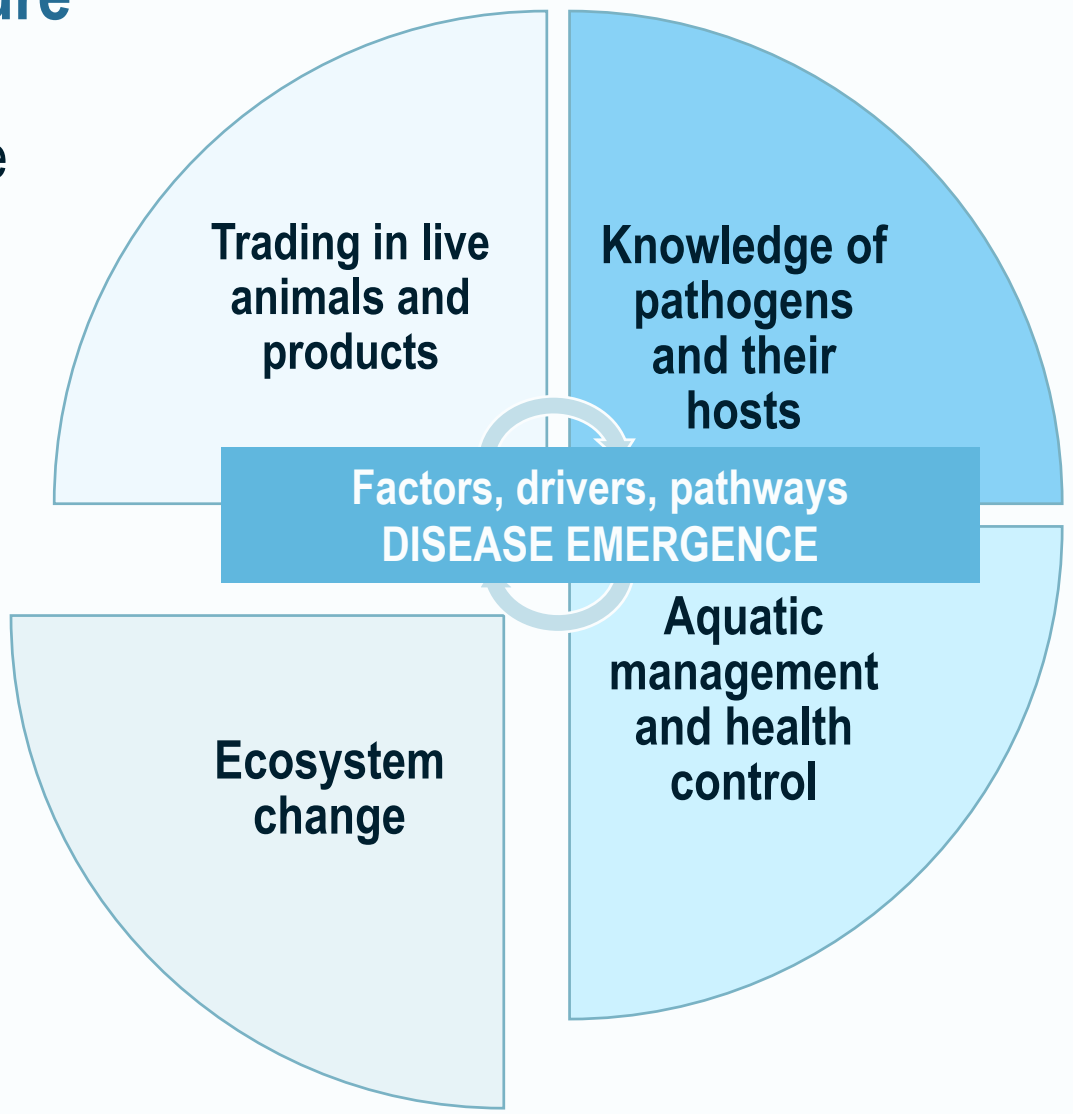
Factors, drivers and pathways to aquatic animal disease emergence in aquaculture



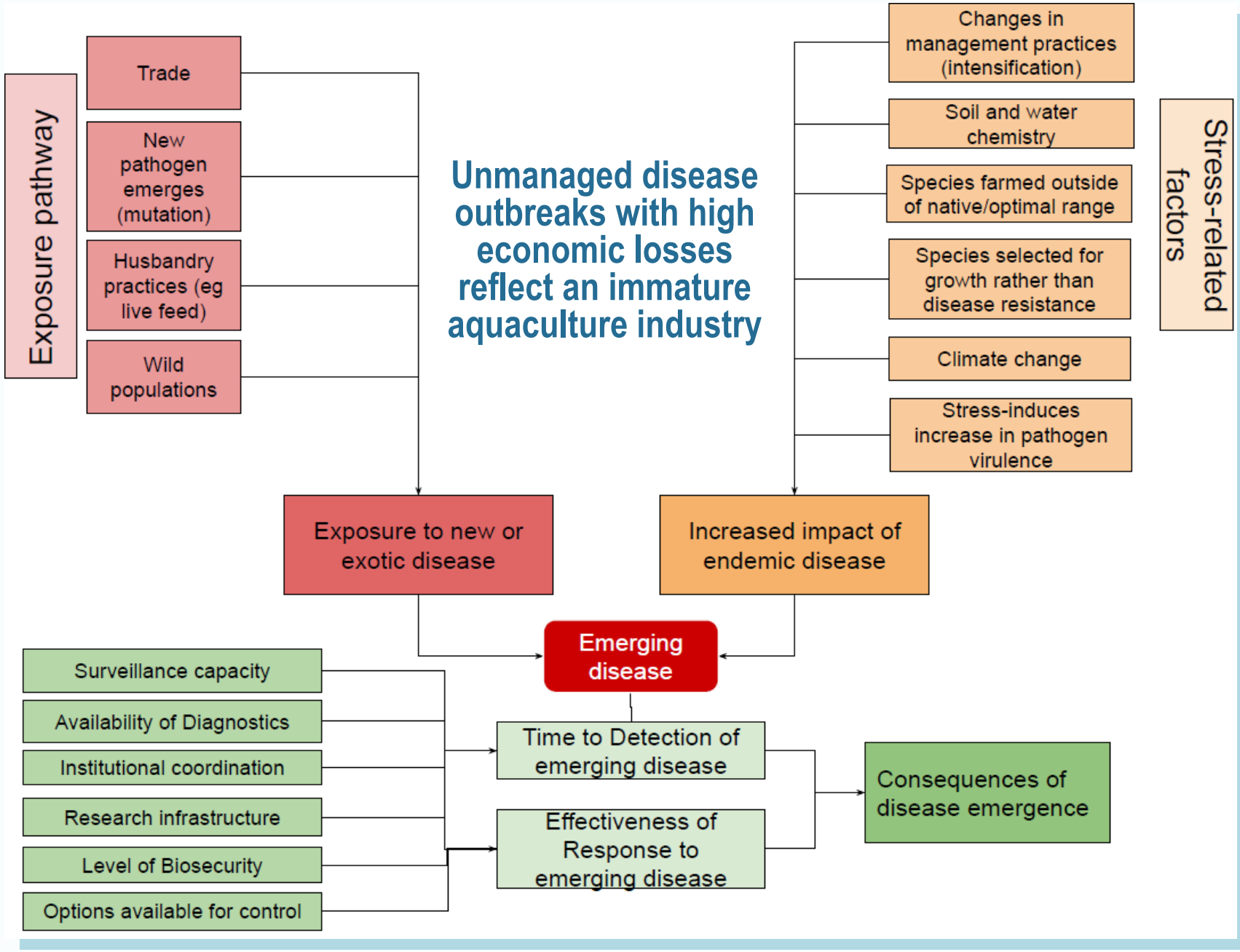
- Multiple institutions involved in AHM. The Competent Authority?
- Inadequate or poorly implemented biosecurity measures/low capacity for emergencies
- Inconsistent or weak implementation of international standards etc
- Perceived low incentive to report on known and emergent diseases (trade)
- Weak regulatory framework and public-private sector partnership working
- Mismatch between research agenda and farmer/commodity sector needs
- Few national pathogen/host inventories

Factors, drivers and pathways to aquatic animal disease emergence in aquaculture

- Physico-chemical conditions in aquaculture are often sub-optimum for host
- Aquatic hosts are cold-blooded (highly responsive to stressors)
- Animals may be farmed outside of native/optimum range and in waters in which they are naïve to native microbial hazards
- Aquatic medium is pathogen rich, diversity changes with environment conditions
- Pathogens evolve and spill-over and spill-back relative to wild populations



Aquaculture Disease Emergence Causal Web



WHAT can we do and WHEN?

Before the disease	or	after the disease?
Prevention	?	Solution
Pro-active	vs	Reactive
<$$	vs	>$$$$$$$

Progressive Management Pathway for Improving Aquaculture Biosecurity (PMP/AB)

PMP/AB refers to a **pathway** aimed at enhancing **aquaculture biosecurity** by building on existing frameworks, capacity and appropriate tools using risk-based approaches and public-private partnerships

PMP/AB is expected to result in sustainable:

- reduction of burden of disease
- improvement of health at farm and national levels
- minimization of global spread of diseases
- optimization of socio-economic benefits from aquaculture
- attraction of investment opportunities into aquaculture and
- achievement of One Health goals

PMP/AB publications:

http://www.fao.org/documents/card/en/c/cb0745en

https://doi.org/10.4060/cb0582en

http://www.fao.org/documents/card/en/c/cb0582en

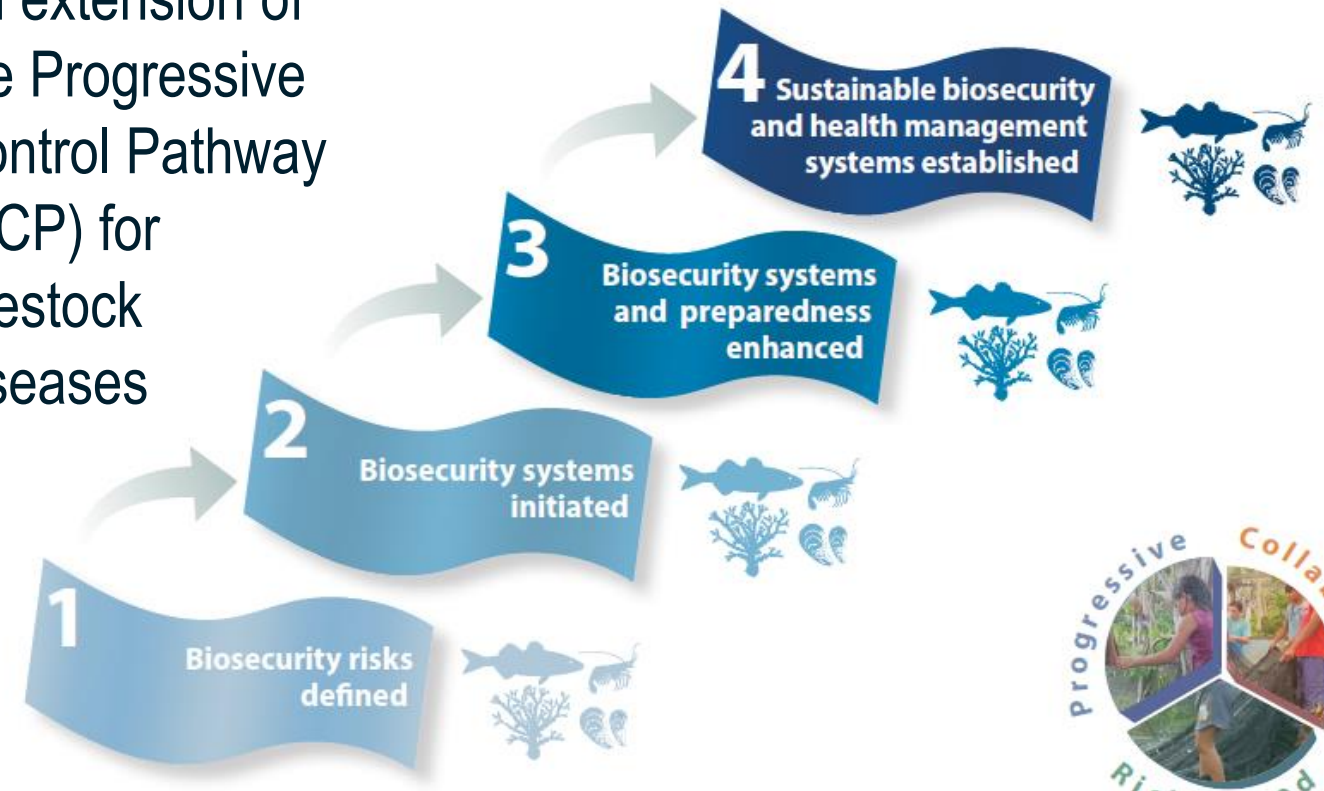
http://www.fao.org/documents/card/en/c/cb0560en

http://www.fao.org/3/ca9229en/CA9229EN.pdf (pages 190-193, SOFIA 2020)

In the context of PMP/AB: Biosecurity refers to the cost-effective management of risks posed by infectious agents to aquaculture through a strategic approach at enterprise, national and international levels with shared public-private responsibilities.

Progressive Management Pathway for Improving Aquaculture Biosecurity (PMP/AB)

An extension of the Progressive Control Pathway (PCP) for livestock diseases



Each stage has key indicators and activities

Risk assessment and emergency preparedness always present at every stage

Biosecurity action plans serve as gateway passes to move from one stage to another

Key indicators and activities

Stage 1

- Value chain stakeholder mapping
- Risk analysis: threats and critical control points identified
- **Enabling environment: Competent Authority identified, draft pathogen list, public-private PMP/AB taskforce, legislative review, aquatic health training, national laboratory**
- National and sector-level risk-based biosecurity strategies

Stage 2

- Biosecurity measures implemented
- Monitor/assess effectiveness (audits & certification)
- **Surveillance** of endemic pathogens
- ***Enabling environment: Lab capacity to support surveillance, AAHIS, legislation, national pathogen list adopted**
- Biosecurity strategies revised and enhanced, e.g strong port/border controls, rapid detection and response

Stage 3

- Revised strategies and policies implemented
- Efficient, effective outbreak management
- Existing, exotic and emerging pathogens under **continuous surveillance**
- Disease incidence and impact reduced
- **Enabling environment: Cost-benefit analysis, multi-agency taskforce, legislation for full implementation of strategies and enforcement of policies, lab capacity: rapid detection, emergency preparedness and response audit**
- Commitment from public and private stakeholders to safeguard progress including investors

Stage 4

- Activities sustained & evidence-based improvement
- **Enabling environment: Legislation reviewed and updated, zones compartments recognized by OIE (if applicable), support other countries in biosecurity development**
- Robust socio-economic situation for all (incl. small-scale producers, food security)
- National & international stakeholders have confidence in the national aquaculture & ecosystem health
- safe trade and transparency

Surveillance is the systematic process of data collection, collation, analysis, and dissemination aimed at ascertaining the health status of a given population of aquatic animals. The information gained guides disease control activities and appropriate measures to prevent or stop disease spread.

National Strategy on Aquatic Animal Health within the PMP/AB

http://www.fao.org/3/a1108e/a1108e00.pdf (FAO, 2007)

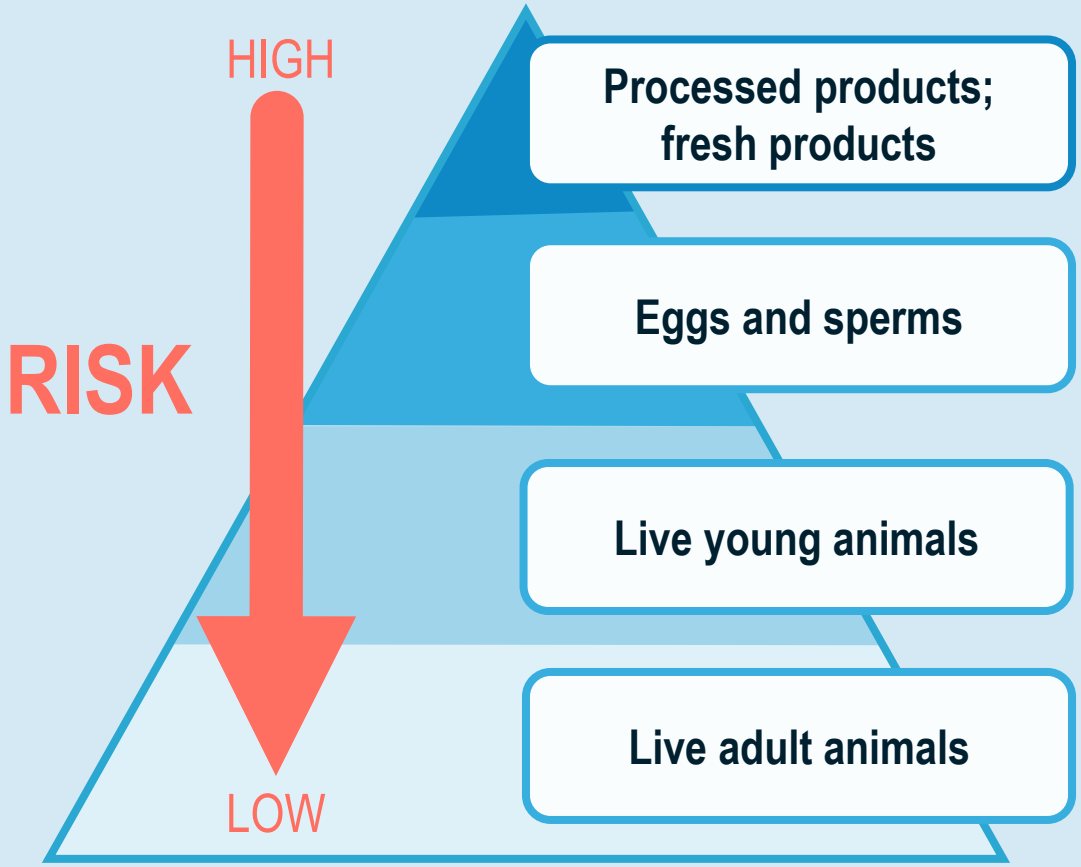
Policy, legislation and enforcement	Risk analysis	Pathogen list	Border inspection and quarantine	Disease diagnostics	Farm-level biosecurity and health management
Use of veterinary drugs and avoidance of antimicrobial resistance	Surveillance, monitoring and reporting	Communication and information system	Zoning and compartmentalization	Emergency preparedness and contingency planning	Research and development
	Institutional structure	Human resources and institutional capacity	Regional and international cooperation	Ecosystem Health	

Stage 1 Stage 2 Stage 3

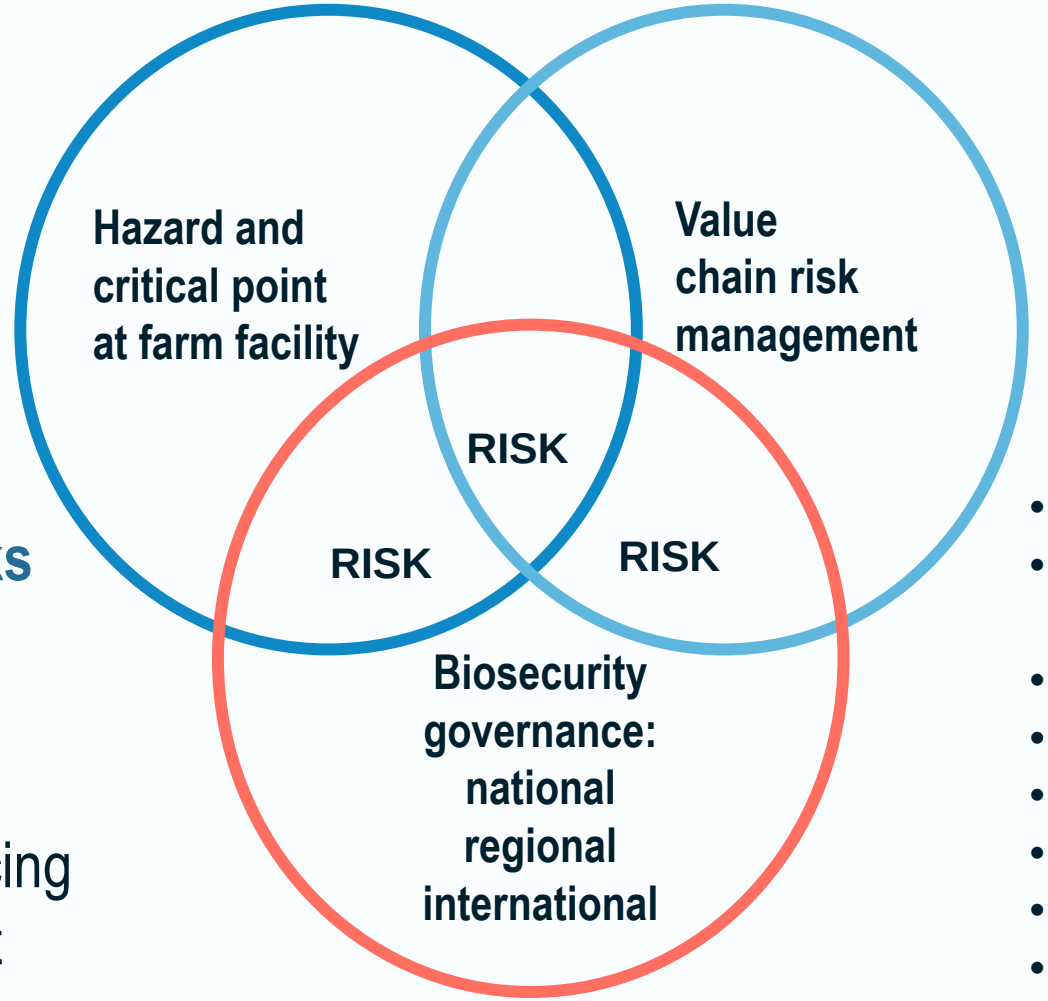
✓ Risk-based ✓ Main component of PMP/AB ✓ Activities continuously applied/improved in higher Stages

Risk hierarchy (Dr Chris Baldock)

Fish is currently the most traded commodity



- hatchery
- nursery
- grow-out
- processing plants
- even markets



- risky areas in the value chain
- supplier of inputs and products
- trading practices

Managing the risks at all levels of the aquaculture chain, identifying critical points and introducing the interventions at that stage

- enabling environment
- policies, legislation and enforcement
- AAH services
- extension services
- compliance: GAP
- CoC, trading standards
- certification schemes
- fisheries/veterinary authorities
- PMP/AB

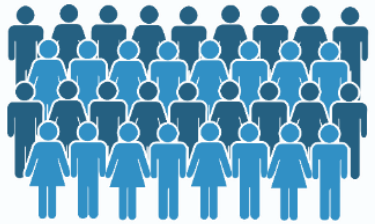
Under-the-water Animal Health and Biosecurity

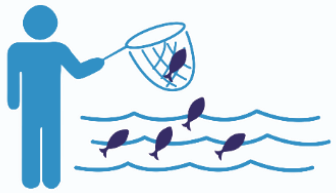
Identify the risk: understand the hazards: HACCP thinking

Have a plan	Hatchery Wild population Environment People	Nursery Grow-out Environment People	Feed Management Environment People	Harvest Environment People	Processing Environment People	Market Environment People	Table Environment People

Good aquaculture practices	Manage the risk	Good biosecurity practices

10-point best biosecurity practices	Have a plan





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SUSTAINABLE DEVELOPMENT GOALS

10-point best biosecurity practices

TCP/INT/3707: Strengthening biosecurity (policy and farm level) governance to deal with Tilapia lake virus

1. Know your fish
2. Know your pathogens
3. Know your systems
4. Know your contamination pathways
5. Source healthy seeds
6. Maintain good husbandry
7. Use antimicrobials in a prudent and responsible way
8. Respect food safety
9. Respect the environment
10. Have a biosecurity plan

Key Messages

- Biosecurity is one of the most challenging if not the most significant aquaculture challenge; should be parallel (not behind) to any aquaculture development
- Equivalent to risk; understanding of these risk is very important
- Biosecurity measures are less expensive when put in place proactively and preventatively, and are more expensive as solution-based, reactionary responses to outbreaks
- Biosecurity plan: generic principles but needs to fit the local conditions

Key Messages

- Effectiveness of biosecurity measures - practitioners, industry; science explained by academe; governance authorities facilitates and disseminates
- Holistic approach not only at the farm facility and looking at the whole value chain from seed source to market, each segment has some risk element, risk-based thinking is needed and should be an everyday practice
- Aquaculture: cannot cut and paste because dependent on local conditions
- PMP/AB offers a big-picture and farm-level perspectives and uses risk-based thinking and collaborative approach (governance authorities, industry and academe)

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

Thank you for your attention!

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TCP/INT/3707:
Strengthening biosecurity (policy and farm level) governance to deal with Tilapia lake virus

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