Environment and Natural Resources Trust Fund
2009 Phase 2 Request for Proposals (RFP)

LCCMR ID: 068-B4

Project Title: Vulnerability of Lakes to Endocrine Disruption

Total Project Budget: $ $297,000

Proposed Project Time Period for the Funding Requested: July2009-June 2011

Other Non-State Funds: $ $33,000.00

Priority: B4. Deep Water Lakes

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Sponsoring Organization: USGS

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Region:	County Name:	City / Township:
Metro	Ramsey	

Summary: Develop quantitative data on juvenile and adult fish vulnerability to endocrine-active emerging contaminants (EACs) found in Minnesota lakes using pond-scale enclosures (i.e., mesocosms).

Main Proposal: 1008-2-054-proposal-2009_kiesling_shoenfus_main_proposal2.doc

Project Budget: 1008-2-054-budget-Kiesling_LCCMR_2009budget.xls

Qualifications: 1008-2-054-qualifications-Kiesling_CV_LCCMR.doc

Map:

Letter of Resolution:

MAIN PROPOSAL

PROJECT TITLE:

Assessing the Vulnerability of Lake Fish Communities to Endocrine Disruption from Water and Sediment using Pond Mesocosms

I. PROJECT STATEMENT

Develop quantitative data on juvenile and adult fish vulnerability to endocrine-active emerging contaminants (EACs) found in Minnesota lakes using pond-scale enclosures (i.e., mesocosms). Recent work has identified on-site septic systems as a source of emerging contaminants to lakes (Carrara and others, 2008; Godfrey and others, 2007), and recent results from whole-lake experimental exposures to endocrine disruptors have documented complete reproductive failure of short-lived species of fish (Kidd and others 2007), raising questions about the effects of these compounds on longer-lived species of fish common to Minnesota lakes. ***Preliminary data from ongoing research in Minnesota have found biomarkers of endocrine disruption in female fish from urban lakes (Schoenfuss and others, unpublished data) raising questions regarding how Minnesota fish communities will respond to EAC exposure. Given the large number of lakes at risk from point and nonpoint sources of emerging contaminants, there is a need for relevant data on how vulnerable fish populations are to chronic EAC exposure from contaminated lake water and sediment.***

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Developmental impacts of juvenile exposure to water and sediment concentrations of EACs. Budget: $176,000

Effects of EACs will be measured in a three-way, balanced design using four-cubic meter mesocosms. Mesocosms will be installed in 0.1 acre ponds located at the USGS Upper Mississippi Ecosystem Science Center (UMESC). Three species of juvenile fish reared at the UMESC facility (fathead minnow, bluegill, and walleye or perch) will each exposed to one of three EACs (ethynylestradiol, 4-nonylphenol (4-NP), or nonylphenol ethoxylate (NPEO) through either water or sediment exposure for six weeks. Each treatment combination will be replicated, and exposures will run for six weeks. Water and sediment concentrations will be monitored four times during the experiment, and fish will be evaluated using blood-chemistry biomarkers (e.g., plasma vitellogenin) and histo-pathological indices of abnormal development (e.g., intersex). Half of the fathead minnows and bluegills fish exposed in this experiment will be allowed to grow to sexual maturity and will be evaluated for reproductive success as part of Result 2 below.

Deliverable	Completion Date
Mesocosm Installation	**7/15/2009**
Mesocosm Exposure experiments	**9/30/2009**
Biomaker Evaluation	**12/31/2009**
Analysis and reporting	**4/30/2010**

Result 2: reproductive impacts of juvenile and adult exposure to water and sediment concentrations of EACs. Budget: $121,000

Effects of EACs on reproductive success (i.e, mating behavior and spawning success) will be measured in a two-way, balanced design using four-cubic meter mesocosms. Mesocosms will be installed as above in 0.1 acre ponds. Juvenile fathead minnows and bluegills reared under Result 1 above will be allowed to spawn under controlled conditions and evaluated for reproductive output. Sexually mature adults of walleye or perch from common stock populations at UMESC (and bluegill if necessary) will each be exposed to ethynylestradiol through water or sediment exposure for six weeks prior to spawning. Water and sediment concentrations will be monitored four times during the experiment, and fish will be

evaluated using blood-chemistry biomarkers (e.g., plasma vitellogenin) and histo-pathological indices of abnormal reproductive physiology before and after spawning as appropriate.

Deliverable	Completion Date
Mesocosm Installation	**7/15/2009**
Mesocosm Exposure Experiments	**8/31/2010**
Biomaker Evaluation	**12/31/2010**
Analysis and reporting	**4/30/2011**

III. PROJECT STRATEGY AND TIMELINE

A. Project Partners

This project is a continuing partnership between the United States Geological Survey (USGS). and Dr. Heiko L. Schoenfuss, Associate Professor and Director of the Aquatic Toxicology Laboratory, Department of Biological Sciences, St. Cloud State UniversityTeam members from the USGS include Dr. Richard Kiesling (project Leader), Dr. Mark Gaikowski (USGS-UMESC Mesocosm Facility Director). Team members from the USGS will manage mesocosm installation and experimental protocols, exposure experiments, chemical analysis, and spawning experiments. Team members from St. Cloud State University will manage histopathology, behavioral experiemtns and spawning experiments. All team members will participate in writing the final report and communicating results to state user groups

B. Project Impact

1. Project provides direct estimate of how juvenile fish of common lake species respond to environmentally meaningful EAC exposures in a lake setting.

Most EACs are found at very low concentrations in water (Kolpin and others; 2002; Lee and others; 2004) but reach higher concentrations in sediment (e.g., Mayer and others, 2006; Pojana and others 2007; Kim and Carlson, 2007). Despite these low concentrations, research has identified developmental and reproductive effects on fish species at environmentally relevant concentrations. The proposed work will extend this work to include important lake species under chronic exposure to either water or sediment exposure pathways.

2. Project provides an estimate of the importance of longevity and other reproductive characteristics in the magnitude of fish response to EAC exposure during different growth stages/ages.

In Minnesota, endocrine disruption has been observed in short- and long-lived fish species including vitellogenin induction in male fathead minnows (*Pimephales promelas*) male carp (*Cyprinus carpio*) and walleye (*Stizostedion vitreum*) (Folmar and others, 1996, 2001; Lee and others, 2000). Vitellogenin in male carp was also observed at numerous sites downstream of WWTP discharges throughout central Minnesota (Lee and others, 2000). Two ongoing studies in Minnesota have recently identified additional fish species affected by EACs in tributaries of the Mississippi and the St. Croix Rivers (Jahns and others in prep; Lee and others in review) as well as urban lakes (Schoenfuss and others – unpublished data). Taken as a whole, these results indicate that Minnesota fish communities are vulnerable to reproductive impacts. This study helps answer how vulnerable three important lake species are to EAC

C. Time

This is a two-year proposal. Activities in year will include the installation and testing of mesocosms, the training of two graduate student research assistants, and the executing and analysis of data from the Result 1 experiments. The second year will implement the experiments under Result 2, evaluate the results, and complete the final report. Results will be communicated to state and national peer groups through presentations at regional and national meetings including state resource management meetings.

Project Budget

IV. TOTAL PROJECT REQUEST BUDGET

BUDGET ITEM	AMOUNT	% FTE
Personnel: Academic salary and benefits (Schoenfuss)	$ 12,000	
Personnel: Civil Service salary and benefits (USGS)	$ 60,000	30%
Personnel: Civil Service salary and benefits (field research assistants)	$ 120,000	100%
Equipment/Tools: sampling equipment, sample storage equipment, batteries, and related items.	$ 63,000	
Acquisition (Including Easements):	N/A	
Restoration:	N/A	
Other: Cost for analysis of field samples (non-USGS samples)	$ 30,000	
Other: Shipping, repair of equipment, and mileage reimbursement	$ 8,000	
Other: Travel	$ 4,000	
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 297,000	

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Leveraged During Project Period: United States Geological Survey (USGS) matching funds.	$ 33,000	*Unsecured*
Other State $ Being Spent During Project Period:	N/A	
In-kind Services During Project Period:	$128,000	
Past Spending: $249K trust fund + $77K match already spent, another $249K trust fund + $166K match allocated for spending prior to 7/1/09	NA	

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Education:

University of Michigan: 9/83-7/90, Ph. D. in Biological Sciences awarded 12/90; specialized in ecology and limnology

University of Minnesota: 9/75-6/80, majored in biology and history, BS awarded 6/80

Professional Experience:

US Geologic Survey
Hydrologist and Limnology Specialist, 9/05 to present
Hydrologist and Water Quality Specialist, 8/01 to present
University of Minnesota
Research Associate. Dept. of Fisheries, Wildlife, and Conservation Biology, 2/2006 to 2/2008
University of Texas
Research Fellow, Environmental Science Institute, 1/02 to present.

Recent Publications:

Baker, J.W., J.P. Grover, B.W. Brooks, F. Ureña-Boeck, D.L. Roelke, R.M. Errera, R. Kiesling. 2007. Growth and toxicity of Prymnesium parvum (Haptophyta) as a function of salinity, light and temperature. Journal of Phycology. 43:219-227.

Grover, J.P., J.W. Baker, F. Ureña-Boeck, B.W. Brooks, R. Errera, D.L. Roelke, R.L. Kiesling. 2007. Laboratory tests of ammonium and barley straw extract as agents to suppress abundance of the harmful alga Prymnesium parvum and its toxicity to fish. Water Research. 41: 2503-2512.

Roelke D.L., R. Errera, R. Kiesling, B.W. Brooks, J.P. Grover, L. Schwierzke, F. Ureña-Boeck, J. Baker, J.L. Pinckney. 2007. Effects of nutrient enrichment on Prymnesium parvum population dynamics and toxicity: Results from field experiments, Lake Possum Kingdom, USA. Aquatic Microbial Ecology. 46:125-140.

Kiesling, R.L. 2003. Applying Indicators of Hydrologic Alteration to Texas Streams- overview of methods with examples from the Trinity River basin. U.S. Geological Survey Publication FS 128-03.

Kiesling, R. L, A. M. S. McFarland, and L. M. Hauck. 2001. Stream community responses to eutrophication from nonpoint source nutrient loading. In J.J. Warkick, ed., AWRA Spring Specialty Conference Proceedings. "Water Quality Monitoring and Modeling". American Water Resources Association, Middleburg, Virginia, TPS-01-1, 284 pp.