

Project Completion Report
Project Title:

Subaward # Z520301
Grant # 2007-38500-18589

PROJECT CODE: 07-03

SUBCONTRACT/ACCOUNT NO: Z520301

PROJECT TITLE: The Infection Cycle of Viral Hemorrhagic Septicemia Virus

DATES OF WORK: October 1, 2008 to May 30, 2012 (includes no-cost extension)

PARTICIPANTS:

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REASON FOR TERMINATION:

Objectives completed

PROJECT OBJECTIVES:

1. To determine the fate of key fish species (Atlantic salmon, hybrid striped bass, walleye) when challenged with standard challenge doses of VHSV IVb to identify fish most susceptible to development of disease and/or development of a carrier state of the infection.
2. To generate the needed data to support the validation of a quantitative RT-PCR for VHSV.
3. To provide an effective and timely distribution of new information to the aquaculture community relative to VHSV.

ANTICIPATED BENEFITS: State how the project will benefit the aquaculture industry either directly or indirectly.

The project will directly benefit the aquaculture community by providing information on the relative risk to important cultured fish to infection by VHSV Genotype IVb. With this information, aquaculturists will be better able to develop effective biosecurity programs for their facilities. The development and evaluation of the qRT-PCR for VHSV Genotype IVb will provide the industry with a rapid and accurate diagnostic test of the virus. The presentation of the extension/outreach programs associated with this project has provided the industry, as well as governmental regulators, administrators and resource personnel with the most current information on the status of VHSV Genotype IVb.

PRINCIPAL ACCOMPLISHMENTS: Summarize in a concise form the findings for each objective for the duration of the project. Measurement data are to be given in SI units. However, to minimize confusion, a dual system of measurement may be used to express results.

1. Challenge Studies:

The relative risk posed by VHSV IVb to Atlantic salmon, walleye and hybrid striped bass were determined by laboratory-based challenge studies. All of these challenge studies have been completed. These species were selected due to their importance in aquaculture (Atlantic salmon, hybrid striped bass) or their potential importance (walleye) as cultured species in the Northeastern United States. They were also selected so as not to duplicate studies of which we are aware and are funded by other sources. Based on the development of signs of disease, ability to isolate the virus in cell culture and ability to detect the virus by qRT-PCR, Atlantic salmon and walleye appeared to have a relatively low risk to VHSV IVb. Using the same criteria, hybrid striped bass appeared to have a moderate risk to the virus. Studies were conducted at 10C and 15C. Of the two test temperatures, 10C appeared to be a water temperature that was a greater risk factor than 15C. Manuscripts describing these studies have been published or are in press in the peer-reviewed literature.

2. Validation of the qRT-PCR:

We have continued to summarize qRT-PCR results from field investigations as well as from laboratory-based studies in our effort to build a compelling data base of information in support of the qRT-PCR validation. We continue to collaborate with the scientists at the USGS Western Fisheries Research Center, Seattle, WA in this effort. A manuscript detailing the qRT-PCR has been accepted for publication in the peer-reviewed scientific literature. We have also participated in a VHSV Diagnostic Test Ring Trial of a number of qRT-PCR tests in an effort coordinated by the USDA APHIS National Veterinary Services Laboratories, Ames, Iowa. In that evaluation, several tests were evaluated by a number of fish health and veterinary diagnostic laboratories. We anticipate that this aspect of the investigation will result in an additional peer-reviewed manuscript.

3. Extension:

Both extension/outreach workshops supported by this grant have been presented. Those workshops were held at the Headquarters of the New York State Department of Agriculture and Markets, Albany, NY (3 December 2009) and at the USFWS Northeast Fishery Center, Lamar, PA (23 June 2010). In addition, personnel of the Cornell University Aquatic Animal Health Program have cooperated with the Aquaculture Biosecurity workshops organized by Dr. Michele Walsh through a complementary NRAC project. Cornell personnel have served as faculty at all 5 workshops organized by Dr. Walsh:

Carlisle, PA 9, August 2008 (Dr. G. Groocock)
Turners Falls, MA, 18 October 2008 (Dr. P. Bowser and Dr. J. Casey)
Edmeston, NY, 8 April 2008 (Dr. P. Bowser)
Canaan, Maine, 23 June 2009 (Dr. R. Getchell)
Moorefield, WV (29 July 2009; Dr. P. Bowser)

IMPACTS: In concise statements (possibly a bulleted list) indicate how the project has or will benefit the aquaculture industry either directly or indirectly and resulting economic values gained (where appropriate).

1. The experimental challenge trials have documented the relative susceptibility of fish to infection and development of disease due to VHSV Genotype IVb. Such information will be invaluable to the commercial aquaculture community when they develop and employ biosecurity measures.
2. The validation of the qRT-PCR will provide the fish health community with a valuable tool for the rapid and accurate diagnosis of infection due to VHSV Genotype IVb.
3. The extension effort has provided the commercial aquaculture community, as well as governmental administrators, regulators and resource personnel with the most contemporary information on the status of VHSV Genotype IVb and the risk posed by this disease.

RECOMMENDED FOLLOW-UP ACTIVITIES: State concisely how future studies may be structured.

Our efforts supported by this source of funding as well as by others have allowed us to build a preliminary knowledge base on the emergence of VHSV IVb in the Great Lakes Region of North America. To date the disease has not been found in any aquaculture facility. The initial emergence of the virus resulted in several instances of large and devastating fish kills as well as numerous smaller disease events. These fish kills were primarily in 2005-2007. Since that time, significant fish kills have not been reported. It is critical to emphasize the verb “reported.” We are aware that fish kills have occurred, but if they involve less desirable fish species, such as round gobies or freshwater drum, the public does not feel they are important. Beyond these instances of “soft data” we do have solid scientific information documenting that the virus is still present in the Great Lakes Basin. Surveillance efforts as recent as 2011 show that the virus was present in 40% of the round gobies collected from the St. Lawrence River. Further, over the course of the emergence of VHSV IVb we have been involved with collaborators in an effort that has identified over 50 different genetic types of the virus. We are currently conducting a preliminary effort to determine if there is a difference in virulence between two of the genetic variants.

Seeing genetic variability in VHSV is a completely predictable event. VHSV is an RNA virus and the mode of replication of RNA virus is prone to genetic mistakes; these are the mutations we hear about in RNA viruses. The take-home message is that VHSV IVb is still in the Great Lakes Basin and it is changing. Future studies should be focused on the changes that are occurring and if those changes will be associated with changes in biological behavior of the virus, such as virulence. These efforts

should be coordinated with a continued outreach effort to keep the public aware of the VHSV as well as other emerging pathogens. Only with a combined and coordinated effort between research and extension can the movement of VHSV IVb from wild fish into the aquaculture environment be avoided. Should VHSV IVb become endemic in aquaculture in North America, the impact on the industry would be devastating.

SUPPORT: Use the format in the table below to indicate NRAC-USDA funding and additional other support, both federal and non-federal, for the project. Indicate the name of the source(s) of other support as a footnote to the table.

YEAR	NRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVERSITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	
1	\$ 96,260						\$ 96,260
2	\$ 103,003						\$ 103,003
TOTAL	\$ 199,263						\$ 199,263

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED: List under an appendix with the following subheadings: *Publications in Print*; *Manuscripts*; and *Papers Presented*. For the first two subheadings, include journal articles, popular articles, extension materials, DVDs, technical reports, theses and dissertations, etc. using the format of the Transactions of the American Fisheries Society (example below). Under *Papers Presented* subheading include the authors, title, conference/workshop, location, and date(s). Example of Transactions of the American Fisheries Society citation format: Billington, N., R. J. Barrette, and P. D. N. Hebert. 1992. Management implications of mitochondrial DNA variation in walleye stocks. North American Journal of Fisheries Management 12:276-284.

Publications in Print

Hope, K.M., R.N. Casey, G.H. Groocock, R.G. Getchell, P.R. Bowser and J.W. Casey. 2010. Comparison of quantitative RT-PCR with cell culture to detect viral hemorrhagic septicemia virus IVb (VHSV IVb) infections in the Great Lakes. Journal of Aquatic Animal Health. 22:50-61.

Cornwell, Emily R., Eileen A. Penner, Rodman G. Getchell, Geoffrey H. Groocock, and Paul R. Bowser. 2012. Experimental infection of rainbow trout (*Oncorhynchus mykiss*) and hybrid striped bass (*Morone chrysops* ♂ X *M. saxatilis* ♀) to viral hemorrhagic septicemia virus type IVb. Journal of the World Aquaculture Society. (Accepted for publication by the journal.)

Groocock, Geoffrey H., Stephen A. Frattini, Emily R. Cornwell, Rodman G. Getchell and Paul R. Bowser. 2012. Comparative Susceptibility of Four Aquacultured Species to Viral Hemorrhagic Septicemia Virus Type IVb. Journal of the World Aquaculture Society. 43:459-476.

Manuscripts

Hope, K.M. 2011. The Development and Application of a Zebrafish Infection Model for Viral Hemorrhagic Septicemia Virus (VHSV) IVb. PhD Dissertation. Cornell University, Ithaca, New York.

Cornwell, E.R. 2012. Infection Dynamics of Viral Hemorrhagic Septicemia Virus Genotype IVb. PhD Dissertation. Cornell University, Ithaca, New York.

Papers Presented

Geoffrey H. Groocock, Stephen A. Frattini, Geoffrey E. Eckerlin, Rodman G. Getchell, Gregory A. Wooster, William T. Heath, Kristine M. Hope, Rufina N. Casey, John M. Farrell, James W. Casey and Paul R. Bowser. 2009. The Emergence of Viral Hemorrhagic Septicemia virus type IVb in the Lower Great Lakes Basin. Aquaculture America. Seattle, WA, 15-18 February 2009.

Emily Cornwell, Heath, William T., Kristine M. Hope, Rufina N. Casey, Paul R. Bowser, Geoffrey E. Eckerlin, Ingrid Lombardino, Eileen Penner, Stephanie Owczarczak, Mark B. Bain, William N. Batts, James R. Winton and James W. Casey. 2009. Targeted Surveillance for VHSV-GL in the Absence of Clinical Disease. Aquaculture America. Seattle, WA, 15-18 February 2009.

Eckerlin, Geoffrey E., John M. Farrell, Rufina N. Casey, Kirstine M. Hope, Paul R. Bowser, James Casey and Geoffrey H. Groocock. 2009. Viral Hemorrhagic Septicemia Virus (VHS) Type IVb in the Great Lakes: Ecological and Monitoring Implications and Recommendations. GLRC Poster Session. Great Lakes Goes to Albany. Albany, NY. 28 April 2009.

Cornwell, E.R., Heath, W.T., Hope, K.M., Casey, R.N., Bowser, P.R., Eckerlin, G.E., Lombardino, I., Penner, E., Owczarczak, S., Bain, M.B., Batts, W.N., Winton, J.R., and Casey, J.W. 2009. Persistence of VHSV-GL in the Absence of Clinical Disease. 2009 International Conference on Aquatic Invasive Species. Fairmont Queen Elizabeth, Montreal, Quebec, Canada. 19-23 April 2009.

Cornwell, E.R., W.T. Heath, K.M. Hope, R.N. Casey, P.R. Bowser, G.E. Eckerlin, I. Lombardino, E. Penner, S. Owczarczak, M.B. Bain, W.N. Batts, J.R. Winton, and J.W. Casey. 2009. Targeted Surveillance for VHSV in the Great Lakes in the Absence of Clinical Disease. 34th Annual Eastern Fish Health Workshop, Lake Placid, NY. 27 April – 1 May, 2009.

Bowser, P.R. 2009. Bait Minnows and Fish Health Regulations in New York State. 34th Annual Eastern Fish Health Workshop, Lake Placid, NY. 27 April – 1 May, 2009.

K.M. Hope, R.N. Casey, E.R. Cornwell, I.M. Lombardino, E.A. Penner, S.A. Owczarczak, W. T. Heath, M.B. Bain, G.E. Eckerlin, W.N. Batts, J.R. Winton, J.W. Casey and P.R. Bowser. Targeted Surveillance for VHSV-GL in the Absence of Clinical Disease. 50th Western Fish Disease Workshop and American Fisheries Society - Fish Health Section Annual Meeting. Park City, UT. 8 – 10 June 2009.

MacNeill, D.B. and P.R. Bowser. 2009. NY Sea Grant's Proactive Research and Extension Responses to Viral Hemorrhagic Septicemia (VHS). Brown Bag Lunch Seminar Series. National Sea Grant Program, NOAA, Department of Commerce. Silver Springs, MD. 18 June 2009. (invited abstract)

Cornwell, Emily R., Geoffrey E. Eckerlin, Kristine M. Hope, Rodman G. Getchell, Geoffrey H. Groocock, Paul R. Bowser, Rufina N. Casey, Mark B. Bain, William N. Batts, James R. Winton and James W. Casey. 2010. Distribution and prevalence of Viral Hemorrhagic Septicemia virus in Lake

Ontario and the St. Lawrence River. Annual Meeting of the New York Chapter of the American Fisheries Society. Lake George, New York. 10-12 February 2010. (Best Student Presentation Award to ERC)

Getchell, R.G., G.H. Groocock, E.R. Cornwell, K.M. Hope, R.N. Casey, J.W. Casey, and P.R. Bowser. 2010. VHSV Research Products Influencing Management and Regulatory Decisions. Coastal Ocean Science Solutions – Research Leading to Management Tools and the Development of Ocean Policy. 2010 Ocean Science Meeting. Portland, OR. 22-26 February 2010.

Cornwell, Emily R., Geoffrey E. Eckerlin, Rodman G. Getchell, Geoffrey H. Groocock, Paul R. Bowser, Mark B. Bain, and James W. Casey. 2010. Evidence for the continued presence of Viral Hemorrhagic Septicemia Virus in the Great Lakes in apparently healthy fish. Great Lakes in Albany. Great Lakes Research Consortium Poster Session. 23 March 2010.

Cornwell, E.R., G.E. Eckerlin, R.G. Getchell, G.H. Groocock, T.M. Thompson, P.R. Bowser, W.N. Batts, G.Kurath, J.R. Winton, M.B. Bain and J.W. Casey. 2010. Detection Of Viral Hemorrhagic Septicemia Virus In Lake Superior. 35th Eastern Fish Health Workshop. Shepherdstown, WV. 24-28 May 2010.

Cornwell, E.R., G.E. Eckerlin, R.G. Getchell, G.H. Groocock, T.H. Thompson, W.N. Batts, G. Kurath, J.R. Winton, P.R. Bowser, M.B. Bain and J.W. Casey. 2010. Results of 2009 Surveillance Efforts for Viral Hemorrhagic Septicemia Virus in Lake Ontario and Lake Superior. Sixth International Symposium on Aquatic Animal Health. Tampa, FL. 5-9 September 2010.

Getchell, R.G., G.H. Groocock, E.R. Cornwell, K.M. Hope, R.N. Casey, J.W. Casey, and P.R. Bowser. 2010. VHSV Research Products Influencing Management and Regulatory Decisions. Sixth International Symposium on Aquatic Animal Health. Tampa, FL. 5-10 September 2010.

Cornwell, E.R., E.A. Penner, G.H. Groocock, R.G. Getchell, G.A. Wooster, and P.R. Bowser. 2011. Effect of temperature on the susceptibility of hybrid striped bass to viral hemorrhagic septicemia virus type IVb. Annual Meeting of the New York Chapter of the American Fisheries Society. Canandaigua, New York. 2-3 February 2011.

Getchell, R.G., E.R. Cornwell, G.H. Groocock, L.L. Coffee, G.A. Wooster, R.N. Casey, J.W. Casey, and P.R. Bowser. 2011. VHSV in the Great Lakes: Comparative Species Susceptibility. Annual Meeting of the New York Chapter of the American Fisheries Society. Candandaigua, New York. 2-3 February 2011.

Cornwell, E.R., E.A. Penner, G.H. Groocock, R.G. Getchell, G.A. Wooster, and P.R. Bowser. 2011. Susceptibility of hybrid striped bass to viral hemorrhagic septicemia virus type IVb at two temperatures. 36th Annual Eastern Fish Health Workshop. Mt. Pleasant, SC 28 March – 1 April 2011.

Faisal, M., G. Kurath, J.W. Casey, P.R. Bowser, and J.Winton. 2011. Emergence and spread of Viral Hemorrhagic Septicemia in the Laurentian Great Lakes: status of knowledge and lessons learned. 141st Annual Meeting of the American Fisheries Society, Seattle, WA, 4-8 September 2011.

Bowser, P.R. 2012. VHSV IVb in the Great Lakes Basin – Introduction And Historical Overview. 37th Annual Eastern Fish Health Workshop. Lake Placid, New York. 23-27 April 2012.

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PART II

TECHNICAL ANALYSIS AND SUMMARY: Describe the work undertaken and results obtained for each objective. Major results should be presented in detail, including graphs, charts, figures, photomicrographs or other presentations. Methodology should be briefly described and statistical analyses and significance should be included where appropriate. This section of the report should be written with style similar to scientific publication. Reports previously or currently prepared for publication may be submitted as part of this section.

PROJECT COMPLETION REPORT

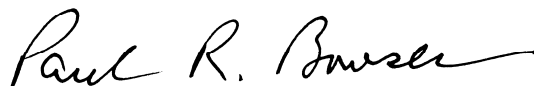
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PROJECT TITLE: The Infection Cycle of Viral Hemorrhagic Septicemia Virus

PREPARED BY:



Project Coordinator of Subawardee

Date **1 August 2012**

Paul R. Bowser, PhD
Professor of Aquatic Animal Medicine