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Viral hemorrhagic septicemia virus infection in yellow perch, *Perca flavescens*, in Lake Erie

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ABSTRACT

Viral hemorrhagic septicemia virus (VHSV) infects wild and hatchery fish in Europe, Japan, and the Great Lakes and Pacific regions of North America. The virus was associated with a large die-off of yellow perch, *Perca flavescens*, in Lake Erie in 2006. To determine the infection pattern of VHSV, we sampled yellow perch during the spring, summer, and fall of 2007 and 2008 in the central basin of Lake Erie during routine sampling by the Ohio Division of Wildlife with bottom trawls in nearshore, mid-depth, and offshore locations near the Chagrin River. The Ohio Department of Agriculture's Diagnostic Laboratories and the U.S. Fish and Wildlife Service's La Crosse Fish Health Center tested for VHSV from homogenized samples obtained from yellow perch kidney, spleen, and brain. At each lake sample location, we also measured temperature, dissolved oxygen, and conductivity. In both years, we found yellow perch infected with VHSV during a three-week period starting in the last week of spawning to early June. A high proportion of adult male and female yellow perch tested positive for VHSV during the infection period in our sample population. Infection appeared to be associated with temperatures between 12 and 18 °C and with significantly higher yellow perch densities during spawning. No large mortalities of yellow perch were observed during the VHSV infection period in 2007 and 2008.

Introduction

Viral hemorrhagic septicemia virus (VHSV) is a fish pathogen that has been present in the Great Lakes since at least 2003 (USDA, 2006). VHSV is an enveloped negative-strand RNA virus belonging to the *Novirhabdovirus* genus of the *Rhabdovirdae* family (Einer-Jensen et al., 2004). The virus is transmitted horizontally by urine and female sex products and in some cases orally by feeding as seen in feeding young northern pike infected trout (Meyers and Winton, 1995, Lorenzen et al., 2000; Wolf, 1988). Gills were thought to be the main portal of infection to fish (Meyers and Winton, 1995, Lorenzen et al., 2000; Wolf, 1988), however, a recent study (Harmache et al., 2006) showed that fin bases are the major portal for *Novirhabdovirus* infection in salmonids. Depending on the species, strain and genotype, wild versus aquaculture fish, and geographical location the virus is associated with an adult fish death rate of 25–75%, while close to a 100% death rate in juvenile fish such as rainbow trout. Strains of European species at low temperatures in freshwater and Pacific herring are more susceptible to isolates of Genotype IVa (Meyers and Winton, 1995; Wolf, 1988). Because of the detrimental effect VHSV infection can have on certain species in freshwaters there has been substantial concern about the effect of the virus on the health of fish populations in Lake Erie.

VHSV was first successfully isolated in cell culture in 1962 Denmark and showed to be the etiological agent of VHSV (Wolf, 1988). Since its first detection in Denmark, researchers sequenced and mapped VHSV into four genotypes, three European (I–III) and one North American (IV) (Snow et al., 1999; Einer-Jensen et al., 2004). The North American (IV) has been subdivided into two sublineages, IVa and IVb (Elsayed et al., 2006). To this date, all isolates of VHSV from fish in the Great Lakes region have been identified as belonging to IVb sublineage while all isolates from fish from the west coast of North America belong to the IVa sublineage (Elsayed et al., 2006).

The source of the virus in the Great Lakes is uncertain, but tissue samples collected from mummichog, *Fundulus heteroclitus*, three spined stickleback, *Gasterosteus aculeatus aculeatus*, striped bass, *Morone saxatlis*, and brown trout, *Salmo trutta trutta*, in Eastern Canada near Nova Scotia and New Brunswick tested positive for VHSV between 2000 and 2004 (Gagne et al., 2007). In 2003, muskellunge, *Esox masquinongy*, tested positive for VHSV in Lake St. Clair, MI, USA (Elsayed et al., 2006). Since 2003, the Ontario Ministry of Natural Resources reported a large fish kill of freshwater drum infected with VHSV in the Bay of Quinte in Lake Ontario in the spring of 2005 (USDA,

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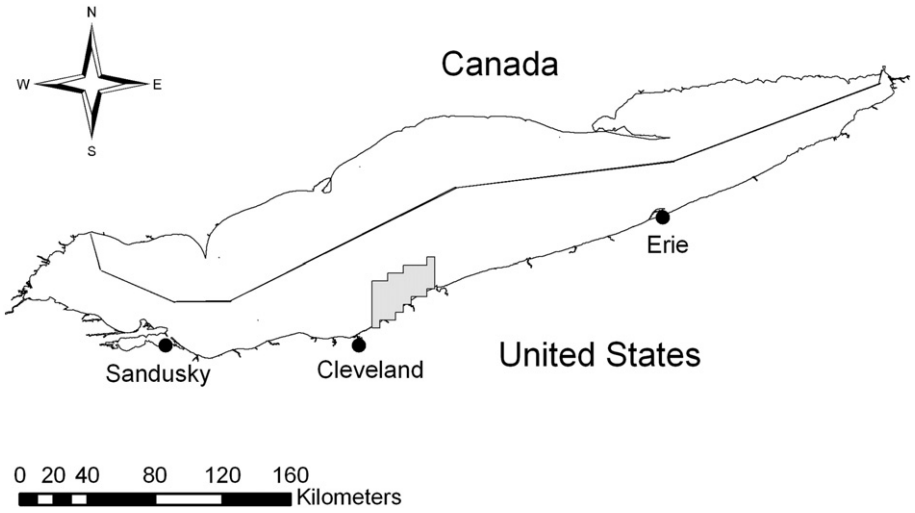

Fig. 1. Chagrin study site in the central basin of Lake Erie (41° 48′N, 81° 20'W).

2006). In 2006, scientists isolated the virus in multiple fish species during fish kills in Lake Ontario, Lake Erie, Lake St. Clair, Consensus Lake, and the St. Lawrence River.

Because the Ohio Division of Wildlife reported VHSV associated with a large die-off of yellow perch, *Perca flavescens*, in central Lake Erie, we focused our studies on the prevalence of VHSV infection in the Lake Erie central basin yellow perch off the mouth of the Chagrin River. We explored the spatial and temporal variability of VHSV infections in yellow perch sampled from nearshore, mid-depth, and offshore trawl catches during routine surveys conducted by the Ohio Division of Wildlife in the vicinity of the Chagrin River. Our results indicated that there is a small window of infection starting the last week of spawning to early June when temperatures are between 12 °C and 18 °C. During this time period adult male and female fish were infected with the virus at all depths sampled. Temperature and fish density during the infection period appeared to be most associated with infection.

Methods

The Chagrin sampling site is an area of 625 km^2 in the central basin (41° 48′N, 81° 20'W) of Lake Erie (Fig. 1) where VHSV had been isolated following a large yellow perch die-off in May 2006. We subsampled yellow perch during routine fish surveys conducted by

Table 1
VHSV results for 2007 and 2008.

Date	Lab	Tissue	Age code	Number pools	Number fish/pool	Positive	Negative	Total number of fish
2007								
May 15	La Crosse	KS	A	6	5	–	6	30
May 22	La Crosse	KS	A	4	5	4	–	20
June 6	La Crosse	KS	A	12	5	12	–	60
June 18	La Crosse	KS	A	3	5	–	3	15
		KS	Y	9	5	–	9	45
July 5	La Crosse	KS	A	2	5	–	2	10
Jul 23	La Crosse	KS	A	2	5	–	2	10
		KS	Y	2	5	–	2	10
		KS	YOY	8	5	–	8	40
Sept 5	ODA	KS	A	5	5	–	5	25
		KS	Y	5	5	–	5	25
		KS	YOY	6	5	–	6	30
Oct 29	ODA	KS	A	14	5	–	14	70
		KS	YOY	2	5	–	2	10
2008								
April 21	La Crosse	KS & B	A	12	5	–	12	30
April 30	La Crosse	KS &B	A	12	5	–	12	30
May 5	La Crosse	KS &B	A	12	5	–	12	30
May 14	La Crosse	KS	A	12	2	–	12	24
	ODA	KS	A	11	2	–	11	22
May 20	La Crosse	KS	A	12	2	–	12	24
	ODA	KS	A	11	2	10	1	22
May 28	La Crosse	KS	A	12	2	–	12	24
	ODA	KS	A	12	2	10	1	24
June 2	La Crosse	KS	A	12	2	–	12	24
	ODA	KS	A	12	2	12	–	24
June 24	ODA	KS & B	A	12	5	–	12	30
July 28	ODA	KS & B	A	12	5	–	12	30

For 2007 and 2008 kidney and spleen (KS) and brain (B) pooled samples are listed and separated by laboratory, La Crosse Fish Health Center (La Crosse) and the Ohio Department of Agriculture (ODA), and by positive or negative results on each date of collection. A number listed under positive represents the number of pools found positive for VHSV and likewise for negative results. Dashes indicate no pools tested positive or negative on sampling date. 2007 included adults (2+ years old), A, yearlings, Y, young of the year, YOY while 2008 included only adult yellow perch.