

# Organisms in trade: Pathogens and pathways

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June 4, 2014

Great Lakes BIOTIC Symposium



UNIVERSITY OF MINNESOTA  
College of Veterinary Medicine  
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**Minnesota Aquatic Invasive Species  
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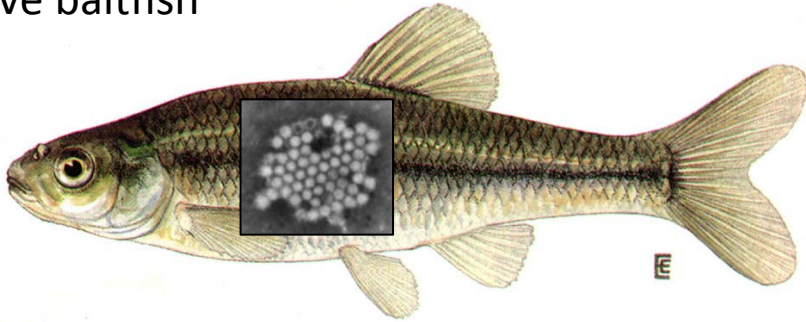


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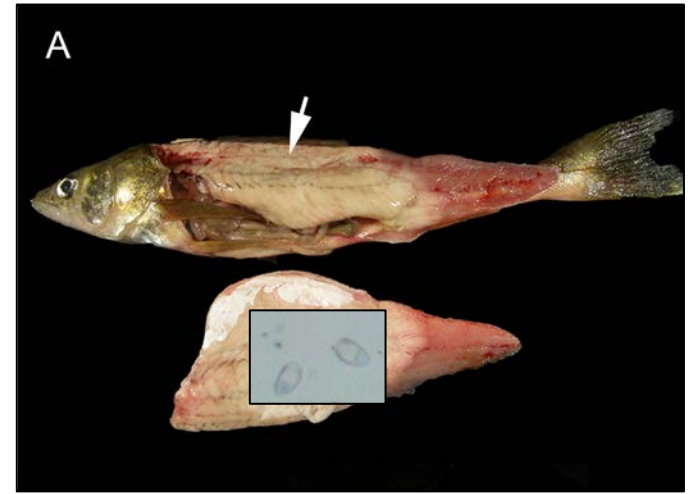
**Can pathogens be spread by  
organisms in trade?**

# We know there are pathogens

Live baitfish



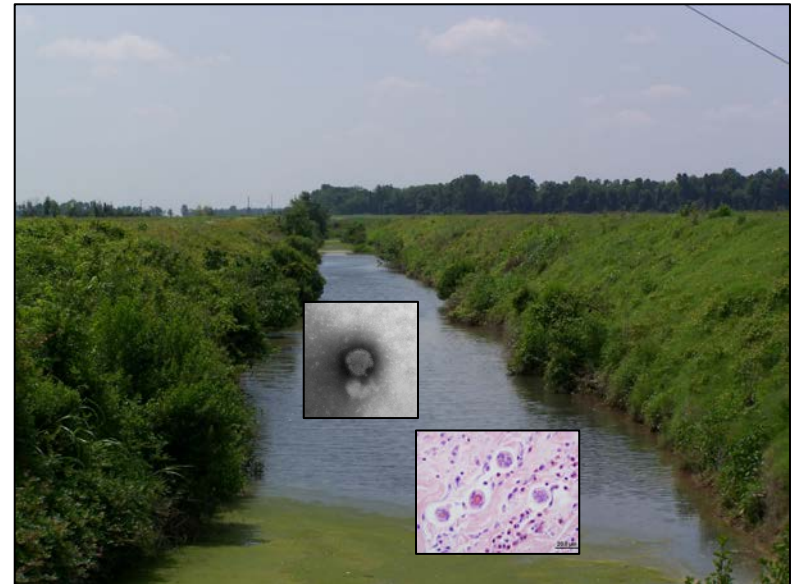
Live specimen release



Aquarium trade



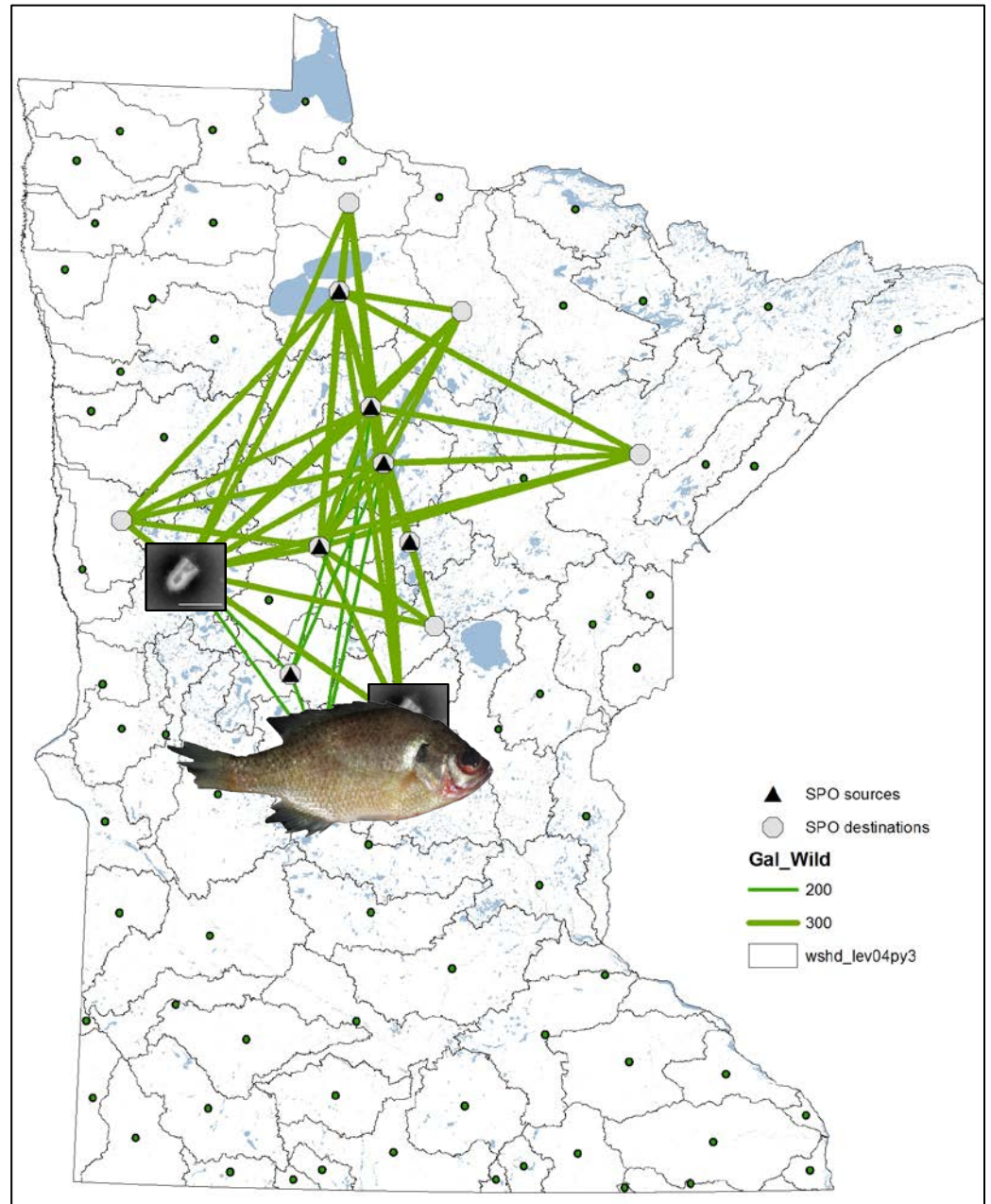
Aquaculture



**We know  
there are  
pathways**

Wild spottail shiner  
network for two  
harvesters

What if they were  
infected with VHSV??



# Risk factors for the introduction of VHSV in the Great Lakes region

VHSV Expert Panel. 2010. Veterinary Preventative Medicine 94:128-139.

Risk factor	Response category	Median	Q1	Q3	sqrtMedian	sqrtQ1	sqrtQ3
Hydrologic connectivity	Connected, with fish movement	10.00	6.00	12.00	3.16	2.45	3.46
	Downstream, no fish movement	2.00	1.00	3.20	1.41	1.00	1.79
	Upstream, no fish movement	0.50	0.40	1.00	0.71	0.63	1.00
	No connection	0.10	0.07	0.23	0.32	0.27	0.48
Linear distance	<100 km	6.25	4.92	14.25	2.50	2.22	3.77
	100–500 km	1.00	1.00	1.33	1.00	1.00	1.15
	>500 km	0.15	0.06	0.20	0.39	0.25	0.45
Known-susceptible species	Yes, with known congregation areas	4.00	2.12	15.00	2.00	1.46	3.87
	Yes, but no known congregation areas	1.50	1.25	3.00	1.22	1.12	1.73
	No	0.06	0.02	0.10	0.24	0.12	0.32
Conducive water temperatures	Yes, cool to cold water	2.25	1.40	6.00	1.50	1.18	2.45
	No	0.22	0.12	0.60	0.47	0.34	0.77
Fomite exposure	Yes, shared traffic or wastes	5.00	2.00	10.00	2.24	1.41	3.16
	Yes, but limited by education or regulation	1.00	1.00	1.60	1.00	1.00	1.26
	No	0.15	0.06	0.44	0.39	0.25	0.67
Live fish transfer, bait	Yes, without testing	7.00	4.50	15.00	2.65	2.12	3.87
	Yes, with testing	1.00	0.40	1.20	1.00	0.63	1.10
	No: transfers prevented	0.12	0.08	0.23	0.34	0.28	0.48
Live fish transfer, culture/stock	Yes, without testing	6.00	3.20	13.00	2.45	1.79	3.61
	Yes, with testing	1.00	0.50	1.33	1.00	0.71	1.15
	No: transfers prevented	0.15	0.08	0.50	0.39	0.29	0.71
Frozen fish Transfer	Yes, without testing	6.00	1.33	9.00	2.45	1.15	3.00
	Yes, with testing	1.00	0.50	1.00	1.00	0.71	1.00
	No: transfers prevented	0.33	0.10	0.75	0.58	0.32	0.87
Regulatory framework	Sufficient	0.64	0.33	1.00	0.80	0.58	1.00
	Insufficient	1.80	1.00	2.33	1.34	1.00	1.53

# Examples of (potential) pathogen spread via organisms in trade

1. Concern in Great Lakes region
2. Easily transmissible
3. Probable past and/or future trade pathway



# Aquarium Trade



## Koi Herpes Virus

- Highly lethal virus to naïve koi/common carp
- Intentionally infected-recovered to make ‘immune’
  - Primarily done in Israel, sold around world
  - Survivors can shed virus!
- Spread to many koi farms, ponds, and wild

## Largemouth Bass Virus

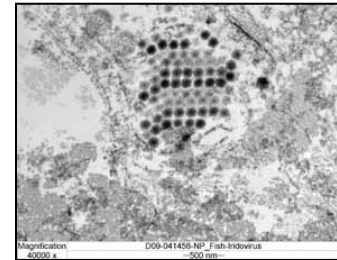
- Major disease of LMB in SE USA
  - Recent mortality event of other Centrarchid species
- Likely introduced via aquarium fish in Florida



# Aquarium Trade

## Banggai Cardinalfish iridovirus

- Repeated 100% mortality of purchased fish
- Likely post-collection transmission at export center
  - High stress, multiple species



## Sturgeon herpes virus-3

- Major lesions and eventual death in Lake Sturgeon
- Recent introductions of smaller LS
- Source unknown

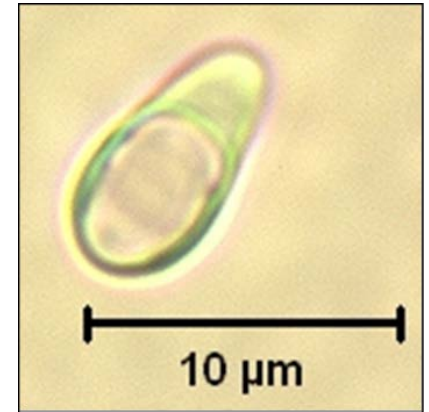




# Baitfish Trade

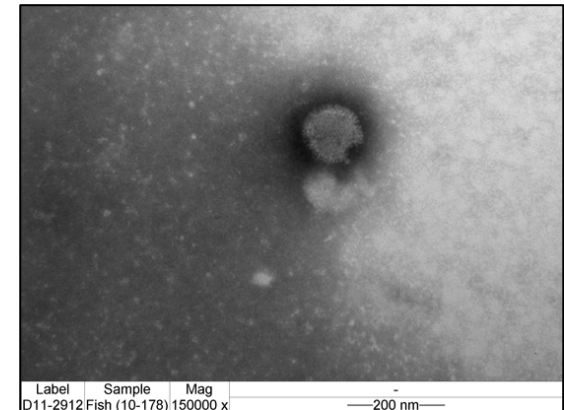
## Ovipleistophora ovariae

- Sterilizes golden shiners
- First found in AR in 1960s



## Novel viruses

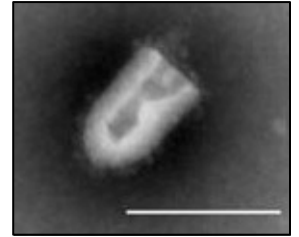
- UW-La Crosse survey and MN VDL
- 10+ new viruses (and counting...)
- Largely unregulated



# *Frozen* Baitfish Trade

## Viral hemorrhagic septicemia

- Most serious disease of freshwater fish in USA
  - First identified in Great Lakes in 2003
  - Limited to wild fish in Great Lakes region
- Source unknown
  - Frozen baitfish?
  - Ballast water?
- Live fish and fomite transfer is high risk
- Current management:
  - Limit spread



# Aquaculture Trade

## White sucker bunyavirus

- Routinely found in several apparently healthy white sucker populations
- Transmissible to muskellunge, high mortality

## Fathead minnow picornavirus

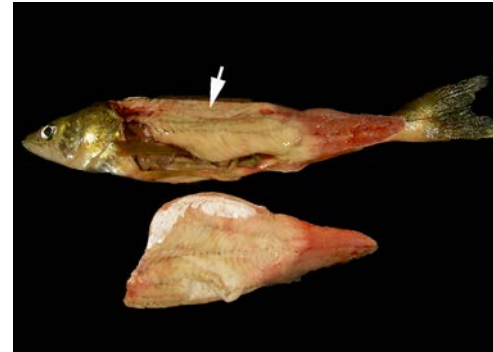
- First isolated: IL, Now: MN, MT, WI
  - Fathead minnow and brassy minnow
- Farm and wild populations positive
- No clinical disease?
- Transmissible to walleye, no known disease



# Aquaculture Trade

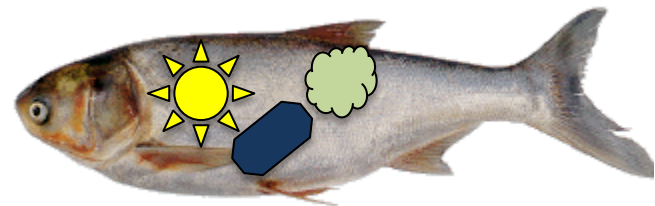
## Heterosporis spp.

- Intracellular muscle parasite
- First identified in MN and WI in 2000
- Introduced via aquarium trade?
- Potential transmission via walleye or baitfish



## Invasive carp

- ???
- Baseline health to be established
- Send me sick carp!

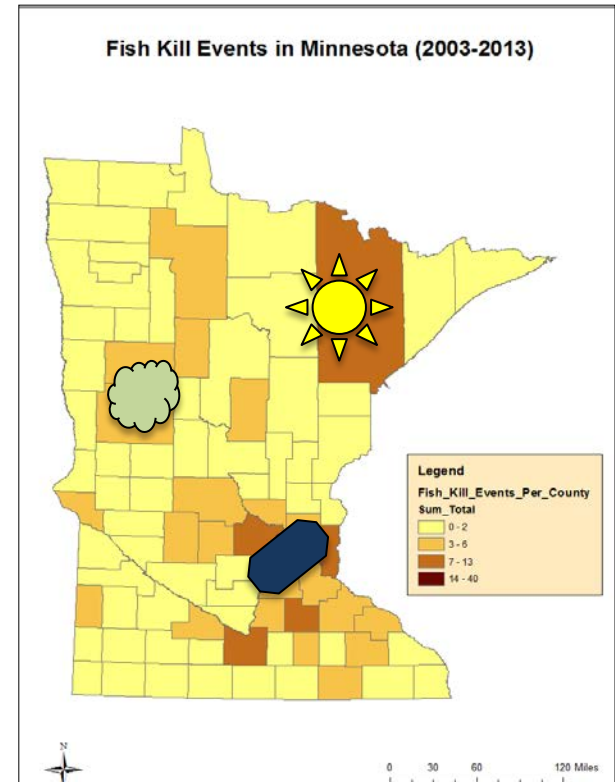


# Fsh



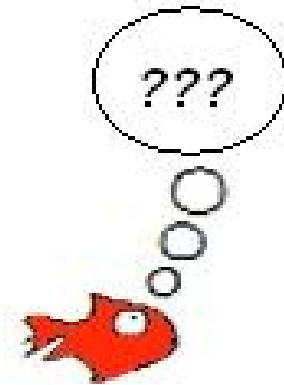
# Not convinced?

- Undiagnosed fish kills
  - 350+ reported in MN from 2003-2013
    - Estimated 10% reported
  - Can not rule out potential invasive pathogens



- Will all pathogens cause problems?
  - No, don't panic!
  - NEED risk assessment specifically for pathogens

# What can we do about it?



**Emerging disease = Invasive species**

# Control Options

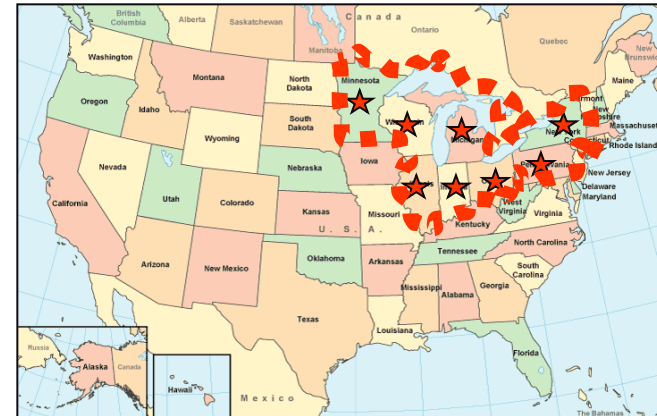
- Establish risk tolerance
- Involve all stakeholders
  - Essential for pathway intervention
- Maintain status quo
  - How effective has it been?
  - Consider long-term collateral damage from pathogens





# Control Options

- Regulatory intervention
  - Selective trade restrictions
    - VHS
      - USDA-APHIS, swift and severe trade restrictions in 2006
      - No consensus on Final Rule, removed from list in 2014
      - Plethora of state regulations now in place
  - Complete prohibition
    - Baitfish
      - Minnesota and Maine: No import
      - Michigan: No export



# Interrupt Pathway

- Testing, testing, testing
  - Pre-VHS, testing limited to salmonids
  - Post-VHS: All susceptible species must be inspected when moving between state lines
    - Intrastate testing for additional assurance
    - Slow, labor intensive, expensive
  - Targeted surveillance testing
    - Establish baseline
  - Challenge: What and how to test??
- Visual exam, report and/or cull



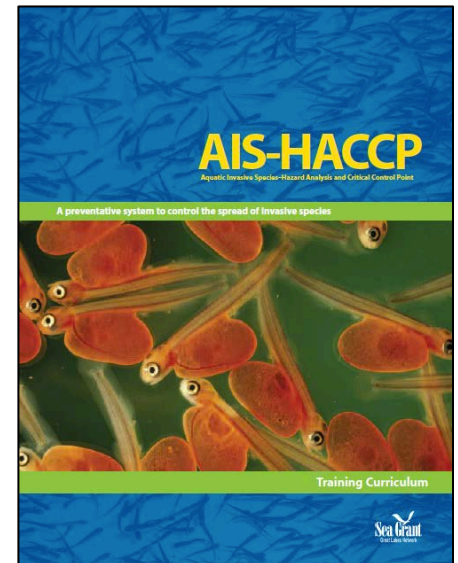
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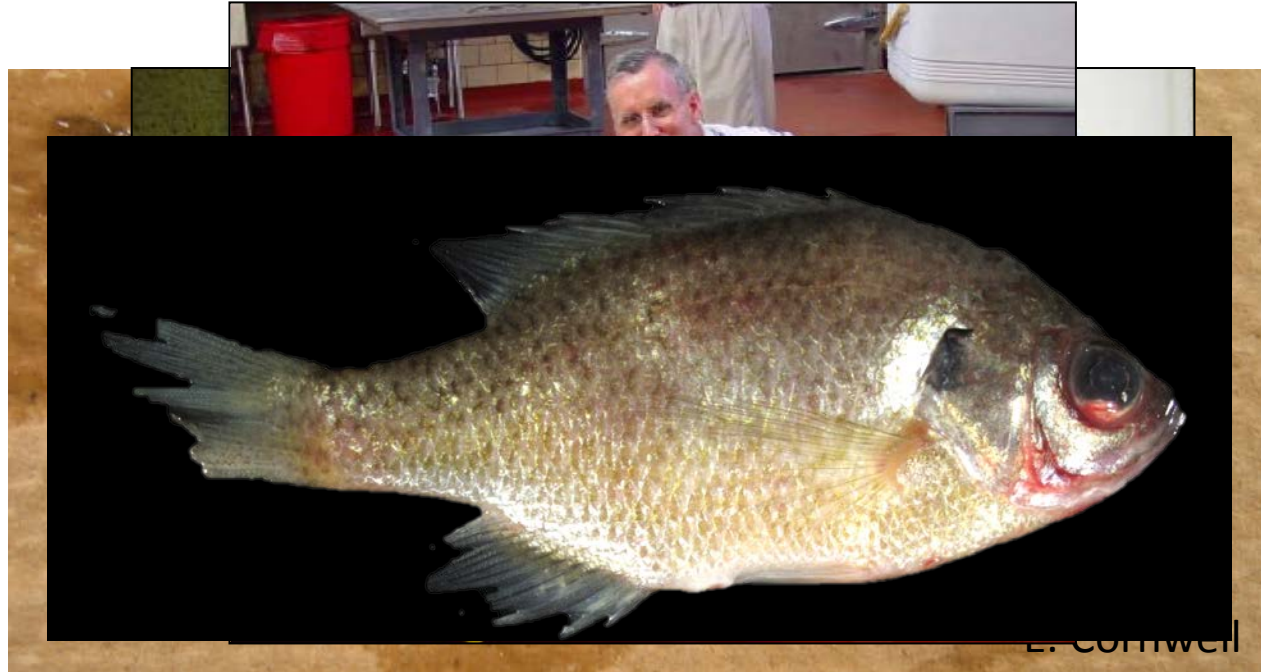
# Interrupt Pathway

- AIS-HACCP
- Good aquaculture practices
- Aquaculture
  - Increase local, healthy options
  - Must be cost effective
  - Must have regulatory support



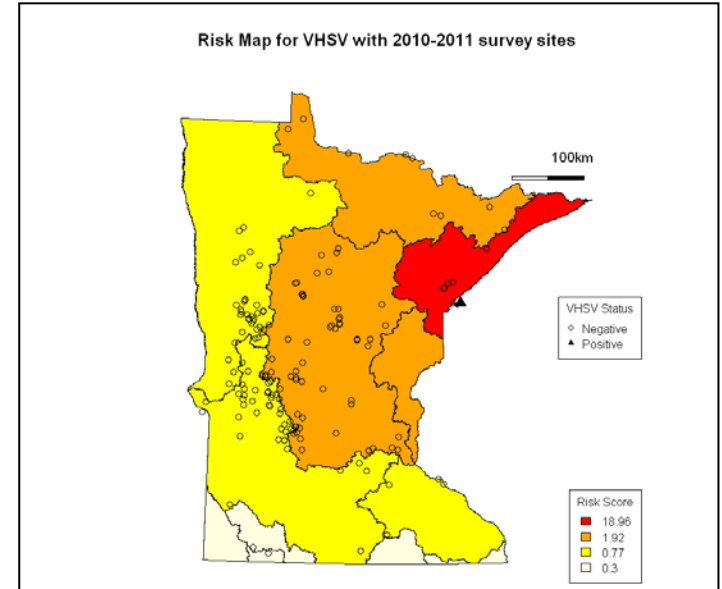
# Interrupt Pathway

- Public education/outreach
  - Integrate disease into AIS efforts
    - Pathways are similar – why not?
    - Powerful message!



# Interrupt Pathway

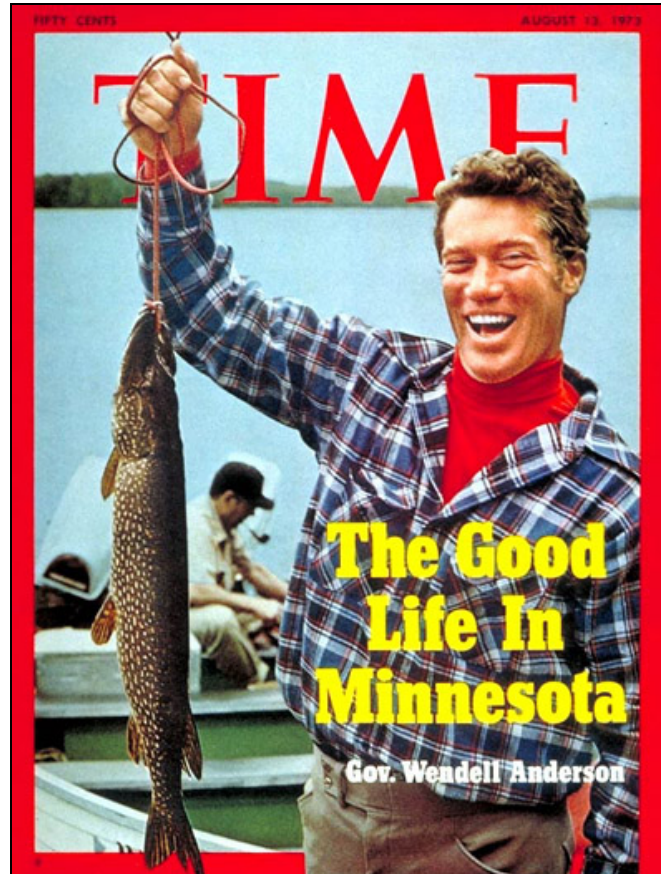
- Explicit integration of risk assessment
  - Identify and prioritize new and existing threats?
  - What can be done to mitigate risk?
  
- Proactive research
  - Surveillance
  - Infection trials
  - Modeling



# Take home messages

- Pathogens are (and have been) moving with invasive organisms in trade
- Will continue to spread without pathway disruption
  - Opportunities for intervention exist
- We don't know what is next, be prepared

# Questions?



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