



Dr. Paul Bowser (left, alongside Postdoctoral Associate Geoffrey Groocock), analyzes samples of several fish internal organs affected by VHSV. “The virus is very unstable,” he says. “If fish are collected by a field biologist in a remote location, and they are not properly refrigerated, the virus will decompose by the time it reaches the lab.”

Photo by Jason Koski, Cornell University Photography

VHS: THE ANATOMY OF AN EMERGING VIRUS

This past January, NYSG’s Fisheries Specialist **Dave MacNeill** convened a meeting in Watertown to discuss a disease of immediate urgency in the Great Lakes – a disease known as VHS, viral hemorrhagic septicemia. “Our recreational and commercial fisheries are a vital part of New York State’s economy,” says MacNeill, “and VHS poses a potentially serious threat to the fisheries and to the businesses dependent on them.” At the meeting, elected officials obtained firsthand accounts of VHS effects on freshwater fish and the economic loss and burdens on small businesses in upstate NY. Then, the elected municipal and state officials met with federal legislators—including staff in U.S. Senator Hillary Clinton’s and Congressman John McHugh’s offices – and APHIS, the U.S. Department of Agriculture’s Animal and Plant Health Inspection Service.

In May, NYSG’s other Fisheries Specialist **Antoinette Clemetson** coordinated a seminar on Long Island to educate representatives in the bait and tackle industry about management actions being undertaken in response to the VHS disease outbreak in the Great Lakes. “An outbreak of VHS in our marine waters would be disastrous to businesses dependent on sport and commercial fishing,” says Clemetson.

At the January meeting, participants discussed options for obtaining low interest emergency loans as economic assistance to mitigate problems being experienced by VHS-impacted businesses, as well as a mechanism for cross-border transport of fish for processing. Industry representatives at the May meeting offered several suggestions that were used to streamline the NYS Department of Environmental Conservation’s set of regulations to create new standards for fish health inspection and restrict movement of uncertified bait fish within New York. “We’re trying to make anglers aware of the new regulations developed to halt movement of the VHS pathogen into new water bodies,” says Clemetson. “Anglers need to familiarize themselves with the disease symptoms and report incidents of infected fish to the DEC.”

Of course, detection of the VHS virus (VHSV) is best left up to the researchers. So, in February, NYSG awarded **Dr. Paul Bowser**, Professor of Aquatic Animal Medicine at Cornell University’s College of Veterinary Medicine, a two-year, \$178K grant to develop a genetics-based test to detect VHSV in both tissues and water samples. The grant will also be used to study optimal ways for handling study specimens and to examine the virus’ stability in fresh and

turbid water to determine if these conditions affect the diagnostics.

In an interview with *Coastlines* editor **Barbara A. Branca**, Bowser explained the technique he and his lab are developing to more rapidly detect VHSV, what the virus is and why it has such a profound effect on fish.

Q: Dr. Bowser, what is this virus and does the name refer to its effect on fish?

A: VHS is a rhabdovirus—a bullet-shaped RNA virus—one that’s adapted to cold blooded animals, particularly fish. It is not a threat to human health in any way. The name describes what it does—VHSV creates hemorrhages. The virus destroys the cells that line various blood vessels in the fish and causes bleeding. Bleeding destroys internal organs, such as the heart, liver, spleen and kidneys, and eventually the fish dies.

Q: Which fish species seem to be most affected and how does the virus manifest itself?

A: We’ve seen significant mortality events occur in several species: muskellunge [a kind of pike], round gobies, gizzard shad, smallmouth bass and freshwater drum. Sometimes I’m asked the question, “How bad can it get?” Well, although not everything happens to this degree, the graphic description of the freshwater drum kill that occurred last year on the shores of Lake Erie says it all. There were windrows of fish covering the length of the beach, piled up about 10 feet wide and 4 feet tall. That was an unusual event and it was probably due to a combination of the

fish being particularly susceptible to the virus and maybe some other environmental stressors, possibly high temperatures. We don’t always see the situation being that serious or severe, but there is potential.

Q: Stressors definitely seem to be playing a role in the mortalities. Although it appears not to harm humans, VHSV has a history of affecting fish – it has been reported in Europe as far back as 1938. So, why is it showing up now in the Great Lakes? And what’s this newer, virulent strain in the Northwest Atlantic? Is it the result of ballast water introductions or viral mutations?

A: Historically there have been instances of the VHS virus in freshwater-reared rainbow trout dating back into the 1930s. To this day, the virus remains the most serious viral pathogen of trout in Europe. Over the years, there have been a number of genotypes of the virus found on a worldwide basis. Genotypes I, II, and III are found in Europe and Japan. Genotype IV is found in North America’s Pacific Northwest and off the Atlantic coast in maritime Canada as well as in Japan and Korea. The isolate that first emerged in the Great Lakes in 2005 is genetically most closely related to the North American Genotype IV. But it’s different enough that those who do the genetic studies of the virus are now calling the Great Lakes isolates Genotype IVb and terming what was previously only found in the marine environment Genotype IVa.

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WHAT IS A VIRUS?

“A virus, in a nutshell, is a little package of either RNA or DNA that completely depends upon a host (fish in this case) to replicate and survive. In the case of VHSV, it is an RNA virus,” says Bowser.

“Think of a virus as the ultimate parasite. It must get inside a cell in order to survive in the environment for any extended period of time.”

“Once inside the cell, the virus essentially takes over the metabolic machinery of the cell. It tells the cell, ‘Okay, we’re not going to do cell stuff anymore. We’re going to do virus stuff now.’”

“In some cases that virus will, by the infection of the cell, cause a destruction of the cell,” Bowser continues. “In other cells, it acts as a silent infection and doesn’t cause the destruction of the cell.”

“Although vaccination strategies are working for this type of virus, there currently is no effective way to vaccinate fish in the natural environment [such as the Great Lakes],” adds Jim Casey, Cornell University Associate Professor of Veterinary Microbiology and Immunology.

So, any measure to control the spread of VHS, he says, requires people to “apply procedures that existed prior to the discovery of vaccines, such as monitoring outbreaks and trying to isolate fish so they don’t spread the disease.”



Though it may appear healthy, infected fish like the muskellunge held here by Dr. Paul Bowser are confirmed via tissue cultures. Bowser’s current NYSG research grant focuses on muskellunge fisheries, the second most important sportfish in NYS, in the St. Lawrence River, Chautauqua Lake and the Niagara River. Photo courtesy of Paul Bowser, Cornell University College of Veterinary Medicine

Q: Fish have immune systems, so why are they so vulnerable to this virus?

A: The virus is an RNA virus. RNA viruses as a group, have a tendency to make genetic errors, or mutations, when they replicate [see sidebar page 13]. The genetics tend to suggest that this virus may have originated from the Genotype IVa found in the marine environment and somehow that virus moved into the Great Lakes. And, why are we having a problem now? There is a great deal of talk [in the science community] about new and emerging diseases where you have a new pathogen that moves into an environment and there are a number of host species that were never exposed to this pathogen before. So you have disease events that appear to be very serious in the beginning. And that's probably what we're seeing right now. You can almost liken it to—and, again, I have to emphasize that this is not a human pathogen—what we see with the human Influenza virus, where every 20 or 30 years there is a major change in the genetic type of the flu virus. And more people are sick and those people who do become sick may be affected more seriously. This is probably what we are seeing with the VHS virus in that we have the new pathogen and naïve hosts. And, that combination has resulted in a serious disease event.

Q: The future, Dr. Bowser. You've worked with several fish diseases in your NYSG-sponsored research – botulism in fish and fish-eating birds, swim bladder sarcoma. These are important and destructive diseases. How does this particular disease compare in scope and severity?

A: I agree with many of my colleagues in the fish health field who view the emergence of VHS in the Great Lakes basin as one of the most serious, if not *the* most serious fish health event that has ever occurred in North America. I say that because of the diversity of fish species that are being infected and the degree to which the disease has impacted sportfisheries management. Importantly, although the virus has not yet been found in a North American aquaculture facility, should that happen as it has in Europe, there could be devastating economic consequences. So, we consider invasion of VHSV into the Great Lakes as a very serious infectious disease event and something that needs significant research to understand and formulate ways to prevent its spread and limit its impact.

— Paul C. Focazio and Barbara A. Branca



Outbreaks of Viral Hemorrhagic Septicemia in the Great Lakes 2005 – 2006

DATE	2003-05	Summer '05	May '06	May '06	May '06	May '06	May '06	June '06
LOCATION STATE OR PROVINCE	Lake St. Clair MICHIGAN	Bay of Quinte / Lake Ontario ONTARIO	Sandusky Bay/ Lake Erie OHIO	St. Lawrence River NEW YORK	Lake Erie OHIO	Lake Erie OHIO	Lake Ontario ONTARIO	Lake St. Clair MICHIGAN
PRIMARY SPECIES (OTHER SPECIES)	Muskellunge	Freshwater Drum (Muskellunge, Round Goby)	Freshwater Drum	Round Goby (Muskellunge)	Yellow Perch Walleye White bass (Freshwater Drum Smallmouth Bass)	Yellow Perch	Freshwater Drum Smallmouth Bass Bluegill Crappie	Gizzard shad Redhorse sucker Blunt nose sucker Northern pike (Yellow perch)
ESTIMATED MORTALITY	4 of 27	Several hundred tons	Very large mortality	Large die off	Mortality in wild	Large die off	Mortality event	Large mortality
COMMENTS	Samples submitted over several years	Very large natural mortality	"Windrows" of fish on beach	River origin	Samples from area of traps and mortality	Fish dying in commercial traps	Acute mortality - no external signs	

Modified from: *Viral Hemorrhagic Septicemia in the Great Lakes*. U.S. Department of Agriculture/Animal and Plant Health Inspection Service – Veterinary Services. July 2006 Emerging Disease Notice.