Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan

Date of Submission: 09/14/2016

Date of Next Status Update Report: January 2017

Date of Work Plan Approval: 06/07/2017

Project Completion Date: January 2020

Does this submission include an amendment request? __

PROJECT TITLE: Identification of Chemicals of Emerging Concern in Minnesota Fish

Project Manager: Seth Moore, PhD

Organization: Grand Portage Band of Lake Superior Chippewa

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Location: This project will take place in the 1854 Ceded Territory of Minnesota, in Cook and Lake counties.

Total ENRTF Project Budget:	**ENRTF Appropriation:**	**$400,000**
	Amount Spent:	**$0**
	Balance:	**$400,000**

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 04g

Appropriation Language:
$400,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the Grand Portage Band of Lake Superior Chippewa to identify chemicals of emerging concern and metals in fish, water, and sediments from approximately 30 water bodies in northeastern Minnesota used for subsistence harvest and recreation. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Chemicals of emerging concern in subsistence species used by Minnesota Chippewa

II. PROJECT STATEMENT:

We propose to evaluate levels of unregulated and emerging contaminants within key fish species, waters, and sediments in Northeastern Minnesota within the 1854 Ceded Territory. Specifically, we will assess the threat of low concentration but potentially toxic "micropollutants" within species of fish used for subsistence and their environment as part of a long-term ecosystem health program. Further, the proposed project will be the first of its kind in regard to contaminant surveillance in animals and the environment simultaneously in Minnesota, providing new methodologies for natural resource managers. This project directly addresses the second priority item in the Water Resources strategic guidance of the LCCMR 2017 RFP to determine the environmental fate and ecological effects of emerging and unregulated contaminants.

Tribal communities in Minnesota rely heavily on fish species in the Lake Superior watershed and the 1854 Ceded territory for subsistence; however, concerns for the impact of endocrine-active or toxic chemicals in the environment on the health of fish populations and humans that consume them raises questions about the safety and security of subsistence foods. This has potential long-term implications for the Minnesota recreational industry as well. To address these concerns, the Grand Portage Band of Chippewa is collaborating with the University of Minnesota, Minnesota Pollution Control Agency, and Environmental Protection Agency to assess concentrations of such contaminants in the Lake Superior watershed and describe potential environmental exposure pathways.

A pilot study on fish and water samples on the Grand Portage Indian Reservation conducted in 2015 revealed numerous micropollutants in water and fish tissues from locations in Lake Superior and in remote wilderness sites without an obvious source of contamination. Our team screened for over 100 CECs in four sample locations on reservation lands, which resulted in the detection of five compounds in water (androstenedione, androsterone, cotinine, hydrocodone, and metformin), seven compounds in fish tissue (betamethasone, venlafaxine, triclosan, clotrimazole, hydrocortisone, iopamidol, and triclocarbon), and DEET in both water and fish tissues. Iopamidol was ubiquitous in fish tissue across sites and DEET was ubiquitous in water and fish tissues. Research has found that aquatic exposures to some estrogen-mimics (e.g., ethinyl estradiol, a chemical used for birth control) can render fish sterile and thus threaten the sustainability of those populations. However, little is known about the potential for micropollutants to accumulate in fish and wildlife tissues, thus potentially exposing higher-level organisms and humans that consume them. Baseline levels of these contaminants in the Minnesota ecosystem have not been determined, thus no long-term chemical management strategies exist.

This study will characterize the occurrence of micropollutants within fish from northeastern Minnesota lakes and streams and guide further initiatives to investigate effects on fish populations and risk to human health. Furthermore, this study, *the first of its kind*, will provide new data and new models and tools for risk assessment and surveillance useful for a variety of resource management agencies.

Preliminary data show that there are measurable levels of CECs in this pristine environment that need to be further characterized. Baseline levels of many CECs in the Great Lakes ecosystem have not been determined; coupled with a lack of water quality standards or effects benchmarks for most of these contaminants, no long-term chemical management strategies exist. This study will 1) characterize the baseline occurrence of CECs and trace metals in these waters and in important subsistence species upon which the people of GPIR rely; 2) help prioritize risk management research efforts based upon our results. Ultimately, we will use this information to guide further initiatives to investigate biological effects on wildlife populations. Finally, this study will help evaluate and validate new tools for science-based management of these emerging issues by providing new data and spatial analysis for risk assessment and prediction, and offering information to assist systematic surveillance useful for a variety of resource management agencies.

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The goals of this research are to:
 1) Collect baseline data on the presence of chemicals of emerging concern (CECs) and trace metals in fish from areas used by tribal members for the harvest of subsistence species within the Minnesota Lake Superior watershed.
2) Analyze detected contaminants to identify how they may be related to human landuse characteristics, natural landscape dynamics, and measures of fish health.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *[January 2018]*:

Project Status as of *[July 2018]*:

Project Status as of *[January 2019]*:

Project Status as of *[July 2019]*:

Project Status as of *[January 2020]*:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:
This study will 1) characterize the baseline occurrence of CECs and trace metals in these waters and in important subsistence species upon which the people of GPIR rely; 2) help prioritize risk management strategies and 3) guide further initiatives to investigate biological effects on wildlife populations, as well as risks to human health. Finally, this study will help evaluate and validate new tools for science-based management of these emerging issues by providing new data and models for risk assessment and prediction, and systematic surveillance useful for a variety of resource management agencies.

ACTIVITY 1: Collect data on chemicals of emerging concern from 18 waterbodies by sampling fish, water, and sediments ($331,723).

Description:
Eighteen eco-hydrologically relevant sites will be chosen within GPIR and the 1854 Ceded Territory for contaminant surveillance. Sites will include inland lakes and rivers as well as locations along the Lake Superior coast. Site selection will follow a multicriteria selection process that includes fish assemblage information, human land use, and watershed characteristics including proximity to potential point sources of contaminant release (e.g. downstream of wastewater effluence or mining activities, as well as several control sites); presence of important subsistence species; and value as a fish harvesting location for tribal members (implying human and wildlife exposure risk). Each site will be sampled once. For comparative purposes, efforts will be made to sample all locations in the same season to control for seasonal fluctuations associated with environmental conditions.
Table of Experimental Design

Landuse	Waterbodies	Tissue	Water	Sediment	Species	Species of interest
Undeveloped watersheds/systems	6	12	6	6	2	Inland lakes
Wastewater effluences	6	12	6	6	2	Walleye
Highly developed watersheds	6	12	6	6	2	Perch
		36	18	18		
						Lake Superior
Note: Each waterbody gets two pooled tissue samples, each comprised of a single species used for subsistence consumption						Lake trout
						Lake Herring
		Total Samples		72		

Sampling for chemical surveillance will include water, sediment, and fish tissue in order to understand the ecohydrology of the phenomena systemically. For water sampling, POSIS samplers, will be used to collect a time-

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integrated water sample that will be more representative (than by comparison, a grab sample) of what aquatic organisms might be exposed to over a longer time period such as a season. A single sediment sample will be collected from each site for chemical screening and to detect chemicals that partition to particulate. At the same time that water and sediment samples are obtained, fish will be collected by standard field methods (e.g. electroshock, gill netting, etc.) and sacrificed according to an IACUC-approved protocol for chemical analysis. Following collection, fish will be weighed, measured by length and logged by species. Tissues from all species caught at a site will be pooled in equal proportions to obtain a representative measure of CECs in fish tissue for the site. This method has been utilized in our preliminary investigations and will be followed for consistency and comparability. However, we are also interested in understanding chemical exposures by species. Thus, in addition to an overall pooled sample, we will also pool tissue samples by species for CEC and metal analysis. Two key subsistence species will be captured from each location (e.g. walleye/yellow perch from inland lakes, and lake trout/cisco from Lake Superior locations) and be prioritized for species-stratified chemical sampling. We expect that lake trout/cisco and walleye/yellow will be consistently collected from Lake Superior and inland water bodies, respectively; therefore, in our efforts to assess contaminant exposure by species, we will prioritize pooling tissues among these four species for CEC testing. In addition, a piece of liver (a traditional sampling tissue for trace metal analysis) will be sampled (prior to tissue pooling for CEC analysis, which will include remaining liver among all other tissues) from all fish and pooled in the same manner for site and species-specific trace metal analysis. As with the stratified CEC analysis, we will prioritize pooling of liver samples from two key subsistence species for species-stratified analyses, specifically targeting walleye and lake trout.

Following collection of fish, water, and sediment samples, they will be processed and shipped for screening of more than 100 chemicals of emerging concern.

Summary Budget Information for Activity 1:	**ENRTF Budget:**	**$ 331,723**
	Amount Spent:	**$ 0**
	Balance:	**$ 337,723**

Outcome	Completion Date
1. *18 sites sampled for fish, water, and sediment*	November 2018
2. *Analyze sampling data with UMN ecohealth researchers and state and federal toxicologists*	January 2019

Activity 1 Status as of *[January 2018]***:**
Activity 1 Status as of *[July 2018]***:**
Activity 1 Status as of *[January 2019]***:**

ACTIVITY 2: Interpret findings with University of Minnesota ($68,277).
Description:
Statistical analysis will be used to test research hypotheses using conventional means of data analysis. In addition, for spatial hypotheses, contaminant data will be uploaded into GIS software for analyses of spatial distribution. Contaminant distribution maps will be overlaid with data layers containing point sources of environmental contaminants (e.g. mining activities, wastewater effluents), population centers, habitat /development, tribal use (e.g. characterization of water bodies based on level of harvest for subsistence or commercial purposes), and environmental pathways of river basins (channels and hillslope pathways). These new maps will be used to estimate the potential contribution of point and non-point sources to contaminant levels across the environment and identify areas of risk where human consumption of contaminated subsistence species warrants further investigation. Dynamical network models will establish the interdependencies of factors and geographical areas of the system investigated. These data will be used in future eco-hydrological models to describe how contaminants move through the Lake Superior watershed and up into the food web of the ecosystem.

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Summary Budget Information for Activity 2:　　　　　　　　ENRTF Budget:　$ 68,277
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Amount Spent:　$ 0
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Outcome	Completion Date
1. *Analyze data and develop spatial maps of results*	January 2019
2. *Disseminate findings to MPCA*	March 2019
3. *Evaluate pathways to consumption among GPIR members and plan future strategies*	January 2020

Activity 2 Status as of *[July 2019]***:**

Activity 2 Status as of *[January 2020]***:**

V. DISSEMINATION:
Description:
The core intent of this project is to provide science-based information for assessing and managing risks associated with sustainable cultural use of natural resources and interaction with the environment in and around the grand Portage Tribal area. Our goal is also to communicate our findings in both the policy and scientific arenas. In order to reach this broad range of stakeholders, we anticipate the following public and scientific communications.
1) Tribal and regional audience:
- local public radio program will provide updates on study results
- results and recommendations will be made to Tribal Council, including potential warnings and advisories for risk management and food safety
2) Minnesota Pollution Control Agency:
- this project fills a data gap in MPCA maps and will allow for a more complete picture of MN. Thus, inclusion of this area in MPCA communication pieces will be carried forward to the general public and interested stakeholders.
3) LCCMR policy-based audience
- the final report should be useful in several ways. First, maps with baseline threat data will add science to general policy discussions. Second, this project will help prioritize long terms monitoring strategies that could be useful to several State Agencies (DNR, DPH, MPCA specifically). We believe findings will also inform LCCMR review community regarding the potential priority for this issue in the future. That is, GPIR could be considered one of the least "at risk" places from a land use standpoint in the State. If we verify considerable contamination here, as we believe we will, this project may provide stimulus for further investigation across the State AND help validate new scientific tools that can assist in this endeavor.
4) Scientific Audience
- a minimum of two peer-reviewed papers, one for each objective, will be submitted to peer reviewed journals. These publications will communicate scientific results, as well as sampling methods, diagnostic methodologies and system-based analyses.
5) UMN Education/Extension programs
-Dr. Phelps is the director of the UMN aquatic invasive spp. Center, and Dr. Primus the aquatic animal health lead for the UMN CVM. As such, both play a large extension role in the State of MN. They will incorporate important parts of these findings in extension products for the State.
-Drs. Convertino, Wolf and Travis have overlapping appointments in the UMN School of Public Health and Veterinary Medicine (ecosystem health). They teach courses to undergraduate, graduate and professional

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students, as well as in the Grand Challenge Curriculum. These findings will be incorporated into already developed case studies in all of the above.

Final Report Summary *[August 2020]***:**
This project is unique in that it will focus on system-wide exposures across a variety of aquatic systems and subsistence fish species in the Lake Superior watershed. Data collected will be analyzed for presence/absence of both traditional/known hazards, as well as CECs across a large landscape, allowing for prioritization of in depth studies on food safety and security. Specific outputs in the final report will include:

Spatial distribution of CECs and metal occurrence data from 27 locations within Northeastern MN and the Lake Superior watershed. This data will be derived from surface water samples, pooled fish samples of species-specific samples from important subsistence species for local populations: walleye/yellow perch and lake trout/cisco (the number of species-specific samples may be limited by availability at each site). We will also relate measures of fish health and parasite loading to CEC's and landuse. These data may later be linked to a water flow model for this watershed system.

Quantitative data of contaminants present in fish and water samples from each location. Depending upon the results gathered, these data will potentially allow us to identify current chemical risks to biological systems and/or public health. Regardless of our findings, however, these data will allow us to start developing hypotheses about pathway-based biological effects (e.g. neuroendocrine, cell-cycle specific, etc.) of contaminants found at each location, as well as potential adverse outcomes.
Detection of potential contaminant pathways (sources and transport networks) and attribution of their variability to human and environmental dynamics
By evaluating contaminants across a gradient of human development, ranging from known point sources such as wastewater treatment plant effluent streams to remote wilderness, we will be able to detect how emerging pollutants may be transferred across the landscape and through biota. Spatial mapping of pollutants and biota will be used to determine likely pathways through which CEC's and metals move through the environment. Once known, specific management actions can be developed to reduce the spread of contaminants in the environment through these pathways.

Identification of at-risk areas and/or populations
Results from our analyses will identify sites or water bodies that are at risk for biological impacts on aquatic species or contaminant exposure to humans via consumption of subsistence species based on chemical detections. Such sites will form the basis of future monitoring research and be the focus of future management plans.

VI. PROJECT BUDGET SUMMARY:
A. Preliminary ENRTF Budget Overview:
*This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 48,980	Tribal personnel for project field effort
Professional/Technical/Service Contracts:	$331,555	University of Minnesota (analysis and interpretation) and Sample detection laboratory (chemical analysis)
Travel Expenses in MN:	$ 19,465	Field trips for university and tribal staff visits
TOTAL ENRTF BUDGET:	**$400,000**	

Explanation of Use of Classified Staff:

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Explanation of Capital Expenditures Greater Than $5,000:

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:
0.67
Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:
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B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State			
	$	$	
TOTAL OTHER FUNDS:	$	$	

In-kind Services To Be Applied To Project During Project Period:		
Principle Investigator: Seth Moore 15% FTE x 2.5 yrs (11,850 + 38% fringe)	$40,882	Secured
EPA Research Ecotoxicologist - Mark Jankowski 1% FTE salary and 34% fringe	$2,381	Secured
UMN Fish Health Specialist: Nicholas Phelps - 2% FTE x 2.5 yrs (12,592 + 34% fringe)	$8,417	Secured
MPCA Environmental Scientist - Mark Ferrey salary and 34% fringe	$9,527	Secured
Field logistics and personell for sample collection (crew of 3, vessel, fuel $888/day X 40 field days)**	$35,520	Secured
Preliminary sample collection and analysis by Grand Portage ***	$140,000	Secured
Laboratory resources at UMN College of Veterinary Medicine:		
Lab facilities and equipment	$25,000	Secured
TOTAL OTHER FUNDS		**$281,727**

VII. PROJECT STRATEGY:
A. Project Partners:
Partners receiving ENRTF funding
- *Tiffany Wolf, DVM/PhD, Research Associate, University of Minnesota, $31,009, UMN project manager*
- *Dominic Travis, DVM, Associate Professor,University of Minnesota, $11,093, UMN Ecohealth Lead*
- *Mateo Convertino, PhD, Assistant Professor, University of Minnesota, $8,452, Spatial Modeler*
- *Alex Primus, DVM/PhD, Research Associate, University of Minnesota, $11,725, Fish health specialist*

Partners NOT receiving ENRTF funding
- *Seth Moore, PhD, Director of Biology and Environment, Grand Portage Band of CHippewa, Overal project manager*
- *Nick Phelps, PhD, Assistant Professor, University of Minnesota, Fish health specialist*
- *Mark Ferrey, Ecotoxicologist, Minnesota Pollution Control, Toxicology expert*
- *Mark Jankowski, PhD, Ecotoxicologist, Evironmental Protection Agency, Toxicology expert*

B. Project Impact and Long-term Strategy:
This project is unique in that it will focus on system-wide exposures across a variety of aquatic systems and subsistence fish species in the Lake Superior watershed. Data collected will be analyzed for presence/absence of both traditional/known hazards, as well as CECs across a large landscape, allowing for prioritization of in depth studies on food safety and security. Tools used to characterize predicted biological effects and spatial mapping will be employed to interact with managers and other decision/policy makers to determine long term chemical and biodiversity monitoring locations key for management and cultural sustainability.

The core intent of this project is to provide science-based information for assessing and managing risks associated with sustainable cultural use of natural resources and interaction with the environment in and

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around the grand Portage Tribal area. In this case, we will continue ongoing research known contaminants, while increasing baseline knowledge regarding micro pollutants (emerging contaminants) as it interacts traditional fishing practices by the people of the Grand Portage Tribe. Secondarily, this work fills a data gap in ongoing monitoring projects conducted by the MPCA. The emerging nature of "emerging contaminants" also implies that findings will be new, and thus interesting to the general public, specifically outdoor/sportsmen and tourism industries in Northern MN. Our goal is also to communicate our findings in both the policy and scientific arenas.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
University of Minnesota	2015	$20,000
U.S. EPA Great Lakes Restoration Initiative	FY2016	$45,000
U.S. EPA Great Lakes Tribal Initiative	FY2016	$75,500

VIII. REPORTING REQUIREMENTS:
- **The project is for 2.5 years, will begin on 07/01/2017, and end on 01/31/2020.**
- **Periodic project status update reports will be submitted** *[July 30]* **and** *[January 31]* **of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2020**.

IX. VISUAL COMPONENT or MAP(S):

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Environment and Natural Resources Trust Fund

M.L. 2017 Project Budget

Project Title: Identification of Chemicals of Emerging Concern in Minnesota Fish

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 04g

Project Manager: Seth Moore

Organization: Grand Portage Band of Lake Superior Chippewa

M.L. 2017 ENRTF Appropriation: $400,000

Project Length and Completion Date: Fill in the expected date of project completion in the format: 2.5 Years, Final Report: June 30, 2020

Date of Report: Fill in the date of report submission (this will be updated for each status update report)

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	*Sample collection and analysis*			*Data interpretation*				
Personnel (Wages and Benefits) overall							**Personnel**	
Grand Portage Biologist: Yvette Chenaux- 25% FTE x 2.5 yrs (21,000 + 38% fringe)	$28,980		$28,980			$0	$28,980	$28,980
			$0			$0		$0
Professional/Technical/Service Contracts			$0			$0	**Contracts**	$0
UMN contract: T. Wolf 10% FTE, A. Primus 5% FTE, D. Travis 2% FTE, M. Convertino 2% FTE, Post Doc 6% FTE, Grad Student	$68,278		$68,278	$68,277		$68,277	$136,555	$136,555
Sample Procesing: AXYS LABS: Analysis of contamination with micropullutants (78 samples @ $2,500 sample)	$195,000		$195,000			$0	$195,000	$195,000
1854 Treaty Authority: Field Work: Logistics and sample collection and transport ($10,000 per field season)	$20,000		$20,000			$0	$20,000	$20,000
Travel expenses in Minnesota							**Travel**	
Grand Portage Staff: 5 two-day trips for 2 staff	$3,000		$3,000			$0	$3,000	$3,000
UMN Staff: 1 six-day trip per investigator per year (6)	$16,465		$16,465			$0	$16,465	$16,465
COLUMN TOTAL	**$331,723**		$331,723	**$68,277**		$68,277	**$400,000**	**$400,000**

06/27/2017   Subd. 04g