

M.L. 2009 Projects Completed in 2013-2014

M.L. 2009 Projects

MN Laws 2009, Chapter 143, Section 2 (beginning July 1, 2009)

NOTE: For all projects, contact us to obtain the most up-to-date work programs for current projects (project updates are required twice each year) or the final reports of completed projects.

The following documents are short abstracts for projects funded during the 2009 Legislative Session. The final date of completion for these projects is listed at the end of the abstract. When available, we have provided links to a project's web site. The sites linked to this page are not created, maintained, or endorsed by the LCCMR office or the Minnesota Legislature.

Subd. 05 Water Resources

05b Vulnerability of Fish Populations in Lakes to Endocrine Disrupting Contaminants - **RESEARCH**

05c Cooperative Habitat Research in Deep Lakes - **RESEARCH**

Subd. 06 Aquatic and Terrestrial Invasive Species

06b Emergency Delivery System Development for Disinfecting Ballast Water - **RESEARCH**

06d Controlling the Movement of Invasive Fish Species

Subd. 05 Water Resources

Vulnerability of Fish Populations in Lakes to Endocrine Disrupting Contaminants

Subd. 05b \$297,000

Richard Kiesling

USGS

2280 Woodale Dr

Mounds View, MN 55112

Phone: (763) 783-3131

Email: kiesling@usgs.gov

Fax: (763) 783-3103

Web: <http://mn.water.usgs.gov/index.html>

RESEARCH

Appropriation Language

\$297,000 is from the trust fund to the commissioner of natural resources for an agreement with the United States Geologic Survey and St. Cloud State University to develop quantitative data on juvenile and adult fish vulnerability to endocrine-active emerging contaminants found in Minnesota lakes. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

Overall Project Outcome and Results

Effects of endocrine active compound (EAC) exposure to fish have been assessed predominantly at the molecular to organismal level, leaving questions regarding implications for population sustainability.

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One EAC, 17 beta-estradiol (E2), is frequently detected in aquatic environments because it is a hormone produced by vertebrates. This study assessed developmental and reproductive effects of E2 exposure on fathead minnows and bluegill sunfish. Continuous, six week exposures were conducted in outdoor tanks to simulate natural lake environments. First generation (F0) fathead minnows and bluegill sunfish were exposed during sexual maturity. Second generation (F1) fathead minnows were exposed during early development, sexual maturity, or both stages. Multiple biomarkers were measured to assess the effects of E2 exposure on fecundity, fish health, and development. Differences in the timing of egg production for both species indicate differences in lifetime fecundity between unexposed and exposed females. Exposure to E2 resulted in lower relative health and reduced expression masculine secondary sexual characteristic expression in F0 fathead minnows. Similar results were not observed in F1 fathead minnows. First generation bluegill sunfish males exposed to E2 had significantly smaller testes compared to controls. Supplemental, laboratory exposures were conducted on a separate fathead minnows cohort to assess reproduction and larval ability to escape a predator threat. Predation tests suggest E2 exposure of the current generation has the greatest effect on larval survival. Larval fathead minnows exposure to E2 in the F2 generation had longer escape responses and lower survival rates when compared to controls. Females exposed to E2 tended to lag behind controls in terms of larvae production after an initial period of similar activity. Results from this study suggest that exposure to E2 (in the absence of other estrogenic compounds) at environmentally relevant concentrations has subtle reproductive and developmental effects on fathead minnows and bluegill sunfish and implications for long-term survival in a predator-rich environment.

Project Results Use and Dissemination

Results from this study feed into an ongoing study assessing septic system discharge to lakes and effects on bluegill fitness (Assessing Septic System Discharge to Lakes, funded by Environment and Natural Resources Trust Fund in 2010).

A manuscript was submitted to the Journal of the American Water Resources Association for inclusion in a special issue on contaminants of emerging concern (originally submitted in February 2013, revised copy submitted in July 2013). A copy of the revised manuscript is included as an attachment to this final report.

Results from portions of this study have been included in two graduate student theses at St. Cloud State University under the supervision of Co-PI, Heiko Schoenfuss.

Results have been presented at the following scientific conferences:

March 2012 - Midwest Society of Environmental Toxicology and Chemistry (Minneapolis, MN)

June 2012 - American Water Resources Association specialty conference on contaminants of emerging concern (Denver, CO)

October 2012 - Minnesota Water Resources Conference (Minneapolis, MN)

This study was discussed in conjunction with similar work in a [MPR story](#) that aired on February 20, 2013.

Project Publications:

Fathead Minnow and Bluegill Sunfish Life-Stage Responses to 17 Beta-Estradiol Exposure in Outdoor Mesocosms (PDF - .2 MB)

Master's Thesis: Effect Differences of Estrogenic Exposure Between an Endangered Species and Two Model Species and Across Life Stages (PDF - 2.1 MB)

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Project completed: 06/30/2013

Cooperative Habitat Research in Deep Lakes

Subd. 05c \$825,000

Donald Pereira

DNR

500 Lafayette Rd

St. Paul, MN 55155-4040

Phone: (651) 259-5231

Email: don.pereira@dnr.state.mn.us

Fax: (651) 297-4916

RESEARCH

Appropriation Language

\$825,000 is from the trust fund to the commissioner of natural resources to assess the consequences of large ecological drivers of change on water quality and habitat dynamics of deep water lakes with coldwater fish populations. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

Overall Project Outcome and Results

We designed a long-term lake monitoring program that incorporates a synoptic view of lakes, including understanding historic and current lake conditions along statewide gradients of nutrients, climate, ecoregion, and land use. Twenty-four lakes and their associated watersheds were established as sentinel systems to serve as focal points of collaborative long-term monitoring, research, and environmental education. The research funded here focused primarily on the 7 deep-water sentinel lakes with coldwater fish populations. With our project partners, we examined current and forecasted relationships among resident lake biota, water quality, and lake habitat features, and extrinsic factors including watershed inputs, climate, and invasive species. Key deliverables include:

- U.S. Geological Survey developed biophysical water quality models to predict responses in the distribution of temperature and oxygen in Carlos, Elk, and Trout lakes based on current conditions. In Phase 2, models will be used to simulate the consequences of land-use change and climate dynamics on lake ecosystems, including sensitive cold-water fish communities.
- St. Croix Watershed Research Station provided a reconstruction of the historical water quality and diatom communities of seven sentinel lakes. Results provide a context for interpreting future community-level shifts based on land-use changes and climate trends.
- A data visualization tool has been developed that enables interested scientists and others to interact with SLICE data. Improvements are planned to make the tool more user-friendly and provide greater access to databases currently managed by DNR, PCA, and other partners.
- Analysis of zooplankton collections from 24 sentinel lakes suggests that zooplankton will be a sensitive indicator of current and changing lake conditions. Data collected thus far has allowed us to focus sampling on specific times and components of the zooplankton community.
- Our understanding about cisco behavior and population status in Minnesota lakes has been greatly enhanced. We developed and refined sampling techniques, and now have baseline information to understand climate and land use impacts to cisco lakes.

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Project Results Use and Dissemination

The information gathered during the SLICE project has been invaluable to fisheries and lake managers in a number of ways. First, the ability to collect water quality, zooplankton, fisheries, and historical lake data over consecutive years from a suite of lakes has been foundational for the implementation of a long-term monitoring program for Minnesota lakes. That information will provide researchers and managers with a wide variety of specialties and interests to focus on specific metrics that are most likely to reflect change from various stressors. The ability to identify those metrics and their response to specific stressors will enable managers to quickly respond and develop best management practices in lakes facing environmental changes. Second, techniques developed and refined during the project have strongly influenced our basic understanding of the ecology and behavior of cisco population in Minnesota. Understanding how cisco populations, vulnerable to both biotic (i.e. invasive species) and abiotic (i.e. climate change) stressors, respond to change will be important for the management of not only cisco but other cold and cool water species as well. Third, by including partners with differing discipline backgrounds and expertise, e.g., USGS, St. Croix Watershed Research Station, et al., the project was able to provide unique and holistic insights into how lake ecosystems function now and in the future (models), as well as how they may have in the past (sediments).

Project Publications:

Assessing the Water Quality and Habitat Dynamics of Deepwater Lakes with Coldwater Fish Populations (PDF - 8.5 MB)

Reconstruct historical water quality and habitat conditions in the seven coldwater sentinel lakes (PDF - 1 MB)

Exploring Hydraulic Residence in Minnesota's Sentinel Lakes: Implications for Management (PDF - .7 MB)

Project completed: 06/30/2013

Subd. 06 Aquatic and Terrestrial Invasive Species

Emergency Delivery System Development for Disinfecting Ballast Water

Subd. 06b \$125,000

Scott Smith

USGS

6505 - 65th Street NE

Seattle, WA 98115

Phone: (206) 427-8374

Email: sssmith@usgs.gov

Fax: (206) 526-6654

RESEARCH

Appropriation Language

\$125,000 is from the trust fund to the commissioner of the Pollution Control Agency for an agreement with the United States Geologic Survey to test the viability of treating ballast water through tank access ports or air vents as a means to prevent the spread of invasive species.

Overall Project Outcome and Results

This project was part of Phase III of an overall effort to produce an Emergency Response Guide to

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Handling Ballast Water to Control Non-Indigenous Species. Phase I (\$25,000) was funded by National Oceanic and Atmospheric Administration and resulted in a study plan entitled "Mixing Biocides into Ships' Ballast Water: Efficiency of Novel Methods." Phase II (\$185,000) was funded by the Great Lakes Fisheries Trust and studied in-line injection, bulk dye dosing, perforated hose dosing, and passive mixing methods, such as ship's motion.

Similar to Phase II, this effort (Phase III) prepared ballast tank mixing and sampling equipment, field work on a working ship to trial promising ballast mixing methods, and analysis/report. The active methods being studied in Phase III are venturi eductors and air lifts. The outcome will be the incorporation of these methods (if determined to be effective and practical) into a best practices guide for treating the ballast water of ships either:

- Arriving in port with high risk ballast water,
- Leaving a port that contains ballast known to be high risk for the destination port, or
- Grounded and laden with high risk, untreated ballast water.

Project Results Use and Dissemination

Preliminary information from Result 1 and Result 2 activities were shared at the May 18, 2010 Great Lakes Ballast Water Collaborative meeting in Montreal, QC and at the June 1, 2010 Lake Superior Binational Program - Invasive Species Workshop in Duluth, MN.

The final project results consisting of two reports entitled "Emergency Response Guidance for Handling Ballast Water to Control Aquatic Invasive Species" and "Mixing Biocides into Ship's Ballast Water-Great Lakes Bulk Carrier Field Trials" are posted on the National Park Service web site at <http://www.nps.gov/isro/naturescience/handling-ballast-water-to-control-non-indigenous-species.htm>.

Project Publication:

Emergency Response Guidance for Handling Ballast Water to Control Aquatic Invasive Species (PDF - 2.2 MB)

Mixing Biocides into Ship's Ballast Water: Great Lakes Bulk Carrier Field Trials (PDF - 3.5 MB)

Project completed: 06/30/2012

Controlling the Movement of Invasive Fish Species

Subd. 06d \$300,000

Vaughan Voller

U of M
2 Third Ave SE
Minneapolis, MN 55414

Phone: (612) 625-0764

Email: volle001@umn.edu

Web: <http://www.safl.umn.edu>

Appropriation Language

\$300,000 is from the trust fund to the Board of Regents of the University of Minnesota to develop and test sonic barriers that could be effective in preventing and controlling the movement of invasive carp in Minnesota's waterways. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

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Overall Project Outcome and Results

The abundance of common carp in lakes has a negative impact on water quality. Hence, great ecological benefit for many Minnesota lakes will be gained if effective barriers can be constructed to control carp movements. The aims of this project were to construct, implement, and test common carp barriers based on air bubble curtain technologies. This work comprised three main results. In result 1 the construction and engineering of bubble curtain barriers was investigated. Focus was placed on generating, measuring, and controlling the sound and flow fields generated by bubble curtains. This work has led to engineering bubble barrier designs that can reliably produce stimuli (sound level and frequency) in the ranges that would deter carp movement. Result 2 focused on the laboratory testing of the barriers of Result 1. This work, representing the first known rigorous and detailed testing of bubble barriers, showed that the barriers are 75-80% effective in reducing fish passage through a control section. In addition, a model capturing fish behavior in the vicinity of the barriers was built and tested. The emphasis of Result 3 was field implementation and testing of bubble barriers. The main work here, in cooperation with Ramsey-Washington Metro Watershed District, was the design and implementation of a test barrier in Kohlman Creek, Maplewood. This barrier construction cost was \$5,000 and operating cost was \$300 per month when operating continuously. Data collected from this site has shown that the barriers are effective in stopping 60% of downstream carp movements, thereby corroborating the laboratory results. Upstream movements of motivated spawning adult carp, however, while deterred by the bubbles were not stopped. The overall results from this work have clearly indicated when bubble curtain barrier technologies for controlling carp movement will and will not work. Thereby providing critical information for land managers to more wisely implement and use this low cost and environmentally friendly barrier technology.

Project Results Use and Dissemination

The engineering design and testing of the bubble barriers has been documented in the MS thesis by Dan Zielinski:

Zielinski, D.P. (2011) Bubble barrier technologies for common carp, University of Minnesota, MS Thesis

The laboratory and field testing, modeling and data analyses is reported in a the PhD Thesis of Dan Zielinski

Zielinski, D.P. (2013) An engineering perspective on invasive fish control: A study of bubble curtain deterrent systems to control carp movement, University of Minnesota, Ph.D. Thesis.

This work also reports the behavioral modeling of fish in the vicinity of the barrier along with the development of the necessary theory to support this model.

A detailed reporting of the laboratory effectiveness is found in the paper:

Zielinski, D.P., Voller, V.R., Svendsen, J.C., Hondzo, M., Mensinger, A.F., Sorensen, P., (2013) Laboratory experiments demonstrate that bubble curtains can effectively inhibit movement of common carp. Submitted to Ecological Engineering.

A detailed reporting of behavioral model is found in the paper

Zielinski, D.P., Hondzo, M., Voller, V.R. (2013a) Mathematical evaluation of behavioral deterrent systems to disrupt fish movement. Submitted to Ecological Modeling.

Elements of all of these works was presented at a number of conferences:

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- Zielinski, D.P., Sorensen, P. (2013), Field study of an air bubble curtain to inhibit Common Carp movement, Minnesota Chapter of American Fisheries Society Annual Meeting, St. Cloud, MN, USA.
- Zielinski, D.P., Voller, V.R., Svenden, J., Hondzo, M. Mensinger, A., Sorensen, P. (2012), Inhibiting Common Carp Movement with a Bubble Curtain, 142nd Annual Meeting of the American Fisheries Society, St. Paul, MN, USA.
- Zielinski, D.P., Voller, V.R., Svenden, J., Hondzo, M. Mensinger, A., Sorensen, P. (2011), Controlling the Movement of Invasive Species, 2nd Annual Upper Midwest Stream Restoration Symposium, Oconomowoc, WI, USA.
- Zielinski, D.P., Voller, V.R., Svenden, J., Hondzo, M. Mensinger, A., Sorensen, P. (2011), Bubble Barrier Technologies for Common Carp, Minnesota Chapter of American Fisheries Society Annual Meeting, Sandstone, MN, USA.

Project completed: 06/30/2013
