

Environment and Natural Resources Trust Fund (ENRTF) 2010 Work Program

Date of Report: 11/24/2009
Date of Next Progress Report: October 10, 2010
Date of Work Program Approval:
Project Completion Date: June 30, 2013

I. PROJECT TITLE: Estrogenic and Pharmaceutical Septic System Discharge to Lakes

Project Manager: Richard L. Kiesling
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Location: Statewide project

Total ENRTF Project Budget:	ENRTF Appropriation	\$594,000
	Minus Amount Spent:	\$ 0
	Equal Balance:	\$594,000

Legal Citation: ML 2010, Chap.[____], Sec.[____], Subd._____.

Appropriation Language:

II. PROJECT SUMMARY AND RESULTS: Pharmaceuticals and endocrine active compounds, including estrogenic compounds, were found in water and sediment of 12 Minnesota lakes as part of a recent study by USGS and St. Cloud State University in cooperation with the Minnesota Pollution Control Agency. Lakes with a high density of septic systems had the most frequent detections of these chemicals. Low-levels of estrogenic compounds in lakes have caused the extinction of species of forage fish and are known to cause abnormal sexual development in bass and walleye in Minnesota Rivers. Given these results, there is a need to know how estrogenic and pharmaceutical compounds in Minnesota lakes affect fish populations. To answer this question, the USGS Minnesota Water Science Center, in partnership with St. Cloud State University and the MN Department of Health, will survey 24 additional Minnesota lakes with high densities of septic systems for water and sediment contamination from pharmaceuticals and estrogenic compounds. Each lake in the study will also be assessed for watershed and groundwater hydrology characteristics that may contribute to the observed patterns of water and sediment concentrations of estrogenic and pharmaceutical compounds. A subset of lakes with high contaminant concentrations will be chosen for detailed analysis of exposed fish populations, and native fish populations will be assessed during the spawning season for endocrine disruption and mating

success. The project will provide details on what pharmaceutical and estrogenic compounds are present in lakes and whether these compounds affect the native fish populations in these same lakes.

III. PROGRESS SUMMARY AS OF [insert date of Work Program progress report]:

IV. OUTLINE OF PROJECT RESULTS:

RESULT 1: Quantify the occurrence of estrogenic or pharmaceutical compounds in 20 Minnesota lakes that receive groundwater inputs from septic systems.

Description:

Pharmaceuticals and EACs will be measured in water and sediment from 24 Minnesota lakes. Lakes chosen will have significant numbers of septic systems (>35% shoreline development) and will be distributed among the State’s hydrologic and ecological regions. Sampling will follow the general protocol from the recently completed Statewide Survey with MPCA, with site selection and sample distribution designed to follow gradients in groundwater and surface water hydrology within and between lakes. Results from the proposed survey will be combined with the results from the recently completed Statewide Survey to develop an EAC contaminant database for Minnesota lakes. The database will be used to analyze patterns in contaminant occurrence relative to watershed characteristics.

Summary Budget Information for Result 1: ENRTF Budget: \$247,000
 Amount Spent: \$0
 Balance: \$247,000

Deliverable/Outcome	Completion Date	Budget
1.Survey of 12 lakes	9/30/2010	\$96,000
2.Survey of 12 additional lakes	11/30/2010	\$96,000
3. Data report on lakes	6/30/2011	\$55,000

Result Completion Date: 8/31/2011

Result Status as of: 12/31/2010

Result Status as of: 6/30/2011

Result Status as of: 12/31/2011 (completed)

Final Report Summary: 6/30/2013

RESULT 2: Assess the hydrology and ecology of the watershed contributing to water or sediment concentrations of estrogenic/pharmaceutical compounds in the surveyed lakes.

Description:

Each Minnesota lake sampled under Objective 1 will be classified by geologic, hydrologic, and ecological characteristics. Groundwater hydrology, including depth to groundwater, and groundwater contribution to lake water balance, determined using $\delta^{18}\text{O}$ and $\delta^2\text{H}$ isotopes, will be coupled with surface water hydrology (contributing area, morphometry) and watershed characteristics (land use, land cover; fragmentation) to develop categorical classifications for each lake. Groundwater level data will be collected for each lake in the vicinity of sampling sites, and seasonal groundwater isotope sampling in each lake will provide an estimate of groundwater contribution to water balance.

Summary Budget Information for Result 1: ENRTF Budget: \$120,000
 Amount Spent: \$0
 Balance: \$120,000

Deliverable/Outcome	Completion Date	Budget
1.Survey of 12 lakes	11/30/2010	\$48,000
2.Survey of 12 additional lakes	5/30/2011	\$48,000
3. Data report on groundwater characteristics	12/31/2011	\$24,000

Result Completion Date: 8/31/2011

Result Status as of: 12/31/2010

Result Status as of: 6/30/2011

Result Status as of: 12/31/2011 (completed)

Final Report Summary: 6/30/2013

RESULT 3: Assess biological exposure and response to known estrogenic and pharmaceutical compound contamination in Minnesota lakes.

Description:

A subset of the 24 lakes sampled under Objective 1 will be chosen for detailed biological analysis based of the severity of contamination. Adult bluegill sunfish will be sampled during the spring reproductive period from active nesting areas in each lake. Nesting areas will be associated with developed and undeveloped shorelines. Adult male and female fish will be evaluated using a variety of biomarkers, including condition factors, blood-chemistry (e.g., plasma vitellogenin) and histo-pathological indices of abnormal gonad development (e.g., intersex). Nesting sites will be evaluated for

selected Phac and EAC residues in food-web components at the time of active reproduction. Samples from major trophic levels including adult bluegill will also be collected for stable isotope analysis to determine bluegill food web structure during the nesting period.

Summary Budget Information for Result 3: ENRTF Budget: \$117,000
 Amount Spent: \$0
 Balance: \$117,000

Deliverable/Outcome	Completion Date	Budget
1.Tag adult fish in spawn areas	6/30/2012	\$24,000
2.Sample fish in target lakes	8/30/2012	\$66,000
3. Collect samples for food-web analysis	10/30/2012	\$10,000
3. Data report on lakes	6/30/2013	\$17,000

Result Completion Date: 6/30/2013

Result Status as of: 12/31/2010

Result Status as of: 6/30/2011

Result Status as of: 12/31/2011

Final Report Summary: 6/30/2012

Result Status as of: 12/31/2012

Final Report Summary: 6/30/2013

RESULT 4: Enhance EAC analytical capabilities at the Minnesota Department of Health (MDH).

Description:

MDH currently has the capability to quantify a number of Phacs and organic compounds including the EACs bisphenol A, nonyl phenol (NP), and octyl phenol (OP). As part of this project, MDH will enhance its existing Phacs and EAC methods while implementing advanced laboratory techniques to quantify NP precursors. All MDH Phac and EAC analytical capabilities will be used to analyze water samples from the 20 Minnesota lakes in this study.

Summary Budget Information for Result 1: ENRTF Budget: \$110,000
 Amount Spent: \$0
 Balance: \$110,000

Deliverable/Outcome	Completion	Budget
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	Date	
1. Purchase of triple quadrupole mass spectrometer	9/30/2010	\$110,000

Result Completion Date: 12/31/2011

Result Status as of: 12/31/2010

Result Status as of: 6/30/2011

Result Status as of: 12/31/2011 (completed)

Final Report Summary: 6/30/2013

V. TOTAL ENRTF PROJECT BUDGET: \$594,000

Personnel: \$ 235,400; \$198,400 to USGS and \$40,000 to Saint Cloud State University

Capital Equipment: \$110,000 to MDH to aid in the purchase of a Triple quadrupole mass spectrometer for the Organic Research Public Health Laboratory

Supplies: \$ 26,000

Travel: \$ 24,600

Additional Budget Items: \$ 198,000 (laboratory analytical costs at USGS analytical labs)

TOTAL ENRTF PROJECT BUDGET: \$594,000

Explanation of Capital Expenditures Greater Than \$3,500:

Triple quadrupole mass spectrometer for MDH research lab to use in method application to analyze for the compounds of interest in this study - \$110,000.

This piece of equipment will be will remain in service at MDH and will continue to analyze environmental samples for endocrine disruptors and pharmaceuticals after the end of the project.

VI. PROJECT STRATEGY:

A. Project Partners: This project is a continuing partnership between the United States Geological Survey (USGS) and the State of Minnesota to document the occurrence and effects of emerging contaminants in lakes. Team members from the USGS include Dr. Richard Kiesling (project Leader), Kathy Lee (project co-leader; USGS Biologist), and Dr. Mindy Erickson (USGS Groundwater Specialist). USGS will manage project planning, sampling, and sample analysis. Dr. Heiko L. Schoenfuss, Professor and Director of the Aquatic Toxicology Laboratory, Department of Biological

Sciences, St. Cloud State University, will participate in this project by performing histopathology analysis of fish tissues and data analysis and interpretation. Minnesota Department of Health laboratory team members include Paul Swedenborg, (MDH organics lab supervisor) and Dr. Carin Husset (MDH organics lab research scientist). All team members will participate in writing the final report and communicating results to state user groups.

B. Project Impact and Long-term Strategy: In Minnesota rivers, endocrine disruption has been observed in short- and long-lived fish species including vitellogenin induction in male fathead minnows, male carp, and walleye (Folmar and others, 1996, 2001; Lee and others, 2000; 2004). 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 from EACs. The proposed study helps answer how vulnerable a common fish species is to EAC exposure during spawning in lakes across Minnesota. The study takes advantage of the specific life-history characteristics of bluegill sunfish to investigate the impact of EAC exposure on their spawning activity and reproductive output. The anticipated outcomes of the study will provide the following benefits:

1. Most EACs are found at very low concentrations in water but reach higher concentrations in sediment. Despite these low concentrations, research has identified developmental and reproductive effects on fish species at environmentally relevant concentrations. The proposed work will determine if lakes under the influence of septic systems are at risk for significant contamination from Phacs and EACs while providing details on what pharmaceutical and estrogenic compounds are present in lakes with high numbers of SSTS systems.
2. In Minnesota, pharmaceuticals and EACs have been observed in a range of lake types from a diverse set of background conditions. This study will provide a comprehensive analysis of the frequency and magnitude of contamination relative to important factors including hydrology and geology, groundwater hydrology and watershed characteristics.
3. Three recent studies in Minnesota indicate river and lake fish communities are vulnerable to reproductive impacts from EACs. The proposed project uses a representative fish (bluegill) to determine how vulnerable adult fish are to pharmaceutical and estrogenic compounds exposure during spawning. The study assesses the role of food-web structure and function when measuring the ecological characteristics that might mitigate EAC exposure while providing an estimate of how pharmaceuticals and estrogenic compounds affect biological communities.

C. Other Funds Proposed to be spent during the Project Period:

Additional funds to be spent on the project include \$215,000 of USGS Cooperative Research funding and \$110,000 in equipment funding match for purchase of equipment by the MDH. MDH will also provide \$153,900 of in-kind staff services during the course of the three year project.

D. Spending History:

VII. DISSEMINATION: Details of results will be available as a final project report to LCCMR in the form of a USGS scientific investigations series report and a scientific journal article manuscript. Results will be communicated to local groups, state agencies and national peer groups through presentations at regional and national meetings including state resource management meetings.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted every six months by Result according to the schedules provided in Section IV above. A final work program report and associated products will be submitted between June 30 and August 1, 2013 as requested by the LCCMR.

IX. RESEARCH PROJECTS: see research addendum.

Attachment A: Budget Detail for 2010 Project 10-A2

Project Title: Estrogenic and Pharmaceutical Septic System Discharge to Lakes

Project Manager Name: Richard Kiesling

Trust Fund Appropriation to MN Dept. of Health: \$110,000

2010 Trust Fund Budget	Result 1 Budget:		Result 2 Budget:	Amount Spent (date)	Balance (date)	Result 3 Budget:	Amount Spent (date)	Balance (date)	Result 4 Budget:	Amount Spent (date)	Balance (date)	TOTAL BUDGET	TOTAL BALANCE
	Quantify the occurrence of estrogenic/pharmaceutical compounds in 30 Minnesota lakes that receive groundwater inputs from septic systems		Assess surface water/groundwater hydrology/watershed characteristics contributing to water/sediment concentrations of estrogenic/pharmaceutical compounds in lakes			Assess biological exposure and response to known estrogenic/pharmaceutical compound contamination in Minnesota lakes			Enhance EAC analytical capabilities at the Minnesota Department of Health (MDH).				
BUDGET ITEM													
Capital equipment over \$3,500 (list specific items)													
MN Department of Health - Triple quadrupole mass spectrometer for the Public Health Laboratory, Minnesota Department of Health									\$110,000			\$110,000	
COLUMN TOTAL	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$110,000	\$0	\$110,000	\$110,000	\$0