Michigan Department of Natural Resources and Environment
Fisheries Division

History of Walleye Culture and Stocking in Michigan with the Emergence of Viral Hemorrhagic Septicemia in the Great Lakes Basin[1]

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Photo credit: Gerald Casey

[1] This paper was originally developed by Patrick Hanchin and Tim Cwalinski, Co-chairs of the Fisheries Division's Walleye Committee. Technical advice and detail have been provided by Dr. Mohamed Faisal, Michigan State University – Aquatic Animal Health Laboratory and Martha Wolgamood, Supervisor of the Wolf Lake State Fish Hatchery and Statewide Fish Health Coordinator. The paper has been updated and edited by Gary Whelan, Manager of the Fish Production Program for Fisheries Division.

Introduction

Recreational fishing for walleyes encompasses some of the most diverse and widespread angling opportunities in the State of Michigan. This prized species of fish inhabits our Great Lakes waters, inland lakes of all sizes and shapes, and many miles of river throughout the State. When recreational fishing for walleyes gained popularity in the 1970s, the Michigan Department of Natural Resources and Environment (DNRE) began developing ways to rear a large number of young walleyes for stocking into Michigan's lakes and rivers. Production of walleyes typically consists of raising fry to a total length (TL) of about 1/2 inch and spring fingerlings to a TL somewhere between 1 and 2 inches. To accomplish this we use a combination of on-site hatchery resources and off-site rearing ponds. In the early years when recreational fishing for walleyes was expanding its reputation and attractiveness among anglers, walleyes were stocked somewhat indiscriminately throughout the waters of the State. Over time however, fisheries managers learned which stocking efforts were most successful and adjusted their efforts accordingly. Success of stocking has typically been determined by the establishment of a consistent fishery rather than incidental catches of walleyes. In most cases, walleyes are not stocked in waterbodies where natural reproduction is strong. Recently, introduction of a pathogen of fish, Viral Hemorrhagic Septicemia (VHSv), to the Great Lakes Basin has significantly altered production of walleyes and stocking in Michigan and elsewhere throughout the region. Prior to the introduction of VHSv, the DNRE stocked on average 3 to 5 million spring fingerling walleyes each year. In contrast, no walleyes were stocked in 2007, only 850,000 fish were stocked in 2008, 1.7 million were stocked in 2009, and 1.3 million were stocked in 2010. As a result of new information on VHSv in walleyes, the moratorium on stocking has been lifted beginning in 2011, and the previous statewide average of 3 to 5 million spring fingerling walleyes will be achieved by the spring of 2012. This paper describes actions taken by the DNRE from 2006 through 2010 to manage production of walleyes in the State of Michigan given the presence of VHSv.

Walleye Culture Process

Unlike some salmonid species we produce, brood sources for obtaining eggs from walleyes are not maintained at any state fish hatchery in Michigan. In fact, most DNRE hatcheries are designed for rearing trout and salmon rather than coolwater species such as walleye, northern pike, or muskellunge. DNRE uses three wild sources for obtaining eggs from walleyes in the Great Lakes; the Muskegon River; the Tittabawassee River; and Little Bay de Noc. Walleye egg-take occurs in the early spring when ripe fish congregate on spawning grounds. The Great Lakes spawning populations used as brood sources are characterized by large fish and larger females have more eggs. Eggs are fertilized, hardened, and disinfected on location, and are then sent to either the Wolf Lake State Fish Hatchery located in Mattawan or the Thompson State Fish Hatchery located in Manistique. After arriving at the hatchery eggs are incubated for 18 to 28 days before hatching.

Once a walleye hatches from the egg, it is called a fry and is less than 1/2 inch long. Occasionally, fry are immersed in an oxytetracycline (OTC) bath that permanently marks their bones and enables fisheries managers to determine their status as stocked fish later in life. Fry spend 3 to 5 days in the hatchery during which they are sustained by the nutrients in their yolk sac. Before the yolk sac is fully absorbed, fry are shipped to outdoor ponds located throughout the state for rearing to the fingerling stage. Ponds vary in size, shape, and water supply, with

some collecting water from natural runoff while others receive water pumped from a local surface or groundwater source. Many of these rearing ponds are owned by private groups that participate in valuable partnerships with the DNRE to increase the number of walleyes available for stocking statewide. Rearing ponds require conditioning prior to and after the arrival of fry. It is crucial that predators of fish, capable of severely limiting production of walleyes, are removed from these ponds before introducing fry. Ponds are further prepared for the arrival of fry by being fertilized with various organic and inorganic fertilizers to improve plankton abundance and ensure fry have an adequate food source. Fisheries technicians continue to fertilize ponds after fry are introduced so that plankton levels remain stable and available as food. As fry approach fingerling size, pond fertilization ceases and plankton levels are allowed to collapse. It is essential to remove fingerlings from the ponds prior to the collapse of plankton. If not removed, cannibalism will occur among these young walleyes, which can significantly limit production. Fry typically reach spring fingerling size between June and July and are ready to be stocked into our waters. The production of spring fingerling walleyes is highly variable from year to year and pond to pond.

Fisheries managers make decisions on which waterbodies will be stocked based on numbers of walleyes produced and management needs. Recommended stocking rates for spring fingerling walleyes are 25 to 100 fish per acre, with appropriate levels determined through experience and success establishing a consistent fishery in a particular lake over time. To the degree possible, biologists attempt to use an appropriate genetic strain of walleye when stocking lakes in a given management unit. For example, an inland lake which drains to Lake Michigan in the Lower Peninsula typically receives walleyes reared from eggs taken on the Muskegon River because that river also drains into Lake Michigan. There are instances in history however, when this guidance could not be followed because production of walleyes was not adequate to meet priority management needs.

Emergence of VHSv in the Great Lakes Basin and Control Measures

VHSv is a virus of fish. The virus is not native to the Great Lakes and was first isolated by the Ontario Ministry of Natural Resources (OMNR) in 2005 while investigating a significant mortality of freshwater drum that occurred in the Bay of Quinte, Lake Ontario. Although this was the first report of VHSv in the Great Lakes, it was not the earliest identification that the virus had invaded the Great Lakes Basin. Biologists at Michigan State University's Aquatic Animal Health Laboratory (MSU-AAHL) isolated an unknown virus from a muskellunge caught in Lake St. Clair in the spring of 2003, but did not pursue identification of the virus until learning of the results reported by OMNR in 2005. Confirmation of the unknown virus as VHSv in the muskellunge collected from Lake St. Clair was made in December 2005. These reports of VHSv placed the virus into a status of an emerging pathogen in the Great Lakes Basin. It is unknown how VHSv was introduced into the Great Lakes Basin. The most likely vector of introduction was via ballast water exchange, but other potential vectors include the movement of live fish and baitfish, and the natural migration of fish.

By the spring of 2006, large mortalities of fish were observed in Lake St. Clair, the St. Clair River, the Detroit River, the western basin of Lake Erie, Lake Ontario, and the St. Lawrence River. These mortalities are thought to be a single, large-scale event. Species of fish affected during the spring 2006 mortality event included Great Lakes muskellunge, walleye, lake

whitefish, burbot, freshwater drum, yellow perch, gizzard shad, redhorse sucker, and round goby. The virus was subsequently identified in several inland lakes in Michigan, Wisconsin, and Ohio as well.

VHSv is a disease of fish that must be reported to the World Organization for Animal Health (OIE). This need for reporting necessitates that DNRE send information regarding occurrences of VHSv to the United States Department of Agriculture – Animal and Plant Health Inspection Service (USDA-APHIS). VHSv can be transferred through the water via urine and reproductive fluids, and can survive in water for at least 14 days. The virus infects gill tissue first, and then progresses to internal organs and blood vessels. Blood vessels are weakened, which results in hemorrhaging of the internal organs, muscle, and skin. Fish can also become infected with the virus by eating other infected fish. Stresses on a fish such as extreme water temperatures, starvation, and spawning can lower immune responses, which could subsequently result in infected fish actually becoming diseased. Additionally, fish under stress may become susceptible to other pathogens of fish as was observed by fish health examiners at the MSU-AAHL when reviewing a die-off of smallmouth bass in Lake St. Clair in 2009.

Fish that survive VHSv infection develop antibodies that will protect the individual against additional infections for some time. In 2010, researchers at the MSU-AAHL found that muskellunge from Lake St. Clair were able to mount a strong antibody response after surviving an initial infection from VHSv, even without finding any live virus in the fish. Despite this natural inoculation of fish against further infection, the concentration of antibodies may eventually decrease leaving a fish susceptible to contracting the virus again. Further study is still needed on this aspect of the virus to be certain of how long a fish may be protected from further infection.

Fisheries managers on the west coast of the United States have three decades of experience managing VHSv in salmon species, and have developed effective disinfection procedures for rearing salmon. Because the virus does not appear to penetrate the eggs produced by salmon, surface disinfection of eggs is effective in killing the pathogen and protecting hatcheries. This appears to also be the case for walleyes. Researchers at the MSU-AAHL conducted experiments in 2010 to determine if adult walleyes pass the virus on to their young at spawning and found that such transmission of the virus does not occur in walleyes. Other recent work by researchers at the University of Guelph in Ontario, Canada has also shown that the virus probably does not penetrate into the eggs of walleyes.

In addition to the question of whether adult walleyes could pass the virus on to their progeny, there was also the outstanding question of whether disinfection procedures used for salmonids would be effective for walleyes. DNRE could not simply assume that such disinfection procedures would be effective for coolwater species of fish, even though the methods have been recommended as appropriate by the Great Lakes Fish Health Committee (GLFHC) of the Great Lakes Fishery Commission. Fortunately, research supporting the effectiveness of standard disinfection techniques was completed in 2010 at both the U.S. Geological Survey's Upper Mississippi Environmental Science Center and at the U.S. Fish and Wildlife Service's LaCrosse Laboratory. The findings at both laboratories indicate that any virus associated with eggs and milt of walleyes at the time of spawning will be killed by the same iodophor compounds that

DNRE uses to disinfect eggs of coldwater species of fish. Further work by fisheries scientists from the Wisconsin Department of Natural Resources indicates that the lethal concentration of iodophor compounds necessary to destroy the virus are maintained even when using de-clumping agents such as Fuller's earth or tannic acid, which are added to prevent the suffocation of the eggs.

All of the research conducted to date suggests that the technique used by DNRE for disinfecting eggs from coolwater species of fish is effective. There is still some uncertainty associated with the disinfection technique. The research findings, however, have significantly increased our confidence in using the disinfection technique as part of a comprehensive biosecurity strategy that greatly reduces the risk of spreading VHSv in the wild or into our hatcheries. It is now our opinion, therefore, that it is possible to reinstitute a full program for rearing and stocking of walleyes and other species of coolwater fishes.

Future Production of Coolwater Fishes in Michigan

There exists a fine line that separates responsible policy for managing the State's aquatic resources from accomplishing all that stakeholders want when faced with a problem as widespread and potentially harmful as VHSv. This is especially true when the threat from VHSv appears to have passed and the detrimental effects are no longer obvious. Still, it is our job to protect, conserve, and manage the aquatic resources of Michigan for the use and enjoyment of current and future generations. We know that protecting is always less expensive and preferable to rehabilitating degraded populations of fish, particularly when funding and capacity for such work is so uncertain.

In light of the good news stated above, we continue to hold the opinion that VHSv poses a serious threat to both populations of fish in the wild as well as in the State's hatcheries. Given the public trust responsibilities of the DNRE, fisheries management actions must not contribute to spreading VHSv. Because the likelihood is high that VHSv will remain present in Michigan's waters for the foreseeable future, fisheries management activities with a potential to spread the virus must undergo a thorough review to evaluate the risks involved when taking those actions.

Given the risks involved with managing VHSv, we also recognize that recreational fisheries for walleye and partnerships for rearing ponds have suffered over the past few years while we dealt with the presence of VHSv. To be sure, we value those fisheries and partnerships very much and look forward to reinvigorating both in the coming year. We expect that our rearing efforts for walleyes will continue with the same energy and commitment of the past, but also with the confidence of knowing that we are doing all that is possible to manage the potential negative effects of VHSv on the aquatic resources of Michigan. We appreciate the continued patience and understanding of our stakeholders who have been directly affected by the limited production of coolwater species of fish in recent years and thank you for your continued support.

Management Timeline

2006 – By the time mortalities of fish became evident in the spring of 2006, hatchery production of walleye, northern pike, and muskellunge was already underway. There was no evidence to suggest the virus had spread to the brood source locations for those species, so DNRE proceeded with normal production and stocking of all coolwater species that year.

DNRE initiated surveillance in 2006 to identify the occurrence and spread of VHSv in Michigan's waters. Samples from fish that were collected during this surveillance effort were sent to the MSU-AAHL. Samples were tested for the presence of VHSv using standard cell culture and genetic techniques, with results available approximately one month after the cultures were started. Samples collected from fish in the northern region of Lake Huron near Alpena and Rogers City in the fall of 2006 tested positive for VHSv. Positive samples were also observed from fish collected from the St. Clair River, Lake St. Clair, and Lake Erie in 2006. The virus was isolated in samples of Chinook salmon, lake whitefish, and walleye, but no large-scale mortality event of these species was observed at the time. Additionally, an archived lake whitefish collected near Cheboygan, MI in the late fall of 2005, obtained from the Chippewa Ottawa Resource Authority (CORA), also tested positive for VHSv. Positive identification of VHSv in fish in Lake Huron, along with previous findings led the DNRE to categorize large portions of the State's waters into three VHSv management areas; a VHSv Free Management Area; a VHSv Positive Management Area; and a VHSv Surveillance Management Area. Each designation includes special regulations for the fisheries operating in those waters. Those designations and rules are available by clicking on the Fishing link at the DNRE internet site (http://www.michigan.gov/dnre).

2007 – Extensive surveillance for VHSv continued statewide in 2007, largely coinciding with regularly scheduled fisheries surveys of inland lakes, streams, and the Great Lakes. Cell culture remained the method used for identifying presence of the virus. In 2007, DNRE tested 8,933 samples from 62 inland and Great Lakes locations. Brood sources of walleyes from the Muskegon River, the Tittabawassee River, and Little Bay de Noc, brood sources of muskellunge from Hudson Lake and Thornapple Lake, and brood sources of northern pike from Sanford Lake and Little Bay de Noc were all inspected and all tested negative for VHSv.

In May of 2007 however, VHSv was isolated in fish collected from Budd Lake (Clare County) during investigation of a large fish kill that included black crappie, bluegill, golden shiner, largemouth bass, muskellunge, pumpkinseed, and yellow perch. Budd Lake is a land-locked waterbody with essentially no flow of water in or out, suggesting the source of VHSv in this case was from release or use of infected baitfish, or the illegal stocking of infected gamefish. Samples collected later in the year after the fish kill failed to turn up additional positive detections of VHSv. With this occurrence in inland waters, one of the worst case scenarios relative to containing the disease was realized and highlighted the seriousness of the threat to the State's waters and hatcheries. VHSv was showing up in other locations across the basin as well. Samples of fish collected in the spring of 2007 from Lake Winnebago in Wisconsin and from Green Bay on Lake Michigan tested positive for VHSv. Given the apparent spread of the virus across the Great Lakes and into some inland waters, and a serious lack of information regarding the transmission of VHSv in coolwater species of fish, the DNRE did not raise or stock any walleye in 2007 even though our brood sources all tested negative for the disease.

At the time, managers considered using large inland lakes as brood sources for walleye. This option was eventually dismissed because there are generally insufficient numbers of large adult walleyes available in any inland lake to meet the egg needs for production. That approach would have been extremely labor intensive and costly to accomplish due to the lack of a concentrated run like we see in stocks using tributaries to the Great Lakes. In addition, large public lakes

considered to be best candidates to try as brood sources for walleye also have the highest risk of becoming infected with VHSv through introduction of bait or some other vector. We also evaluated the use of rearing locations off-site from our hatcheries (e.g., remote field stations or trailers), but those options were dismissed because of problems in securing water sources, limitations in staffing, and the high cost. There was some small-scale stocking of walleyes done in 2007 by CORA, and other limited, private stocking events were approved when the sources of fish were confirmed to be free of VHSv.

There was no production of northern pike in 2007. The stocking program for northern pike uses fry transferred from the hatchery to rearing marshes. Eggs of northern pike hatch in 10 days and are ready to transfer to ponds 7-14 days after hatch. Testing protocols for VHSv require a minimum of 28 days to complete cell culture, so there was not enough time between egg-take and transfer of fry to outlying ponds to complete the required testing. Muskellunge production in 2007 was limited to fish transferred to Michigan from Iowa, which tested negative for VHSv. These fish were intensively reared in the Fish Health and Quality Lab at Wolf Lake Hatchery. This building isolates coolwater species of fish from coldwater species, and appropriate biosecurity measures were in place to protect the entire hatchery complex from possible contamination by VHSv. Production of lake sturgeon was accomplished in streamside rearing facilities, which were used because of their isolation from State fish hatcheries.

2008 – Surveillance for VHSv using funding provided by USDA-APHIS was conducted by State and Provincial agencies on all the Great Lakes. Few samples collected during these efforts tested positive for VHSv. Cell culture remained the standard used to accurately identify VHSv, using Polymerase Chain Reaction (PCR) as a confirmatory test. The occurrences of VHSv expanded further in 2008 to include a positive detection from fish sampled from Clear Fork Reservoir, Ohio, the first detection in a water body outside of the Great Lakes Basin, and detections from fish collected from Lake Michigan by Illinois and Wisconsin. In 2008, DNRE tested 7,156 samples of fish collected from 57 locations on the Great Lakes and inland waters. None of the fish tested by DNRE were positive for VHSv. DNRE also tested 650 samples from brood sources for walleye over multiple occasions in 2008 and all were negative for VHSv. Brood sources for muskellunge and northern pike were again tested in 2008 and all were negative for VHSv. Samples of fish collected from Budd Lake in 2008 were also negative. In response to the continued negative results of our surveillance testing on brood sources for walleye, we began a limited rearing program in 2008. Stringent restrictions were placed on brood sources, disinfection procedures, disease testing regimes, and biosecurity measures. In addition, DNRE aimed to further minimize risk of spreading the disease to inland waters and State fish hatcheries by carefully selecting rearing ponds and stocking locations around the State.

Brood Sources for Walleye – Given that VHSv has caused mortality of fish in the Lake St. Clair-Lake Erie basin and in the Lake Huron Basin, the brood source from the Tittabawassee River was considered the highest risk for potential transfer of VHSv. The populations of wallyeys in Little Bay de Noc represented the second highest risk for transferring the disease because VHSv was found in southern Green Bay. The brood source for walleye in the Muskegon River was believed to have the lowest risk for transferring VHSv because it was furthest away from previous detections of the virus at that time. Consequently, a decision was made to use only walleyes from the Muskegon River as a brood source for production in 2008.

Disinfection Procedures – Despite documented success disinfecting eggs of salmon species, researchers were unable to confirm the effectiveness of disinfecting eggs against VHSv for coolwater species in 2008. Experiments by DNRE to determine the effectiveness of iodine disinfection were unsuccessful because we were unable to collect eggs from infected wild walleyes. We were also unable to artificially infect eggs with VHSv in 2008 and so did not pursue in vitro experiments. Notwithstanding the uncertainty regarding effectiveness of the disinfection protocols for eggs of coolwater species of fish, the GLFHC still recommended an iodophor disinfection protocol prior to bringing eggs of coolwater species into hatcheries.

Biosecurity Measures – The GLFHC made several recommendations to protect hatcheries from becoming contaminated with VHSv, including: testing source waters used for egg-takes, implementing disinfection methods, annual testing and fish health inspections for brood sources and production lots, hatchery fish health certifications, and considerations for developing protected Great Lakes salmonid and non-salmonid brood source lines. Other general guidance included the requirement that eggs being moved between hatcheries should be disinfected prior to transfer, and that hatchery equipment and trucks should be disinfected after each use. DNRE has incorporated many, if not all, of these measures to protect State fish hatcheries from becoming contaminated with VHSv. The most ominous recommendation from the GLFHC was that agencies should destroy all fish at hatcheries found to be contaminated with VHSv; a recommendation that is consistent with the OIE Aquatic Animal Health Code. Inclusion of such a recommendation by these multi-agency and international animal health organizations highlights the seriousness of contaminating a hatchery with VHSv.

The cost of depopulating and disinfecting an entire hatchery in Michigan would be high, and the idea that such a thing might happen with VHSv has been taken very seriously by the DNRE. In the mid-1980s, the DNRE was faced with such a catastrophe. The Marquette State Fish Hatchery was depopulated and disinfected when Epizootic Epitheliotropic Disease Virus (EEDv) was identified as the cause of mortalities in lake trout. The cost to the DNRE was significant and the loss of fish was a major setback to lake trout rehabilitation efforts. Taking appropriate biosecurity measures to avoid a similar catastrophe with VHSv is critical.

To minimize the risk of contaminating hatcheries in 2008, incubation of eggs from walleyes was limited to the Thompson State Fish Hatchery since incubation there could be isolated from other rearing areas by constructing a wall and reconfiguring the plumbing. Unfortunately, the Thompson Hatchery was designed as a coldwater fish hatchery and steelhead rearing is a primary purpose. Coolwater production capabilities, including our attempts to isolate the incubation area for walleyes, were retrofits aimed at making the best of a facility that was designed for other purposes. Efforts at the Thompson Hatchery reduced the risk of spreading VHSv to other species being reared there, but it did not ensure 100% elimination of the risk. As an additional precaution, all eggs from steelhead that are normally incubated at the Thompson Hatchery were instead incubated at the Wolf Lake Hatchery. Additionally, eggs from steelhead were not transferred back to the Thompson Hatchery until walleye fry had been transferred to rearing ponds and disinfection of the incubation area had been completed.

Disease Testing Regime – All three brood sources for walleyes were tested in February 2008 prior to spawning and again at the time of spawning. In addition to the standard 60-fish sample

used for full health inspection, all adults used for spawning were sacrificed and tissue samples were collected specifically to test for VHSv. Fish sacrificed were filleted by staff in Fisheries Division and donated to local shelters.[2] If any adult walleyes had tested positive for VHSv, all eggs and/or fry produced from those eggs would have been destroyed. Fortunately, none of the fish tested positive for VHSv. Later in the production process, VHSv testing continued with 1,500 fry from each day's egg-take. None of these fish tested positive for VHSv. Although all adults used for egg collection were VHSv-negative, fry could also be exposed to the virus via the open water sources of rearing ponds. Thus, fingerlings from all rearing ponds were also tested prior to any fish being stocked. As with adults, if any fingerlings had tested positive for VHSv, then all fish from that pond would have been destroyed.

Selection of Rearing Ponds and Stocking Locations – The final precaution against spreading VHSv to previously uninfected waters was to be highly selective in our use of rearing ponds and stocking locations. Rearing ponds were limited to non-drainable ponds with no connection to other surface waters. Stocking of walleyes was limited to spring fingerlings, which were only stocked into inland lakes that had no inlets or outlets, or into inland lakes with immediate connections to a Great Lake already designated as a VHSv Positive Management Area or a VHSv Surveillance Management Area. As such, absolutely no rearing or stocking of walleyes took place in the Lake Superior Basin, which is still designated a VHSv Free Management Area. Walleye fry are ready for transfer to rearing ponds or for direct stocking at 1-5 days old. It takes 28 days to complete testing for VHSv, therefore, no direct stocking could be done, only transfers to rearing ponds where fish would be held for an additional 40-60 days prior to stocking. This conservative approach to rearing and stocking of walleyes in inland waters was far safer than implementing full production, but it also greatly reduced the number of active rearing-pond partnerships and acceptable stocking sites statewide.

Other Coolwater Species of Fish – There was no production of northern pike in 2008 for the same reasons provided in the summary for 2007. Culture and stocking of muskellunge from Michigan broodstocks began again in 2008. Eggs were taken from muskellunge in Thornapple Lake and Lake Hudson where we have historical fish health inspection data showing the stocks are free of VHSv. Non-lethal samples were collected from all fish to test for VHSv. Eggs were incubated and fry were intensively reared in the Fish Health and Quality Lab at Wolf Lake Hatchery. This building isolates coolwater species of fish from coldwater species, and appropriate biosecurity measures are in place to protect the entire hatchery complex from possible contamination with VHSv. Muskellunge fry were tested for VHSv, and since all were negative, spring fingerlings were available for stocking into approved waters. Muskellunge fall fingerlings received a full health inspection, including testing for VHSv, prior to being stocked in the fall and were negative as well. As in 2007, lake sturgeon production was limited to streamside rearing facilities.

2009 – Surveillance for VHSv using finding provided by USDA-APHIS was conducted by State and Provincial agencies on all the Great Lakes, although at a lower level than in 2008 because of budget constraints. Cell culture remained the standard used to accurately identify VHSv, using Polymerase Chain Reaction (PCR) as a confirmatory test. The occurrences of VHSv expanded

[2] VHSv is not a pathogen of humans and therefore presents no consumption risk for people.

further in 2009 to include a positive detection from fish sampled from Baseline Lake, Washtenaw County (Huron River watershed). Brown bullheads collected during surveillance sampling were positive for VHSv. Although VHSv has already been found in Lake St. Clair, two additional samples of fish were found to be positive for VHSv in 2009. The first positive was a Great Lakes strain of muskellunge and the second was a smallmouth bass collected during a fish kill. While VHSv was found in the smallmouth bass, additional pathogens were identified and the primary cause of death could not be determined. In 2009, DNRE tested 7,261 samples collected from 64 locations on the Great Lakes and inland waters. Brood sources for Coolwater species were again tested in 2009 and all were negative for VHSv. These included walleyes from the Muskegon River, the Tittabawassee River, and Little Bay de Noc, muskellunge from Hudson and Thornapple lakes, and northern pike from Sanford Lake and Little Bay de Noc.

Brood Sources for Walleye – Production of walleye expanded slightly in 2009 to make use of brood sources from both the Muskegon River and Little Bay de Noc. Because VHSv was found in southern Green Bay and southwest Lake Michigan, we believe the addition of the brood source from Little Bay de Noc presents no more risk of transferring VHSv into our hatcheries than does the use of the brood source from the Muskegon River. Our decision was also made in light of the fact that CORA had used this same brood source in 2008 with extensive testing and no positive results for VHSv. Because of differences in the timing of spawning runs of walleyes in the Muskegon River and Little Bay de Noc, using both brood sources allowed crews to run egg-take operations over a longer period. Despite no detections of VHSv in walleyes from the Tittabawassee River, it was again our opinion that the close proximity of this brood source to places where the virus caused large mortality events in the past posed a high risk. Also, timing for the run of walleyes on the Tittabawassee River is similar to that on the Muskegon River, so taking eggs at the Tittabawassee River would not provide a timing advantage that the run on Little Bay de Noc does to allow for additional production of fry at the hatchery. Although using walleyes from the Tittabawassee River would have provided the preferred genetic strain for stocking into the Lake Huron watershed, research has determined little genetic difference between walleyes from the Muskegon River and the Tittabawassee River. This is not surprising given the main source used to rehabilitate the population in the Tittabawassee River was from the Muskegon River, and insufficient time has transpired to allow for significant genetic divergence. Consequently, by not using walleyes from the Tittabawassee River as a brood source, we did not further restrict stocking of walleyes into the Lake Huron Basin in 2009.

Disinfection Procedures – In 2009, the DNRE continued to use the GLFHC-recommended disinfection protocol for eggs from coolwater species (see above). Additionally, researchers were again unable to confirm the effectiveness of disinfection procedures to kill VHSv on eggs from coolwater species of fish.

Biosecurity Measures – In 2009 we utilized the same biosecurity measures as we did in 2008. Incubation of eggs from walleyes was limited to the Thompson Hatchery, and steelhead eggs were not transferred to the Thompson Hatchery until walleye fry had been transferred to rearing ponds and disinfection of the incubation area had been completed. Because production at the Thompson Hatchery is limited to 6 million fry, we looked into additional facilities for incubation outside of the State fish hatchery system. The Mason County Walleye Association was assessed for its potential to incubate and hatch eggs from walleyes. It was determined that water from

their well would require processing to improve its quality before it could be used for rearing purposes. Additionally, some work would need to be done where water would be discharged from the building because of concerns by the club with water pooling near the building. While the club was willing to invest in the changes to their facility for this project, with no guarantee that the State would use it in the future they opted to wait until it was clear that the State would use their facility. Although we did not have any agreement with CORA regarding stocking of walleyes in 2009, they ended up stocking surplus walleyes in several inland lakes in the Upper Peninsula.

Disease Testing Regime – The testing regime for VHSv as it related to culture of walleyes in 2009 was identical to that used in 2008 (see above). There were no positive results for VHSv in any of the samples collected.

Selection of Rearing Ponds and Stocking Locations – In 2009, the DNRE implemented the same criteria for determining rearing pond and stocking locations as was used in 2008 (see above).

Other Coolwater Species of Fish – There was no production of northern pike in 2009 (for the same reasons no production was undertaken in 2007 as explained above), though production of muskellunge continued in the same manner as in 2008. As in previous years, lake sturgeon production was limited to streamside rearing facilities.

2010 – Surveillance for VHSv was continued by all State and Provincial management agencies on the Great Lakes. Cell culture remained the standard used to accurately identify VHSv and Polymerase Chain Reaction (PCR) was the confirmatory test. While no samples collected in 2010 by DNRE were found to be positive, the first confirmed positive samples were collected from fish in Lake Superior, including yellow perch near Paradise, MI and lake herring from the Apostle Islands, WI. Re-sampling of fish that were previously found to be positive in Baseline Lake (Washtenaw County) and Budd Lake (Clare County) did not yield any positive samples. In 2010, DNRE tested 16,570 fish collected from 83 Great Lakes and inland locations. Coolwater brood sources were again tested in 2010 and all were negative for VHSv. These brood sources included walleye from the Muskegon River, the Tittabawassee River, and Little Bay de Noc; muskellunge from Hudson and Thornapple lakes; and northern pike from Sanford Lake and Little Bay de Noc. The current data on VHSv show that the virus has not spread broadly throughout Michigan's waters to date, and that fish previously found to be infected may not be continuously positive for VHSv.

Many of the key questions about VHSv and the culture of coolwater fish were addressed in 2010. These questions included uncertainties with respect to the transmission of VHSv between adult walleyes and their progeny, and uncertainty around the efficacy of techniques for disinfecting eggs of walleyes to prevent VHSv. As a result of efforts by researchers at MSU-AAHL in 2010, we now know that VHSv does not move from adult walleyes to their progeny through the egg. In addition, information reported by researchers at the University of Guelph in Ontario, Canada indicates that the virus does not move directly into eggs of walleyes. Also in 2010, fisheries scientists at the U.S. Geological Survey's Upper Mississippi Environmental Science Center and the U.S. Fish and Wildlife Service's LaCrosse Fish Health Laboratory were able to demonstrate that standard disinfection techniques using iodophor compounds are successful in killing VHSv

on the outside of eggs from walleyes. Finally, work done by biologists at the Wisconsin Department of Natural Resources in 2009 indicated that the lethal concentration of iodophor is not affected by use of de-clumping agents such as Fuller's earth or tannic acid. De-clumping agents must be used to prevent suffocation of eggs from coolwater species of fish during artificial fertilization. These findings have greatly increased our ability to manage the risks associated with the rearing of walleyes in the face of VHSv.

In 2010, researchers at the MSU-AAHL determined that individual fish that have been exposed to VHSv and survived will develop a strong antibody response, recover from the infection, and maintain the antibody response even after live VHSv is no longer detected. This is very good news and greatly reduces the risks associated with how, when, and where to stock coolwater species of fish. Additionally, this group of researchers made large advances in determining which species are highly susceptible to VHSv (e.g., muskellunge, lake herring, bluegills and largemouth bass), those that have medium to low levels of susceptibility to the virus (e.g., rainbow trout, steelhead, Atlantic salmon, brown trout, lake trout, brook trout, splake, and walleye), and those that are very resistant to VHSv (e.g., Chinook and coho salmon) or immune to the virus (lake sturgeon).

Progress was made on developing rapid tests for VHSv in 2010. New rapid tests for VHSv in fish and in water using PCR were published in the scientific literature in early 2010 by fisheries scientists from Cornell University. Final quality control testing of these tests is in progress at this time. A new rapid ELISA test that detects VHSv antigens in fish was developed and published in 2010 by researchers at the MSU-AAHL. There were also efforts by staff at the USDA-APHIS to improve quality control methods for test results for VHSv between laboratories. This effort should hopefully reduce the variation in results received by DNRE. It is expected that most of the new tests will be available for use in 2011 or 2012. We will be involved in moving these tests from the laboratory to implementation in the field. Finally, development of a full VHSv testing tool box will allow us to rapidly determine the status of VHSv in a population of fish, including whether an active VHSv infection is ongoing, whether a population of fish has been exposed to VHSv, and whether the population of fish has recovered after being infected by the virus.

There are still gaps in our understanding about VHSv. For example, we do not yet know how long the virus can survive outside of a fish host; or what the reservoirs are for maintaining viable concentrations of VHSv in natural systems. Surveillance for VHSv will be continued by all State and Provincial agencies on the Great Lakes in 2011. Such surveillance will help us determine which water bodies have fish that are infected with VHSv, the rate at which VHSv spreads, how fish infected with the virus respond over time, and which other aquatic species can harbor VHSv.

Brood Sources for Walleye – We used brood stock from both the Muskegon River and Little Bay de Noc for production of walleyes in 2010. Routine testing of walleyes from the Tittabawassee River has not identified the presence of VHSv. However, the proximity of that brood source to areas where previous mortality events attributed to VHSv have occurred resulted in the DNRE rejecting the use of this brood stock in 2010.

Disinfection Procedures – The DNRE used the GLFHC-recommended disinfection protocol for coolwater eggs.

Biosecurity Measures – The DNRE used the same biosecurity measures in 2010 as we did in 2009. Incubation of eggs from walleyes only occurred at the Thompson State Fish Hatchery. To further the risk of spreading VHSv from eggs of walleyes to steelhead in Thompson Hatchery, we did not transport eggs from steelhead to the hatchery until walleye fry had been transferred out of the hatchery to rearing ponds and disinfection of the incubation area had been completed. The private hatchery facility in Mason County was not used in 2010 because there was no need for additional space to incubate eggs and hatch walleye fry. Sufficient walleye fry were incubated at Thompson State Fish Hatchery to meet the State's needs for stocking in 2010. CORA again assisted in 2010 by stocking surplus walleyes in Mullet Lake and Little Bay de Noc.

Disease Testing Regime – The testing regime for VHSv as it related to the culture of walleyes in 2010 was identical to that used in 2009 (see above). There were no positive results for VHSv in any samples collected by the DNRE.

Selection of Rearing Ponds and Stocking Locations – In 2010, the DNRE implemented the same criteria for choosing rearing ponds as was used in 2009. Stocking locations for 2010 were essentially the same as those used in 2009. The only difference for stocking locations was the addition of a few waterbodies that did not meet the previously established criteria, but after further review were shown to have a low risk for expanding the range of the pathogen.

Other Coolwater Species of Fish – As in 2009, there was no production of northern pike in 2010. Rearing of muskellunge continued as it has in the previous two years, with a total of 29,000 fall fingerlings raised at the Wolf Lake State Fish Hatchery and subsequently stocked. As in previous years, production of lake sturgeon was limited to streamside rearing facilities.

2011 – All of the research conducted to date suggests that the technique used by DNRE for disinfecting eggs from coolwater species of fish is effective. There is still some uncertainty associated with the disinfection technique. The research findings, however, have significantly increased our confidence in using the disinfection technique as part of a comprehensive biosecurity strategy that greatly reduces the risk of spreading VHSv in the wild or into our hatcheries. It is now our opinion, therefore, that it is possible to reinstitute a full program for rearing and stocking of walleyes and other species of coolwater fishes.

Brood Sources for Walleye – Given the current knowledge concerning VHSv, brood sources for walleyes from the Muskegon River, the Tittabawassee River, and Little Bay de Noc, may all be used in 2011 for egg-take, as long as appropriate disinfection methods are used.

Disinfection Procedures – The DNRE will use the disinfection protocol for eggs from coolwater species of fish as recommended by the GLFHC, including the use of iodophor compounds to disinfect eggs. We will also conduct periodic tests of the iodophor concentration to ensure we maintain a level that is lethal to VHSv.

Biosecurity Measures – With the use of appropriate disinfection procedures, we will resume incubation of walleye fry at both the Wolf Lake and Thompson State Fish hatcheries. To reduce any residual risks of transmitting VHSv to other species of fish in the hatcheries, we will keep susceptible species, including muskellunge and lake herring, away from eggs of walleyes that are being incubated and away from fry that have hatched. All other biosecurity measures with respect to disinfection and cleaning of the facilities will be maintained.

Disease Testing Regime – The testing regime for VHSv as it relates to the culture of walleyes in 2011 will be similar to that used in 2010, with some changes in the number of fish sampled. We will continue to test pre-spawning walleyes from each brood source, a sub-sample of walleyes from each spawning (between 60-100 fish), fry, and a sub-sample of walleyes from all rearing ponds used for production. If new tools for testing become available for use in 2011, we will implement those into the culture and stocking program for walleyes as appropriate.

Selection of Rearing Ponds and Stocking Locations – Based on the most recent information available related to propagation of walleyes and effects of VHSv, there are no limitations on which extensive culture ponds may be used to rear walleyes for stocking in 2011. Similarly there are no limitations on where walleye can be stocked in 2011, except for considerations related to genetics that guide us in such decisions.

Other Coolwater Species of Fish – As in 2010, there will be no production of northern pike in 2011 since there is no information about effects of VHSv on this species. Muskellunge rearing will continue at levels similar to 2010. We will also begin the development of a Great Lakes (spotted) muskellunge broodstock using strict biosecurity measures. Since lake sturgeon are likely immune to VHSv, there will be no limitations on production. All other brood stocks of coolwater species will continue to be tested for VHSv as in 2010, and all fish produced will be inspected for fish pathogens including VHSv.