

VIRAL HEMORRHAGIC SEPTICEMIA VIRUS

Overview

Viral Hemorrhagic Septicemia (VHS) is a viral fish pathogen that has invaded the Great Lakes, threatening native fish populations. As its name suggests, this is a serious systematic disease that often causes fish to hemorrhage which can result in individuals bleeding to death. Typically found in marine fish, VHS was found in the Great Lakes in 2005 and 2006 with the occurrence of large fish kills in lakes Huron, St. Clair, Erie, Ontario, Michigan, and the St. Lawrence River. VHS-infected fish died by the thousands, including muskies, freshwater drum, yellow perch, gizzard shad, redhorse, bluegills, black crappie and round gobies. Other species of fish – Chinook salmon, walleye, lake whitefish, white bass, rock bass, smallmouth bass, emerald shiners, spottail shiners, burbot, northern pike, channel catfish, lake trout, rainbow/steelhead trout, and white sucker – also were infected, but did not die in large numbers.



This viral invader is not a threat to people handling or eating infected fish, but can be deadly to more than 15 fish species and can infect at least another 10 species in the Great Lakes basin. This is the first time a virus has affected so many different species across such a wide range of Great Lakes fish families.

Photo: Mohamed Faisal, Ph.D., Michigan State University

Identification and Symptoms

The VHS virus is classified as a rhabdovirus (rod-shaped virus) which is microscopic. It is a pathogen among fresh and saltwater fish of all size and age ranges in the Great Lakes region of the United States and Canada, VHS can cause hemorrhaging of fish tissue, including internal organs. Other symptoms of fish infected with VHS vary, depending on the stage of the disease, ranging from death to nervous disorders to no signs at all. Hemorrhaging of the skin is often exhibited, including large red patches, particularly on the sides and anterior of the head. Other external symptoms include bulging eyes and bloated abdomens. Internally, organs are often congested with multiple hemorrhages and/or fluid-filled vesicles in the kidney, liver, spleen, intestine and swim bladder. In the acute form of the disease, fish become lethargic, dark, and anemic and often swim erratically or in circles. The pathogen causes the blood vessels to weaken, leaking blood into the surrounding tissues, hence the hemorrhagic symptoms. Usually, the ultimate cause of death is internal organ failure involving the kidney or the inability to regulate body chemistry. There is no clear visual diagnostic for VHS-infected fish. Those fish infected with VHS that do not show symptoms can still carry the disease.

Native range: Different strains of VHS are native to Europe, Japan, and the Pacific (from California to Alaska) and North Atlantic coasts of North America. In 2006 using genetic data, scientists determined that the Great Lakes strain probably originated from the Atlantic coast of North America, specifically the Maritime Provinces of Canada.

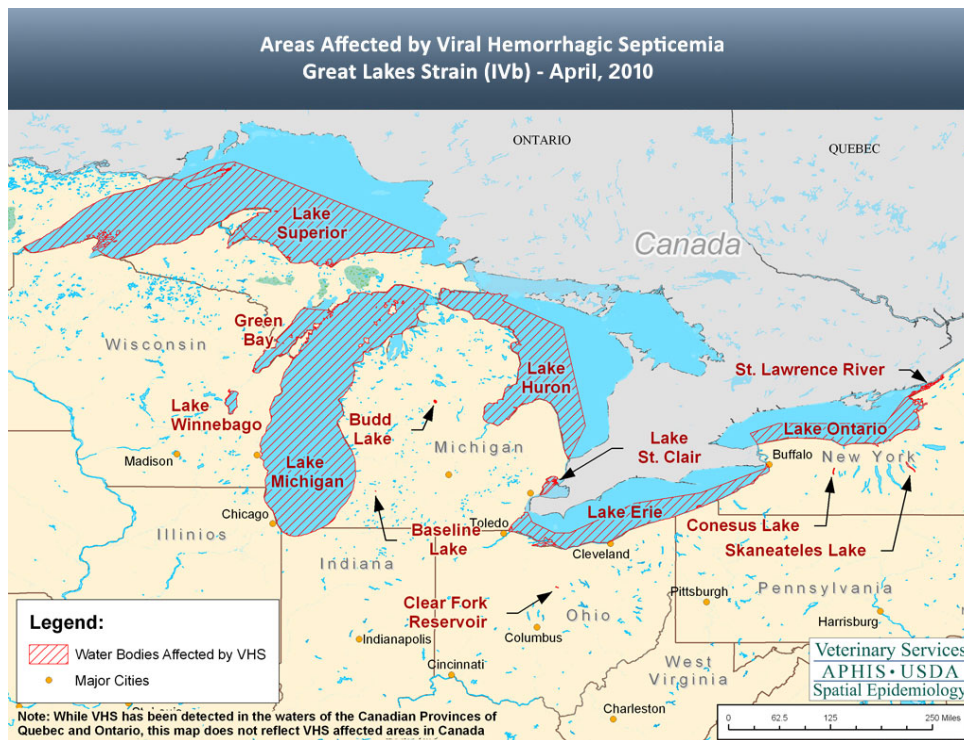
Occurrences in the Great Lakes Basin

The VHS virus has been present in the Great Lakes since at least 2003 based on an archived muskellunge sample from the northwest part of Lake St. Clair, Michigan. In 2005, large scale mortality of freshwater drum infected with VHS (approximately 100 tons) occurred in the Bay of Quinte, Lake Ontario. The Michigan DNR also confirmed VHS in northern Lake Huron in samples of lake whitefish, walleyes, and Chinook salmon in 2005. In the spring of 2006, large fish mortalities were observed in Lake St. Clair, St. Clair River, Detroit River, Lake Erie, Lake Ontario and the St. Lawrence River. These mortalities are considered to be part of one large-scale fish kill event caused by VHS infections. Fish kills detected in Lake Huron in Thunder Bay and Conesus Lake in New York in the fall of 2006 were likely caused by VHS. Additional fish kills were seen in inland waters in the spring of 2007 including Lakes Winnebago and Butte des Mortes, Wisc., Budd Lake, Mich. and the Seneca-Cayuga Canal, NY. The virus was first detected in northern Lake Michigan waters in 2007 in locations of southern Green Bay and around the Door Peninsula in Wisc. In 2008, the virus was detected in western Lake Michigan in the harbors of Waukegan, Ill. and Milwaukee, Wisc., where infected round gobies were killed and infected yellow perch were documented. The first detection of VHS in the Ohio River basin occurred in 2008 in the Clear Fork Reservoir (located in northern Ohio) where the ovarian fluid and milt of muskies being collected for eggs and sperm for fish culture operations were found to be infected. The detection of VHS in Lake Superior in late 2009 (confirmed in April 2010) marked the spread of the virus to all of the Great Lakes. In spring of 2011, a reoccurrence of VHS was observed in Budd Lake, Mich., resulting in die-offs of large and smallmouth bass, bluegills, and pumpkinseed sunfish.

Means of introduction: Based on the genetic evidence, the original source of VHS could have been untreated ballast water or infected migratory or bait fish originating from the Maritimes. However, there is no definitive evidence by which to further determine the actual mechanism of the introduction. At this point in time, the key vectors of spread between water bodies within the Great Lakes in the order of projected threat (high to low) are as follows: 1) the transport of infected fish (bait fish or gamefish); 2) the planting of infected fish or releasing infected fish or water from infected fish hatcheries; 3) the natural movement of fish from one water body to another; 4) moving infected water, fish or fish parts in ballast water of cargo vessels; and 5) moving infected water, fish or fish parts from one water body to another in live wells of fishing boats or in bilges of recreational and fishing boats (Whelan 2007).

VHS can be transmitted between fish by exposure to infected body fluids or by consumption of infected prey. It is also possible for the virus to survive outside a host fish in cool to cold water for a number of weeks. The virus is most active at cooler temperatures (< 59°

F), but has been shown, experimentally, to replicate at temperatures up to 77° F. Factors that effect the vulnerability of fish to infection and disease include the density of fish populations congregating in specific locations (e.g., spawning, foraging, commercial fishing nets, etc.), exposure to similar a virus in the past, physical condition and stress level, and the condition of the immune system.



Status: The North American strain of VHS virus is present in Lakes Huron, Erie, Ontario, Michigan, Superior, and St. Clair as well as the St. Lawrence River and several inland lakes throughout the basin (MI, WI, NY, OH). Distribution of VHS in lakes Michigan and Huron is considered “spotty” at this time, indicating that the infections are more recent and moving slowly within each lake. In contrast, there is a broader distribution of the virus in Lakes St. Clair and Erie. Lake Superior shows the most recent contamination (2009) of VHS, which has not resulted in significant fish mortality.

Map: U.S. Department of Agriculture (USDA) Animal and Plant Inspection Service (APHIS) Veterinary Services (VS) Center for Epidemiology and Animal Health (CEAH)

Distribution Maps: Geographic information on the location of aquatic invasive species sightings in the United States is made available through the U.S. Geological Survey, Nonindigenous Aquatic Species (NAS) program (<http://nas.er.usgs.gov>). The NAS distribution maps for VHS virus can be found at: <http://nas2.er.usgs.gov/viewer/omap.aspx?SpeciesID=2656>

Significant Contributions Provided by:

- U.S. Geological Survey, Nonindigenous Aquatic Species Program. 2009. <http://nas.er.usgs.gov>
- USDA Animal and Plant Health Inspection Service: Emerging Disease Notice. 2006. http://www.aphis.usda.gov/animal_health/emergingissues/downloads/vhsgreatlakes.pdf

References:

- Michigan Department of Natural Resources. VHS Clinical Signs: Photos from Dr. Mohamed Faisal, Michigan State University. http://www.michigan.gov/documents/dnr/vhs-photos_190459_7.pdf
- Elsayed, E., M. Faisal, M. Thomas, G. Whelan, W. Batts, and J. Winton. 2006. Isolation of viral haemorrhagic septicaemia virus from muskellunge, *Esox masquinongy* (Mitchill), in Lake St Clair, Michigan, USA reveals a new sublineage of the North American genotype. *Journal of Fish Diseases* (29): 611-619.
- Whelan, Gary. 2007. *VHS – The Viral Invader*. ANS Update. Great Lakes Commission. <http://www.glc.org/ans/ansupdate/pdf/2007/ansUpdate-spring07.pdf>
- Whelan, Gary. 2007. Viral Hemorrhagic Septicemia (VHS) Briefing Paper. http://www.michigan.gov/documents/dnr/Viral-Hemorrhagic-Septicemia-Fact-Sheet-11-9-2006_178081_7.pdf
- Wisconsin Department of Natural Resources. Facts on Viral Hemorrhagic Septicemia (VHS). <http://dnr.wi.gov/fish/vhs/vhsfacts.html>

Studies, Assessments and Management Plans

Focus on Fish Health: VHS Viral Hemorrhagic Septicemia

Iowa State University and U.S. Department of Agriculture-Animal and Plant Health Inspection Program <http://www.focusonfishhealth.org/> (2011)

This website was launched as part of a national outreach campaign to educate the public about VHS. Its development was a collaborative effort of fisheries and aquaculture stakeholders from industry, universities, state and federal agencies, and national organizations. The purpose of the website is to help the public as well as individuals (involved in recreation and aquaculture) understand the simple precautions that can be taken to help prevent the spread of the virus. Primary topics covered on the website include an overview of the VHS disease, prevention of VHS; federal and state efforts (e.g., regulations and outreach campaign), resources (by topic, organization, audience, type, regulations) and reporting of VHS (state and federal contacts). The website also serves as a clearinghouse for VHS resources for use by extension specialists, educators, and researchers. Resources can be submitted to the site by visitors.

VHS Management in Ontario (May 2010)

Ontario Ministry of Natural Resources

<http://www.mnr.gov.on.ca/en/Business/LetsFish/2ColumnSubPage/239471.html>

This site provides a map of VHS-positive Canadian waters (Lakes Ontario, Huron, and Erie), as well as links to current management actions and regulations aimed at slowing and preventing the further spread of VHS.

Evaluation of the Efficacy of Iodophor Disinfection of Walleye and Northern Pike Eggs to Eliminate Viral Hemorrhagic Septicemia Virus – Fact Sheet (January 2009)

U.S. Geological Survey

<http://pubs.usgs.gov/fs/2009/3107/pdf/fs20093107.pdf>

This fact sheet presents the results of a study that assessed the effectiveness of chemical disinfection for eliminating VHSV (strain IVb) from fertilized eggs of walleye and northern pike intentionally challenged with VHSV following egg fertilization.

Viral Hemorrhagic Septicemia in the Great Lakes Region: Management and Science Needs Workshop Proceedings (September 2008)

ESSA Technologies, Toronto, CA

<http://www.ijc.org/rel/boards/cqlrm/vhs-workshop-report-08.pdf>

Prepared for the International Joint Commission, the Ontario Ministry of Natural Resources, and the Great Lakes Fishery Commission, this document outlines the agencies' ecological and economic concerns as well as management needs, within the Great Lakes basin. Priorities are identified for preventative measures to limit further spread of VHS, and needs are addressed for increased surveillance, monitoring, and information sharing among affected jurisdictions.

Emergency Prevention and Response Plan for Viral Hemorrhagic Septicemia (March 2008)

National Park Service and Grand Portage Band of Lake Superior Chippewa

<http://www.nps.gov/apis/parkmgmt/upload/VHS%20Plan%20-%20Final%202008Mar14.pdf>

This plan is focused on (1) preventing VHS contamination of the waters of the four units of the National Park Service located in the Lake Superior basin and the Grand Portage Indian Reservation; (2) detecting the introduction of VHS; and (3) responding to VHS detection and outbreaks.

Surveillance for Viral Hemorrhagic Septicemia Virus in Wild Fish in Canada (March 2008)

Canadian Food Inspection Agency

<http://www.inspection.gc.ca/english/anima/aqua/virsep/200709e.shtml>

The CFIA implemented a 2-year surveillance of wild fish in Canada for the presence of VHS virus in the spring of 2007. The bilateral surveillance plan was developed by the Aquatic Animal Health Division of CFIA, Fisheries and Oceans Canada (DFO), Animal and Plant Health Inspection Service (APHIS) of the USDA, USFWS, and the Great Lakes Fish Health Committee.

Molecular Epidemiology of Viral Hemorrhagic Septicemia Virus in the Great Lakes Region (January 2008)

U.S. Geological Survey

http://biology.usgs.gov/faer/documents/USGS_Fact_Sheet_1_on_VHS.pdf

The purpose of this fact sheet is to review the results from molecular analyses that have added to our understanding about the distribution and spread of VHS.

Viral Hemorrhagic Septicemia in the Great Lakes Region – Industry Alert (October 2006)

U.S. Department of Agriculture – Animal and Plant Health Inspection Service

http://www.aphis.usda.gov/publications/animal_health/content/printable_version/ia_viral_hemorrhagic_septicemia_vs.pdf

This document serves as an advisory in industry describing the virus and providing information on how to protect facilities (e.g. aquaculture) from VHS.

Viral Hemorrhagic Septicemia in the Great Lakes - Emerging Disease Notice (July 2006)

U.S. Department of Agriculture – Animal and Plant Health Inspection Service

http://www.aphis.usda.gov/animal_health/emergingissues/downloads/vhsgreatlakes.pdf

This Emerging Disease Notice describes the current status of viral hemorrhagic septicemia in the United States, focusing on the 2005 and 2006 outbreaks in the Great Lakes area. It also quantifies trade and production statistics for relevant fisheries products and aquaculture resources and provides a qualitative assessment of potential risks and impacts of this disease in the event that it affects aquaculture fish species.

U.S. and Canadian Federal Resources

National Fish Hatchery System Addressing VHS

U.S. Fish and Wildlife Service

<http://www.fws.gov/fisheries/nfhs/VHS.htm>

Viral Hemorrhagic Septicemia Fact Sheet

U.S. Geological Survey-Nonindigenous Aquatic Species

<http://nas.er.usgs.gov/queries/GreatLakes/SpeciesInfo.asp?NoCache=9%2F29%2F2008+2%3A05%3A31+PM&SpeciesID=2656&State=&HUCNumber=DGreatLakes>

Animal and Plant Health Inspection Service- September 2008 Interim Rule (73 FR 52173)

U.S. Department of Agriculture

http://www.aphis.usda.gov/animal_health/animal_dis_spec/aquaculture/downloads/vhs_regulated_areas.pdf

Questions and Answers: Viral Hemorrhagic Septicemia Interim Rule - Fact Sheet

U.S. Department of Agriculture – Animal and Plant Health Inspection Service

http://www.aphis.usda.gov/publications/animal_health/content/printable_version/faq_vhs_interim_rule.pdf

Aquaculture Disease Information - Viral Hemorrhagic Septicemia

U.S. Department of Agriculture – Animal and Plant Health Inspection Service

www.aphis.usda.gov/animal_health/animal_dis_spec/aquaculture/

Viral Hemorrhagic Septicemia: Species Profile

U.S. Department of Agriculture-National Invasive Species Information Center

<http://www.invasivespeciesinfo.gov/microbes/vhs.shtml>

National Aquatic Animal Health Program - Fact Sheet: Viral Hemorrhagic Septicemia in Various Great Lakes Fish Species

Fisheries and Oceans Canada

<http://www.dfo-mpo.gc.ca/science/enviro/aah-saa/facts-renseignements-eng.htm>

National Aquatic Health Program - FAQ's: Viral Hemorrhagic Septicemia in Various Great Lakes Fish Species

Fisheries and Oceans Canada

<http://www.dfo-mpo.gc.ca/science/enviro/aah-saa/nfaq-eng.htm>

VHS – The Viral Invader

Great Lakes Commission-ANS Update Newsletter

<http://www.glc.org/ans/ansupdate/pdf/2007/ansUpdate-spring07.pdf>

State and Provincial Resources

Illinois Emergency VHSv Rules 07-2008

Illinois Department of Natural Resources

<http://www.ncrac.org/NR/rdonlyres/630502C9-666E-483E-B784-8ADBCFAF550E/82076/ILEmergencyVHSRules72008.doc>

Indiana State Board of Animal Health VHS Pre-Entry Permit Requirements

Indiana Department of Natural Resources

<http://www.in.gov/dnr/fishwild/3607.htm>

VHS News Item

Indiana Department of Natural Resources

http://www.in.gov/dnr/fishwild/files/DNR_VHS_News_Item_Final.pdf

VHS and Permit Procedures for the Interstate Shipment of Fish

Indiana Department of Natural Resources

http://www.in.gov/dnr/fishwild/files/BOAH_DNR_QA_VHS.pdf

Indiana Entry Health Requirements

Indiana State Board of Animal Health

<http://www.in.gov/boah/2388.htm>

Attention Anglers Flyer

Michigan Department of Natural Resources

http://www.michigan.gov/documents/dnr/understandign_vhs_rules_238885_7.pdf

Fish Disease-VHS

Michigan Department of Natural Resources

http://www.michigan.gov/dnr/0,1607,7-153-10364_10950_46202---,00.html

Viral Hemorrhagic Septicemia (VHS) Briefing Paper

Michigan Department of Natural Resources

http://www.michigan.gov/documents/dnr/Viral-Hemorrhagic-Septicemia-Fact-Sheet-11-9-2006_178081_7.pdf

Fish Diseases-VHS

Michigan Sea Grant

<http://www.miseagrant.umich.edu/upwellings/issues/07apr/07apr-article3.html>

Viral Hemorrhagic Septicemia (VHS) in the Great Lakes

Michigan Sea Grant

<http://www.miseagrant.umich.edu/downloads/ais/07-700-fs-VHS.pdf>

Name of the condition: Viral Hemorrhagic Septicemia (VHS)

Minnesota Department of Natural Resources

http://www.dnr.state.mn.us/fish_diseases/vhs.html

Viral Hemorrhagic Septicemia Brochure

Minnesota Department of Natural Resources

http://files.dnr.state.mn.us/natural_resources/animals/fish/vhs_brochure.pdf

VHS Virus Fact Sheet

Minnesota Sea Grant

http://www.seagrant.umn.edu/fisheries/vhs_virus_facts

Spread of Viral Hemorrhagic Septicemia (VHS) in the Great Lakes Region, 2003-2007

Minnesota Center for Environmental Advocacy

<http://www.mncenter.org/LinkClick.aspx?fileticket=i7QF3le12HY%3d&tabid=242>

Viral Hemorrhagic Septicemia (VHS) in New York

New York Department of Environmental Conservation

<http://www.dec.ny.gov/animals/25328.html>

Animal and Plant Health - Viral Hemorrhagic Septicemia

Pennsylvania Department of Agriculture

http://www.portal.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_24476_10297_0_43/http%3B/10.41.0.36/AgWebsite/ProgramDetail.aspx?name=Aquaculture-VHS-Certification-&navid=12&parentnavid=0&palid=26&

Viral Hemorrhagic Septicemia (VHS) in Pennsylvania

Pennsylvania Fish and Boat Commission

http://www.fishandboat.com/pafish/all/vhs/fact_sheet_vhs.pdf

Fishing is at risk, but you can help!

Pennsylvania Fish and Boat Commission

<http://www.fishandboat.com/pafish/all/vhs/vhs.htm>

VHSv poster: Help Stop the Spread of VHS

Pennsylvania Sea Grant

http://seagrant.psu.edu/publications/posters/PA-VHS_Poster.pdf

VHS and You: Keeping Wisconsin's Waters Healthy

Wisconsin Department of Natural Resources

<http://dnr.wi.gov/fish/vhs/>

VHS in Great Lakes Fish

Wisconsin Sea Grant

<http://www.seagrant.wisc.edu/home/Default.aspx?tabid=531>

Viral Hemorrhagic Septicemia - Help Prevent the Spread of this Disease in Ontario!

Ontario Ministry of Natural Resources

http://www.mnr.gov.on.ca/en/Business/LetsFish/2ColumnSubPage/STEL02_166029.html

This website provides comprehensive information on VHS in Ontario, including management zones and fact sheets for several stakeholder groups including anglers, aquarists, fish farmers, property owners and bait fish harvesters.

Viral Hemorrhagic Septicemia (VHS) - VHS Management Zone

Ontario Federation of Anglers and Hunters-Invasive Species Awareness Program

<http://www.invadingspecies.com/Invaders.cfm?A=Page&PID=33>

La septicémie hémorragique virale au Québec en 2008 (French fact sheet)

Aire Faunique Communautaire du Lac St. Pierre

http://www.afclacst-pierre.org/index_fichiers/shv1.htm