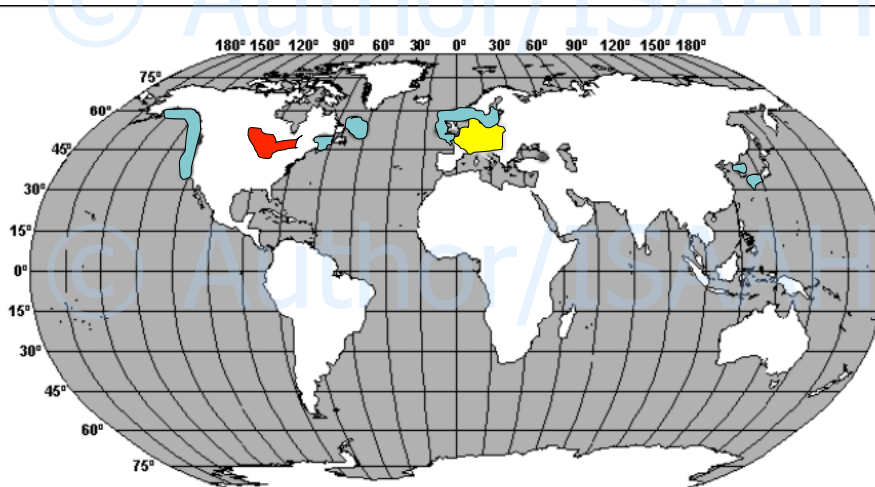


Viral Hemorrhagic Septicemia Virus: An Old Virus with New Tricks



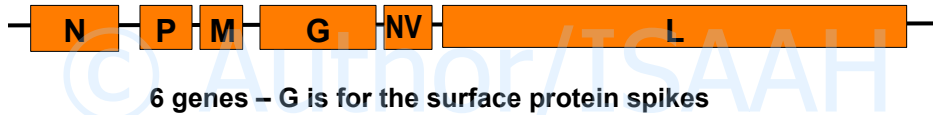
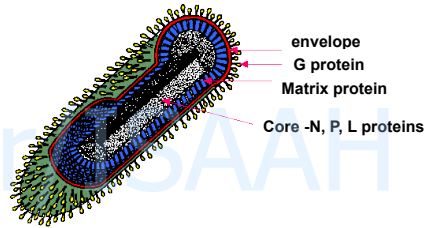
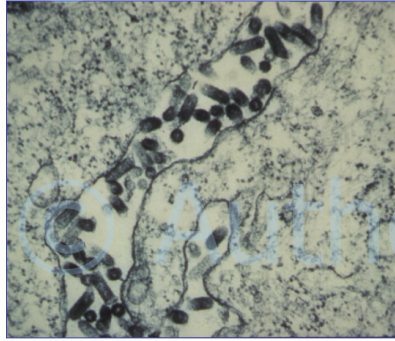
Gael Kurath
USGS Western Fisheries
Research Center
Seattle, WA

VHSV: Global Occurrence

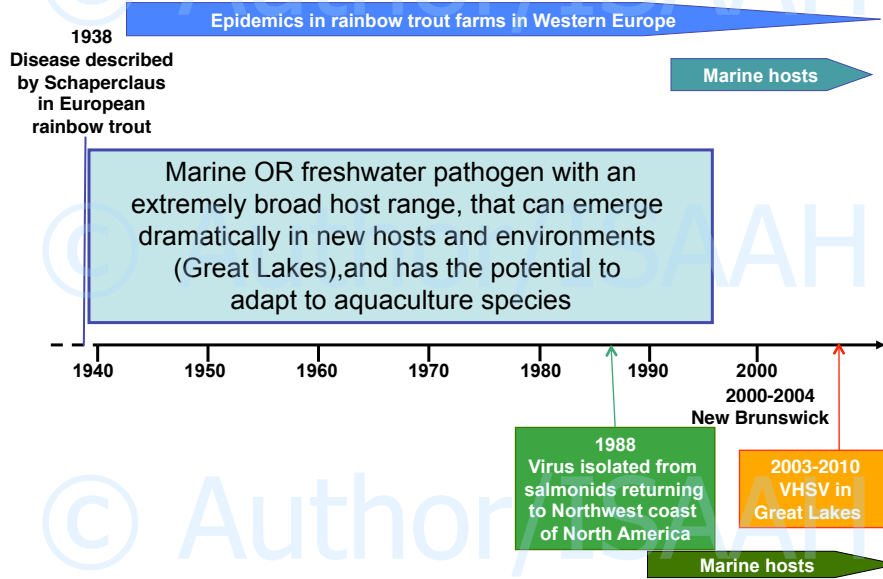


modified from Skall et al., JFD Review 2005

Fish Rhabdovirus: VHSV

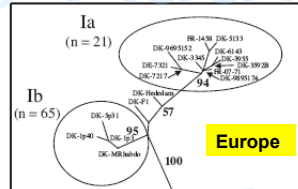


VHSV History: Evolution of our understanding



Genetic typing of VHSV, 2004: Genotypes I-IV

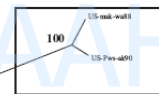
Genotype I (n = 88)



Snow et al., 2004,
128 VHSV isolates,
335 nt partial N gene

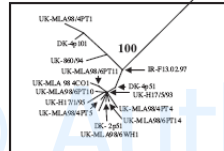
North America

Genotype IV (n = 3)

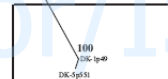


United Kingdom

Genotype III (n = 30)



North Sea and Baltic



Genotype II (n = 7)

0.1

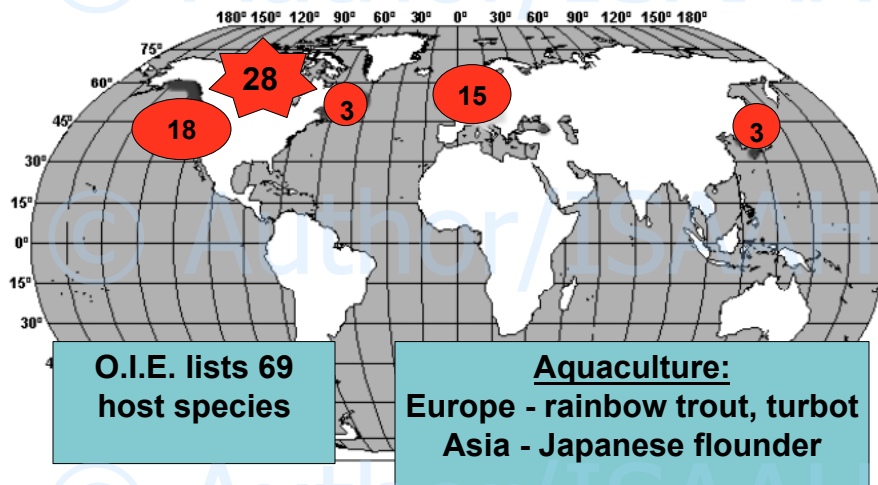
VHSV "Tricks"

1. Broad host range - marine reservoirs
2. Adaptation to new host species - rbt
3. Invasion of the Great Lakes region

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**Marine Reservoirs of VHSV:
 Detections in Wild Fish**

<u>Region</u>	<u>Timing</u>	<u># Sp.</u>	<u>Effort</u>
N. Am. Pacific	1988-2003	18	med
N. Europe	1979,1993-2006	15	high
N. Am. Atlantic	1994,2000-2004	3	low
Asia	1999	2	med
Great Lakes	2003	28	high

© Author/ISAAH
Known Host Range of VHSV

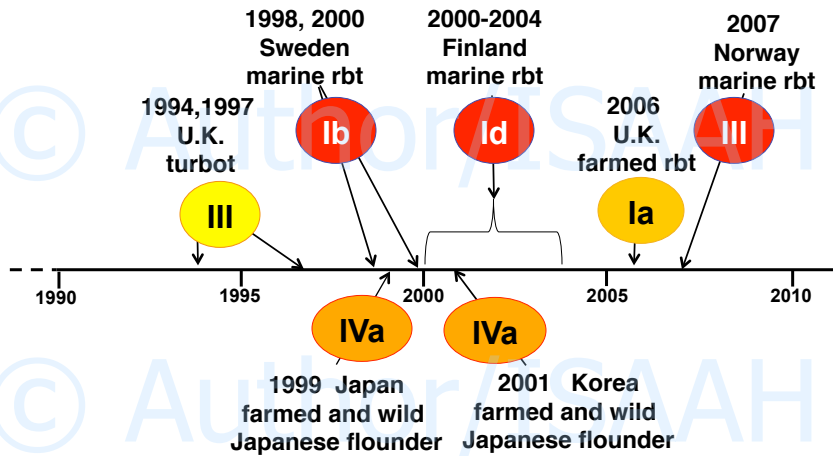


modified from Skall et al., JFD Review 2005

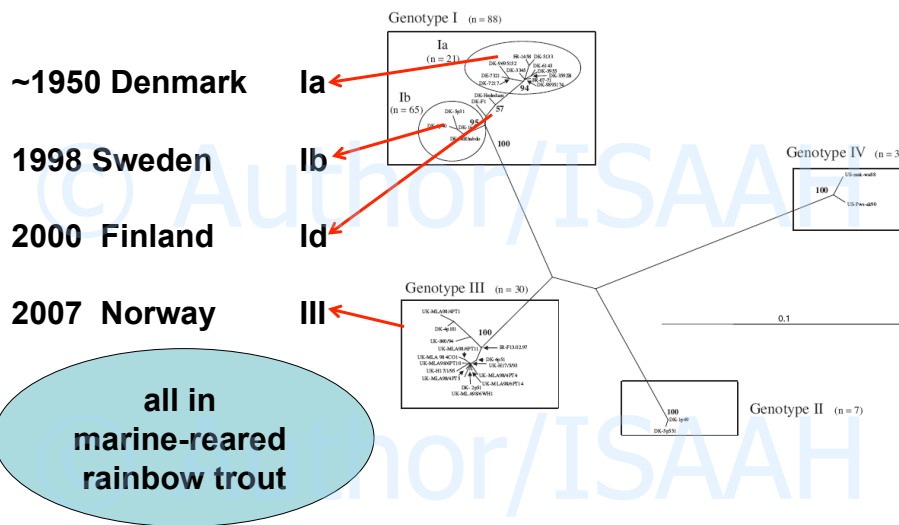
VHSV Recent Events: Europe & Asia

Continuing epidemics in trout farms in Northern Europe

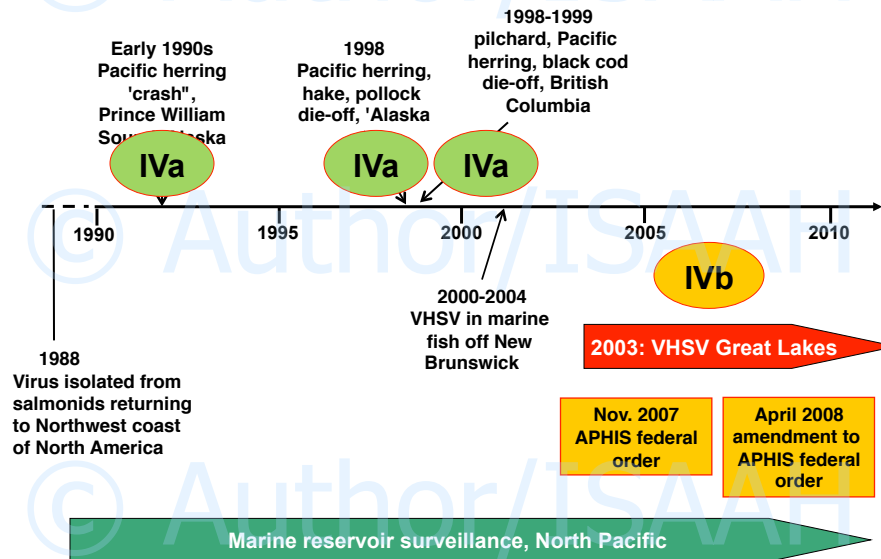
Marine reservoir surveillance in North European waters



4 VHSV Adaptation Events in Europe: Independent Host Jumps to Rbt



VHSV Recent Events: North America



VHSV Emergence in the Great Lakes Region of North America



- 2003- first isolation
- 2005 - first epidemic
- 2006-2007 - large-scale, multi-species epidemics
- 2008-2010 - less overt disease, surveys show presence and spread.

28 diverse host species so far

Our "Tricks"

1. Surveillance, diagnostics
2. Experimental challenge studies
3. Genetic typing, molecular epidemiology
4. Research: virulence determinants, host immunity, control

VHSV Surveillance

Geographic range, host range

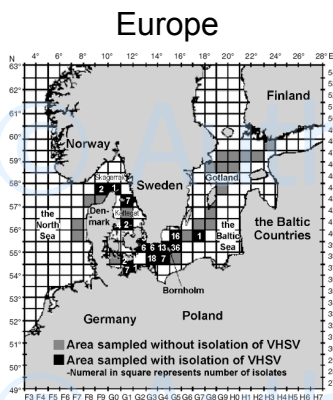


Fig. 1. Sampled area showing location and numbers of viral haemorrhagic septicaemia virus (VHSV)-positive samples. Numbers and letters on the lower x- and right y-axis indicate ICES squares

Skall et al., DAO 2005



Bain et al. PLoS One 2010

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Improved Diagnostics

Cell culture isolation - optimized cell line and protocol
VHSV qRT-PCR development, "fit for purpose"

© Author/ISAAH
**National Aquatic Animal Pathogen Testing Network
NAAPTN VHSV work group**

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**VHSV Experimental Challenge Studies:
Host specificity, Virulence**



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**Europe: rainbow trout, Atlantic salmon, turbot,
cod, halibut**

Japan: Japanese flounder, rainbow trout

North America:

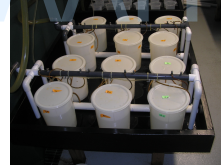
**-rainbow trout, Pacific salmon (Chinook, coho,
sockeye, pink), Atlantic salmon**

-Pacific herring, shiner perch, tube snout

-Great Lakes fish!!

© Author/ISAAH

**VHSV Experimental Challenge Studies:
Great Lakes IVb**



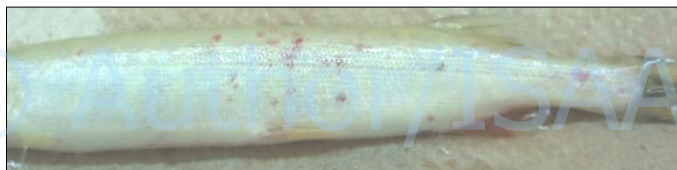
Cool water species:

muskellunge
tiger muskellunge
largemouth bass
yellow perch
fathead minnow
sea lamprey

Cold water species:

rainbow trout
brook trout
brown trout
lake trout
Chinook salmon
Atlantic salmon
coho salmon
Pacific herring

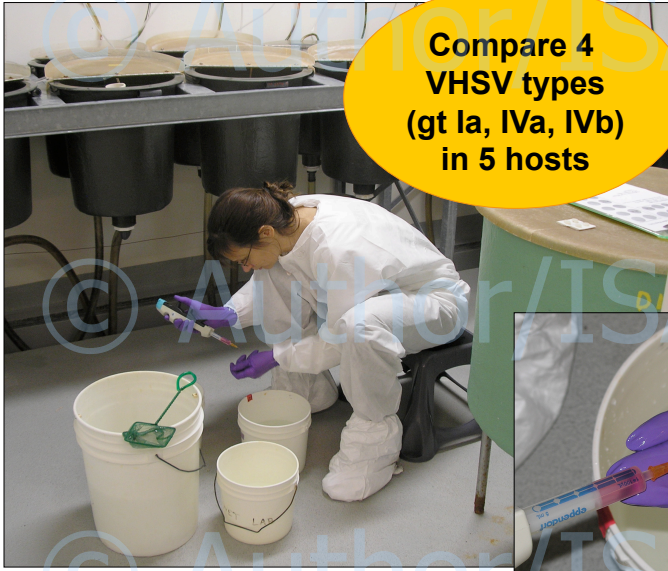

**Muskellunge (*Esox masquinongy*)
most susceptible to VHSV IVb
Kim and Faisal, 2010**



photos R. Kim and M. Faisal

Compare 4 VHSV types (gt Ia, IVa, IVb) in 5 hosts



Aquatic BSL3 Containment Laboratory Challenges: USGS Western Fisheries Research Center Seattle

E. Emmenegger, C.H. Moon, G. Kurath

Great Lakes VHSV Genotyping:

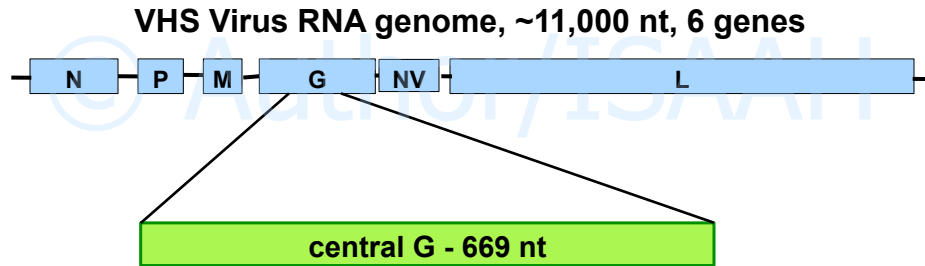
- 108 VHSV isolates
- collected 2003-2009
- all in wild/free-ranging fish
- 37 different sites including all five Great Lakes, inland sites, and one site in Mississippi watershed
- 29 fish host species and 2 invertebrates

Tarin Thomson
Bill Batts

© Author/ISAAH Genetic Typing of Great Lakes VHSV

669 nt region within the glycoprotein (G) gene



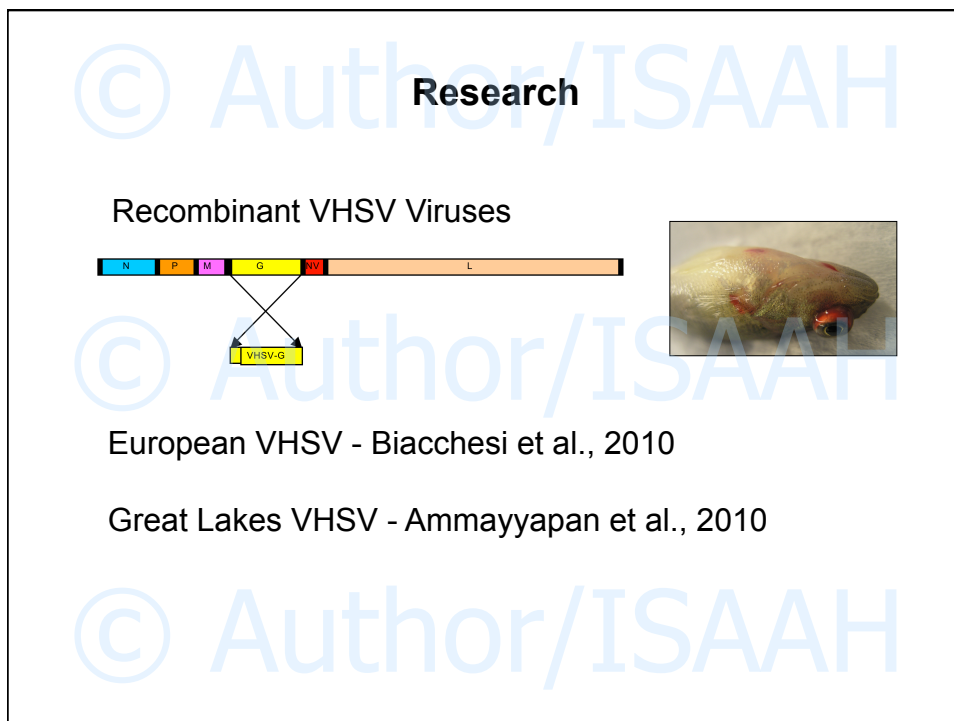
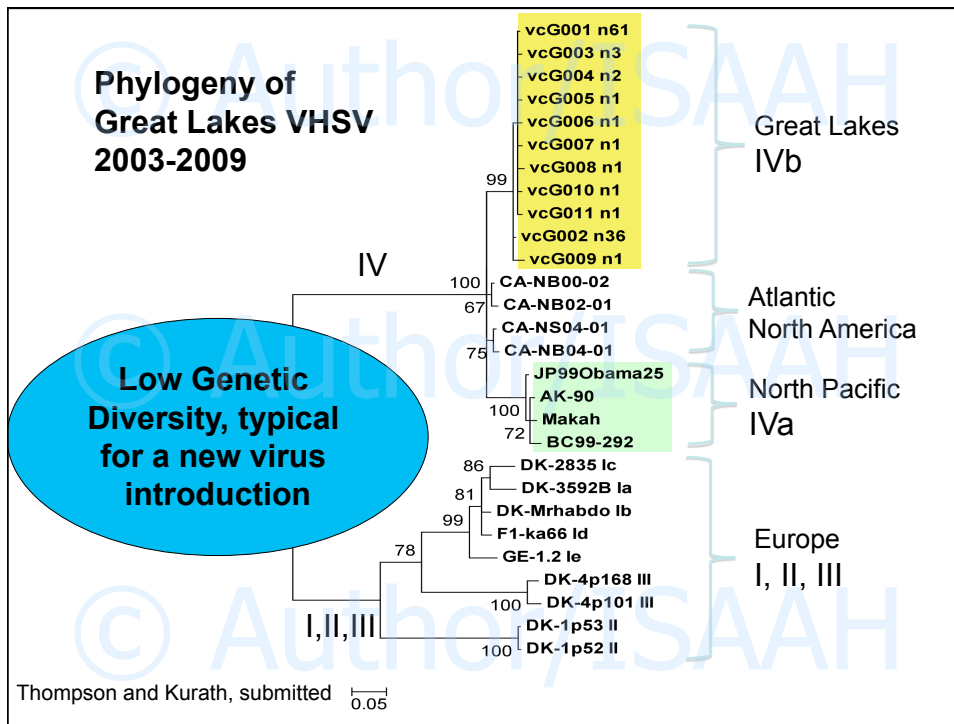
© Author/ISAAH

© Author/ISAAH Great Lakes VHSV Genotyping: LOW genetic diversity

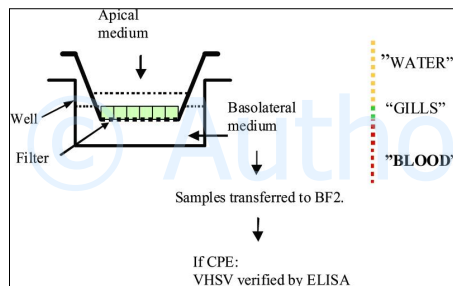
- 11 different sequence types
- two major types found with high frequency
- genetic diversity to date 1% maximum

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Thompson and Kurath, in review



Polarized primary Gill Epithelial Cell (GEC) culture



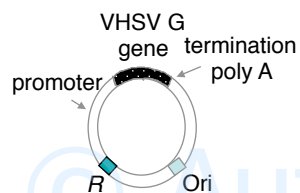
Polarized RBT GEC set-up
"mirrors the water-to-blood barrier of the gills of RBT"

- high virulence VHSV strain infects and translocates in 2 hr;

- low virulence strain does not infect and delayed translocation was at 48 hr

Brudseth et al. 2008

VHSV DNA Vaccine Studies



DNA vaccines with VHSV G gene
First reported 1997, Lorenzen
High efficacy by injection delivery
Mass delivery methods needed

Excellent tool for immunology:
host response profiles

Efficacy in combination with
IHNV DNA vaccine or
oil-adjuvanted vaccine

Temperature effects

© Author/ISAAH
Population Level Effects of VHSV?

Requires big-scale analyses, long-term study,
baseline data often not available

© Author/ISAAH
Pacific herring declines and die-offs?

Muskellunge - one report of 49% decline in population

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**Societal and cultural
importance of fish...**

**Muskellunge
("musky")**

© Author/ISAAH
**Thank
You**

