

Evaluating the Effectiveness of Aquatic Animal Health Programs in Preventing Disease Introductions: A Canadian Freshwater Case Study



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Introduction

The National Aquatic Animal Health Program (NAAHP)

- **Purpose:** A policy to protect Canadian wild and farmed finfishes (among other aquatic taxa) from international (and domestic) infectious aquatic animal diseases by mitigating the risk of introduction and spread
- To protect domestic aquatic health and biosecurity, and meet international trade regulations

Introduction

The National Aquatic Animal Health Program (NAAHP)

- Canada's 2005 response and obligation to the World Organisation for Animal Health (OIE) (180 member countries)
- Authority under *Health of Animals Act* (1990) and *Health of Animals Regulations* (HAR)
- Regulated by Canadian Food Inspection Agency (CFIA), Supported by Fisheries and Oceans Canada (DFO)

Introduction

CFIA's Mitigation of Risk

- Lists susceptible species and associated diseases of concern
- Diseases are classified as reportable (10) or immediately notifiable (4)

Introduction

NAAHP: Reportable Diseases

Reportable Disease	# of listed susceptible species	Present in Canada
Ceratomyxosis (<i>Ceratomyxa shasta</i>) (C)	8	Yes
Epizootic haematopoietic necrosis (EHN)	9	No
Infectious haematopoietic necrosis (IHN)	30	Yes
Infectious pancreatic necrosis (IPN)	46	Yes
Infectious salmon anaemia (ISA)	10	Yes
Koi herpesvirus disease (KHD)	3	Yes
Spring viraemia of carp (SVC)	16	Yes
Viral haemorrhagic septicaemia (VHS)	87	Yes
Whirling disease (<i>Myxobolus cerebralis</i>) (WD)	9	Yes (August 2016)
White sturgeon iridoviral disease (WSID)	0	Historically suspected, never confirmed

<http://www.inspection.gc.ca/animals/aquatic-animals/diseases/reportable/eng/1322940971192/1322941111904>

Introduction

NAAHP: Immediately Notifiable Diseases

Immediately Notifiable Disease	# of listed susceptible species	Present in Canada
Epizootic ulcerative syndrome (<i>Aphanomyces invadans</i>) (EUS)	89	Yes (very rare)
Gyrodactylosis (<i>Gyrodactylus salaris</i>) (G)	7	No
<i>Oncorhynchus masou</i> virus disease (OMVD)	9	No
Red sea bream iridoviral disease (RSIVD)	42	No

<http://www.inspection.gc.ca/animals/aquatic-animals/diseases/immediately-notifiable/eng/1322942180960/1322942280860>

Introduction

CFIA's Mitigation of Risk cont.

- Regulates importation of these fishes via most vectors (including research)
- Regulations include import permits, quarantine
- Exemptions: 13 “pet” or “personal use” species, and EUS-susceptible only species

Introduction

Risk Mitigation Concerns

- No evidence of risk assessments
- Listings not necessarily within Canadian context
- Pet/aquarium trade (**AT**), “personal use”, and live food trade (**LFT**) vectors not fully regulated; while research (**R**) and others regulated
- Probability of release into the wild (Marson *et al.*, 2009a,b): **2% AT** (3% water garden), **LFT release known to occur but probability unknown, ~0% R**
- Overall lack of transparency and consistency

Introduction

Aim of Study

- To assess the ability of NAAHP to be effective in fulfilling its mandate
- Through risk assessment of arrival pathways and overall probability of introduction
- Comparison of Canada's efforts to other OIE member countries

Methods

Creating a Comprehensive List

- Amalgamated host species-disease listings from NAAHP, HAR, OIE into one comprehensive list

Methods

Risk Assessment

- **Risk = Prob. of Intro. (Arrival x Survival x Establish x Spread) x Magnitude of Consequences** (Mandrak & Cudmore 2015; Mandrak *et al.*, 2012)
- Determined species with arrival pathways, including import volume (Mandrak *et al.*, 2014)
- Included species' degree of climate match (Mandrak *et al.*, 2014)
- Noted which agencies (NAAHP, HAR, OIE) recognized/listed each host species and disease

Probability of Introduction

- For each disease

$$P_{\text{Introduction}} = P_{\text{Arrival}} \times P_{\text{Survival}} \times P_{\text{Establish}} \times P_{\text{Spread}} \times \text{Magnitude of Consequences}$$

- P_{Arrival} (by pathway) = Sum of volume of host species imported
x $P_{\text{release into wild}}$

Sum of volume (# ind.)
High (2) = Greater than 1,000,000
Medium (1) = 1 to 1,000,000
Low (0) = 0

$P_{\text{release into wild}}$
AT (1)
LFT (1)
R (0)

Methods

Probability of Introduction cont.

- P_{Survival} = suitable temperature range for disease (literature review)

Water temperature match (°C)		
High (3) = 0-30	Medium (2) = 0-15 or 15-30	Low (1) = < 5 or > 30

- $P_{\text{Establish}}$ = # of native or naturalized hosts (known from list)

Probability of Introduction cont.

- $P_{\text{Spread}} = \sum (\text{Distribution}_n)$, n = number of host species

Distribution of native/naturalized host(s)
Narrow (1) = est. in only 1 province/territory or limited, disjunct distributions in 1+
Moderate (2) = est. in more than 1, but less than 7 provinces/territories
Widespread (3) = est. in 7 or more provinces/territories

- **Magnitude of Consequences** – known to be high

Results

Risk Assessment: VHS Example

Disease	Pathway	P_{Arrival} (Import Vol. x P. of Release)	\times P_{Survival}	\times $P_{\text{Establish}}$ (# hosts)	\times P_{Spread}	\times Magnitude of Consequences	= Relative Risk
VHS	AT	5,075,351 ind. \rightarrow $2 \times 1 = 2$	2.5	46	105	2	48,300
	LFT	296,847 ind. \rightarrow $1 \times 1 = 1$	2.5	46	105	2	24,150
	R	? ind. \rightarrow $? \times 0 = 0$	2.5	46	105	2	0

Import volume (# ind.)
High (2) = > 1,000,000
Medium (1) = 1 to 1,000,000
Low (0) = 0

$P_{\text{Release into wild}}$
AT (1)
LFT (1)
R (0)

P_{Survival}
High (3) = 0-30°C
Medium (2) = 0-15°C or 15-30°C
Low (1) = < 5°C or > 30°C

P_{Spread} Σ (Distribution _n)
Narrow (1) = 1 or limited, disjunct 1+
Moderate (2) = > 1, but < 7 prov/terr
Widespread (3) = 7+ prov/terr

Results

Overall Probability of Introduction

Disease of Concern	Arrival Pathway	Relative Risk	Cumulative Relative Risk
EUS	AT	2,200	4,400
	LFT	2,200	
RSIVD	AT	84	168
	LFT	84	
EHN	AT	120	120
	LFT	---	
IPN	AT	3,600	5,400
	LFT	1,800	
KHD	AT	200	300
	LFT	100	
SVC	AT	1,632	3,264
	LFT	1,632	
VHS	AT	48,300	72,450
	LFT	24,150	

Discussion

Key Findings

- **44** out of 184 listed host species **in an arrival pathway**
- Top three vectors for host species: **AT** (63.6% of 44), **LFT** (40.9%), **R** (29.5%)
- Top three hosted diseases: **EUS** (59.1% of 44), **SVC** and **VHS** (22.7% each)
- **9** out of 13 “**pet**” **exempt** species **in an arrival pathway**; and **17 EUS-only**
- Cumulative Relative Risk by vector: **AT** (56,136), **LFT** (29,966), **R** (0)
- Top three diseases based on Cumulative Relative Risk: **VHS** (72,450), **IPN** (5,400), **EUS** (4,400)
- **All 7 diseases** with known host species in an arrival pathway are a **risk**

Discussion

Case Study: Wiper (*Morone saxatilis* x *Morone chrysops*)

- Not recognized by CFIA (OIE-only)
- Confirmed susceptible to RSIVD (not present in Canada)
- Imported via LFT in significant volumes (78,593 kg or 157,186 ind./yr)
- Family and species climate match, not established in Canada
- 3 native/naturalized hosts to RSIVD with moderate to wide distribution
- LFT release rate unknown, but Wipers have been caught in the Great Lakes



Discussion

NAAHP Policy Review

- **Effective policy** = best, contextual science; clear and accurate communication, and enforceable actions and goals
- **NAAHP policy:**
 - No publically available/known risk assessments (RA)
 - Information not updated regularly
 - Lack of clear and accurate communication, and consultation
 - Lack of transparency
 - Discrepancies
 - Lack of enforceability

Global Comparison

- **United States** – *Risk Tolerant*

- Recommendations, not regulations
- Lack of action
- Import regulations related to 2 diseases (soon 3)

 **Canada**

- **Australia** – *Risk Neutral*

- RAs available, transparent, lots of public resources
- Prohibits importation of fishes for consumption, aquaculture, pets
- Permits importation for aquarium trade (largely unrestricted)

- **New Zealand** – *Risk Adverse*

- No exemption policy (mandatory import permit and quarantine)
- RAs available, relatively transparent, seeks public consultation

Recommendations

- Comprehensive risk assessment of diseases and vectors needed
- “Pet” exemptions not defensible from a risk perspective
- Need a balance between regulation resources (e.g. enforcement) and risk



Thank you! Questions?

