Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2013 Minnesota Aquatic Invasive Species Research Center
Sub-Project Work Plan

Date of Report: June 20, 2017

Date of Next Status Update Report: January 31, 2018

Date of Work Plan Approval:

Sub-Project Completion Date: June 30, 2019

Project Completion Date: June 30, 2019

Does this submission include an amendment request? No

SUB-PROJECT TITLE: MAISRC Sub-Project #16: Sustaining walleye populations: assessing impacts of AIS

Sub-Project Manager: Dr. Gretchen Hansen

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Location:

The study will take place in Minnesota's nine largest walleye lakes (Cass and Red in Beltrami County, Kabetogama, Rainy and Vermilion in St. Louis County, Lake of the Woods in Lake of the Woods County, Leech and Winnibigoshish in Cass County, and Mille Lacs in Mille Lacs County).

The impact of the study is on walleye lakes statewide.

Total ENRTF Sub-Project Budget:	**Sub-Project Budget:**	**$198,700**
	Amount Spent:	**$0**
	Balance:	**$ 198,700**

Legal Citation: M.L. 2013, Chp. 52, Sec. 2, Subd. 06a

Appropriation Language:
$4,350,000 the first year and $4,350,000 the second year are from the trust fund to the Board of Regents of the University of Minnesota to develop and support an aquatic invasive species (AIS) research center at the University of Minnesota that will develop new techniques to control aquatic invasive species including Asian carp, zebra mussels, and plant species. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

I. SUB-PROJECT TITLE: Sustaining walleye populations: assessing impacts of AIS

II. SUB-PROJECT STATEMENT:
Minnesota's walleye fisheries are vulnerable to ecosystem changes following the introduction of invasive species such as zebra mussels and spiny water fleas. For example, zebra mussels reduce zooplankton, limiting the amount of food available for fish in the open water zone of lakes. At the same time, the high filtering capacity of zebra mussels creates an "energy shunt" that moves food and energy from the water column into the bottom of the lake and nearshore areas, changing the structure of the food web by providing extra resources for fish that feed primarily in nearshore areas. Spiny water fleas are large predatory zooplankton that also reduce the abundance of other, smaller zooplankton. They themselves are inedible to some fish species and life stages due to their long protective tail spine. The zooplankton declines associated with both of these invaders are likely to affect predatory fish such as walleye, because both young walleye and many of their prey species rely on zooplankton as a food source. However, the impacts of zebra mussels and spiny water fleas on sport fish populations are not well understood.

The impacts of zebra mussels and spiny water fleas on fish likely depend upon the ability of fish to switch to alternative food sources if and when invaders cause zooplankton become scarce. This ability to switch food sources likely depends on lake characteristics including size, depth, productivity, and fish community composition. Determining how these invasive species affect walleye, and identifying characteristics of walleye populations that can withstand these invasions with minimal effect, will allow managers to set realistic goals for future walleye production and harvest. Managers will also be able to assess the impacts of current and future invasions, and separate these effects from other potential causes of walleye population changes.

We will quantify the impacts of zebra mussels and spiny water fleas individually and together on walleye and their food webs in Minnesota's large lakes. Minnesota's nine largest walleye lakes (all greater than 15,000 acres) are at different stages of invasion by zebra mussels (Cass, Winnibigoshish, Leech), spiny water fleas (Kabetogama, Lake of the Woods, Rainy, Vermilion), both (Mille Lacs), or neither (Red). Notably, we have an unprecedented opportunity to track the effects of each invader on walleye populations throughout all stages of invasion by tracking impacts early in the invasion. Zebra mussel veligers (larvae) were first discovered in Leech Lake in 2016 and no adult zebra mussels have yet been found. Similarly, spiny water fleas were discovered in Lake Vermilion in 2015 but have not reached high abundances and currently only occur in one of the lake's two major basins. Three lakes will be sampled in 2017 due to their unique invasion status (Mille Lacs, Red, and Leech). All nine lakes will be sampled in 2018.

We will use two approaches to evaluate the impacts of zebra mussels and spiny water fleas on walleye and food webs in Minnesota's large lakes. First, we will determine which habitats and food resources support walleye and other fish species in each lake by examining stable isotopes in their bodies. Naturally occurring stable isotopes show what a fish has been eating in the past few weeks to months. This analysis will allow us to determine the amount of food resources various fish species and ages (young or adult) are eating from different habitats (nearshore or open water), and at what trophic level they are feeding (their position in the food web). The results of this analysis in each lake will tell us to what degree walleye and their prey rely on zooplankton in the open water as a food source to sustain their populations. This will allow us to assess how likely it is that walleye could switch to other food sources if zooplankton abundances are greatly reduced by zebra mussels or spiny water fleas.

We will also assess the effects of reduced zooplankton abundance due to zebra mussels and/or spiny water flea invasion on the growth rates of walleye and yellow perch in their first year of life. These young fish rely on small zooplankton prey in their early life stages, but they also can eat invertebrates (for example, insects, snails, small mussels) that are less likely to be reduced by zebra mussels or spiny water fleas. We will assess whether young fish may be less affected by the negative impacts of zebra mussels and spiny water fleas if they can successfully switch to other prey even as zooplankton food resources decline. Growth rates will be compared both among

lakes with and without zebra mussels and/or spiny water fleas, and within lakes pre- and post-invasion using historical data collected by the Minnesota DNR.

This project will provide a greater understanding of the impacts of zebra mussels and spiny water fleas on food webs and fish in Minnesota lakes, and will facilitate better walleye management in the face of these invasions. Quantifying how these invaders disrupt food webs supporting walleye will allow managers to project realistic levels of walleye production. Additionally, understanding the most important prey supporting walleye will allow us to assess the vulnerability of each population to the impacts of invasion. This project will provide a critical supplement to the existing MNDNR Large Lakes program by incorporating the community and ecosystem-level data required for understanding the lake-wide impacts of AIS.

III. SUB-PROJECT STATUS UPDATES:

Sub-Project Status as of January 31, 2018:

Sub-Project Status as of July 31, 2018:

Sub-Project Status as of January 31, 2019:

Overall Sub-Project Outcomes and Results:

IV. SUB-PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Quantify energy pathways and food sources (e.g., food webs) supporting walleye in lakes with and without zebra mussels and spiny water fleas
Description:
The impacts of zebra mussels and spiny water fleas on walleye will depend on the ability of walleye to access new food sources in invaded lakes if zooplankton decline. Walleye populations that can access nearshore or bottom food sources when zooplankton declines are likely to be less sensitive to negative impacts of zebra mussels and spiny water fleas. Walleye populations that can switch to nearshore food resources after invasion, or those that are already supported by nearshore food resources prior to invasion, are likely to be least affected by invasion. Fish that rely on zooplankton as a food source (including young walleye) but that can feed on spiny water fleas despite their long tail spine may avoid negative effects or even benefit from spiny water flea invasion. Fish populations unable to make these switches as invaders alter a lake's food web are likely to experience declines in recruitment, growth, and, ultimately, population size. Therefore, understanding these food webs and the habitats supporting walleye is critical to understanding the ecosystem-level impacts of zebra mussels and spiny water fleas.

We will use stable isotope analysis to understand whole-lake food webs and the contributions of nearshore (littoral) and open water (pelagic) energy pathways supporting walleye in each lake. Stable isotope analysis quantifies the trophic position (level on the food chain) and reliance on various food resources and can identify differences in feeding habits in different lakes or over time. Differences in the food sources supporting walleye among lakes will highlight implications for the ongoing or future impacts of zebra mussels and/or spiny water fleas.

In order to conduct stable isotope analyses, we need samples of body tissues of many different species that are a part of each lake's food web. We will leverage the MNDNR Large Lakes program to collect some fish, zooplankton, and water quality data. Our project team will supplement MNDNR sampling by collecting additional fish species that are not well captured in standard sampling (e.g., common prey fish, young yellow perch). We will also collect benthic invertebrates (e.g., snails, mussels, mayfly larvae), with a particular focus on species that are food sources for young walleye and yellow perch. These samples will be analyzed for their

stable isotope composition by the University of Minnesota Stable Isotope Mass Spectrometry laboratory in St. Paul, MN.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 154,310
Amount Spent: $ 0
Balance: $ 154,310

Activity Completion Date:

Outcome	Completion Date
1. Collect benthic macroinvertebrates from nearshore and deepwater lake bottom areas to quantify baseline isotopic positions to determine which fish feed on these invertebrates. To be done in Mille Lacs, Red, and Leech lakes in 2017 and all nine lakes in 2018. Lead: MNDNR	10/2018
2. Collect muscle tissue from fish sampled during fall gillnetting (part of MNDNR large lakes core sampling) of Mille Lacs, Red, and Leech lakes in 2017 and all nine lakes in 2018. Fish targeted from this sampling include walleye, yellow perch, northern pike, cisco (where present), black basses, and other Centrarchids such as bluegill, black crappie, and rock bass (where present). Lead: MNDNR	10/2018
3. Collect age-0 walleye, age-0 yellow perch, and littoral prey fish in summer for isotopic analysis for food web assessment via seining in Leech and Red lakes in 2017 and Kabetogema, Lake of the Woods, Leech, Rainy, Red, Vermilion, and Winnibigoshish in 2018. Lead: MNDNR ((including subcontract to NPS)	10/2018
4. Collect age-0 walleye, age-0 yellow perch, and littoral prey fish in summer for isotopic analysis via seining in Mille Lacs in 2017 and Mille Lacs and Cass in 2018. Lead: NRRI	10/2018
5. Collect additional invertebrate and prey fish samples found in age-0 percid diets in order to more fully understand the littoral food web and resources supporting age-0 percids in six lakes (Mille Lacs, Cass, Red, Winnibigoshish, Kabetogama, and Rainy). Lead: NRRI	10/2018
6. Process zooplankton samples from Mille Lacs, Red, and Leech lakes in 2017 and all nine lakes in 2018 (part of MNDNR large lakes core sampling) to prepare for stable isotope analysis. Processing includes separating major taxonomic groups (spiny water flea, large native predatory zooplankton, large herbivores, small herbivores, etc.) Lead: MNNDR	12/2018
7. Quantify stable isotope composition of Carbon and Nitrogen of each trophic group collected by MNDNR in all study lakes using an external lab. This will provide the data for the food web analysis. Lead: MNDNR via subcontract to University of Minnesota stable isotope laboratory.	2/2019
8. Quantify stable isotope composition of Carbon and Nitrogen of age-0 walleye and age-0 yellow perch and their prey, collected by NRRI 6 lakes (Mille Lacs, Cass, Red, Winnibigoshish, Kabetogama, and Rainy). NRRI will process samples and isotopic composition will be analyzed using an external lab. Lead: NRRI, including subcontract to University of Minnesota stable isotope laboratory.	2/2019
9. Determine how much food/energy is coming from nearshore versus open water habitats contributing to walleye production in each study lake, and how this varies with invasion status. Lead: MNDNR	6/2019
10. Determine how much food/energy from the littoral zone is supporting age-0 walleye and age-0 yellow perch as well as important forage fish species that feed older walleye and perch. For six lakes (Mille Lacs, Cass, Red, Winnibigoshish, Kabetogama, and Rainy). Lead: NRRI	6/2019

Activity Status as of January 31, 2018:

Activity Status as of July 31, 2018:

Activity Status as of January 31, 2019:

Final Report Summary:

ACTIVITY 2: Quantify the impacts of zebra mussels and spiny water fleas invasion on walleye and yellow perch early life growth.

Description:

We will assess the effects of reduced zooplankton due to zebra mussels and/or spiny water fleas invasion on the growth rates and body condition of walleye and yellow perch in their first year of life. By studying the impacts on walleye and yellow perch growth within the context of the whole food web, we will be better positioned to understand how these important fish are responding to invasion. For example, if we observe strong reliance of walleye on nearshore food resources in invaded lakes but no changes in growth of young walleye, this would suggest that walleye are successfully able to switch to alternative food resources. Conversely, reduced growth rates accompanied by a strong reliance on zooplankton food sources in invaded lakes would suggest that zooplankton declines are having a negative impact on walleye, and that they are currently unable to compensate for these changes by shifting to alternative food sources.

We will collect walleye and yellow perch in their first year of life by seining between June and September in each lake. Young walleye and yellow perch will be measured and weighed, with a target sample size of 50-100 individuals of each species in each lake. We will compare growth among lakes with or without zebra mussels and/or spiny water fleas. Comparisons of growth among lakes will be supplemented by historical data collected by the MNDNR since 1983 to evaluate changes before and after the establishment of zebra mussels and/or spiny water fleas. This rich dataset includes thousands of individual age-0 walleye and yellow perch measured for length and weight from each of our nine study lakes. This existing dataset will allow us to assess changes in young walleye and yellow perch growth after zebra mussels and/or spiny water fleas invasion. Diets of young fish will also be examined to assess the main food sources for these fish and ensure the appropriate species are collected for Activity 1.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 33,920
Amount Spent: $ 0
Balance: $33,920

Activity Completion Date:

Outcome	Completion Date
1. Collect age-0 walleye and age-0 yellow perch length and weight data in summer via seining in Leech and Red lakes in 2017 and Kabetogema, Lake of the Woods, Leech, Rainy, Red, Vermilion, and Winnibigoshish in 2018. Lead: MNDNR (including subcontract to NPS)	10/2018
2. Collect age-0 walleye and age-0 yellow perch length and weight data in summer via seining in Mille Lacs in 2017 and Mille Lacs and Cass in 2018. Lead: NRRI	10/2018
3. Collect age-0 walleye and age-0 yellow perch diets in summer via seining in Mille Lacs, Leech, and Red Lakes in 2017 to target additional littoral prey species sampling in 2018 in support of Activity 1 littoral food web work. Lead: NRRI	10/2017
4. Gather and organize historical MNDNR age-0 walleye and yellow perch growth data from each study lake for pre- and post-invasion comparison. Lead: MNDNR (including subcontract to NPS)	2/2018
5. Analyze data to estimate changes in walleye and yellow perch growth following invasion of spiny water fleas and/or zebra mussels. Co-lead: NRRI and MNDNR (including subcontract to NPS)	3/2019

Activity Status as of January 31, 2018:

Activity Status as of July 31, 2018:

Activity Status as of January 31, 2019:

Final Report Summary:

ACTIVITY 3: MAISRC Service, outreach, and communication of research results.
Description:

Because our research targets Minnesota's high profile large lakes, fisheries, and AIS, we anticipate high public interest in this project. We will work with MAISRC and UM Extension to communicate through innovative and easily understandable means, including MAISRC's AIS Spotlight e-newsletter, www.maisrc.umn.edu, and Facebook and Twitter accounts. We will also target various audiences using outreach tools such as high-impact visuals, handouts to distribute at boat landings and MNDNR offices near our study lakes, presentations, and popular press articles. We will communicate with lake managers throughout the project and present the results of our research in the context of their specific interests. We will work with DNR and MAISRC communications staff to draft press releases and create an information sheet to distribute on the lakes and to be used by DNR outreach staff. We will also deliver scientific presentations at MAISRC events as well as at appropriate conferences (e.g., Minnesota Chapter of the American Fisheries Society, Upper Midwest Invasive Species Conference). We will update LCCMR as requested. Finally, we will serve on MAISRC committees and collaborate and communicate with other MAISRC researchers.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 10,470
Amount Spent: $ 0
Balance: $10,470

Activity Completion Date:

Outcome	Completion Date
1. Dissemination of findings – at least two presentations at stakeholder meetings, policy and planning meetings, conferences, and/or research showcase events Lead: MNDNR	6/2019
2. Dissemination of findings – at least one presentation at stakeholder meetings, policy and planning meetings, conferences, and/or research showcase events Lead: NRRI	6/2019
3. Dissemination of findings – at least one peer-reviewed publication in preparation. Co-lead: MNDNR (including subcontract to NPS) and NRRI	6/2019
4. Coordination with MAISRC and extension for media and communication. Co-lead: MNDNR and NRRI	6/2019
5. Participation on 1-2 MAISRC committees. Co-lead: MNDNR and NRRI	6/2019

Activity Status as of January 31, 2018:

Activity Status as of July 31, 2018:

Activity Status as of January 31, 2019:

Final Report Summary:

V. DISSEMINATION:

Description: We have incorporated dissemination into our project itself as Activity 3. Please see a thorough description of our outreach and dissemination plan under Activity 3, including status updates.

Final Report Summary:

VI. SUB-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. See the Sub-Project Budget document for an up-to-date project budget, including any changes resulting from amendments.

Budget Category	$ Amount	Explanation
Personnel - MNDNR	$ 17,644	DNR summer intern x 2: $17,644, $15/hr,13% fringe, 2 positions at 25% FTE in FY2018
Personnel - NRRI	$62,763	Principal Investigator: $15,061 salary, $5,076 benefits (33.7% fringe rate); 0.24 FTE; co investigator: $11,326 salary, $3,817 benefits (33.7% fringe rate); 0.22 FTE; co investigator: $1,609 salary, $542 benefits (33.7% fringe rate); 0.02 FTE; Taxonomist: $4,430 salary, $1,214 benefits (27.4% fringe rate); 0.09 FTE; Lab tech: $12,919 salary, $3,540 benefits (27.4% fringe rate); 0.36 FTE; and Temp field/lab assistant: $2,993 salary, $236 benefits (7.9% fringe rate); 0.1 FTE.
Professional/Technical Services and Contracts - MNDNR	$72,600	Contract to the University of Minnesota Department of Earth Sciences Stable Isotope Laboratory in Minneapolis, MN ($60,840) for stable isotope analysis 4,680 tissue samples (390 samples/ lake, 3 lakes in yr 1, 9 lakes in yr 2, $13/sample, incl. drying, grinding, and weighing). MNDNR has a state contract with the U of M lab for this type of analysis. Contract to Voyageurs National Park ($8,760) for sampling lakes inside park (Rainy and Kabetogama). Includes funds for partial support of a summer technician ($8,260; 23% FTE @ $32,844/yr, includes 7.65% fringe); $400 for in-state travel to project team meeting, and $100 for equipment/supplies. DNR Publication fees for 2 open access papers ($3000)
Professional/Technical Services and Contracts - NRRI	$6,100	Lab services ($6,000): 600 samples at $10/sample for stable isotope mass spectrometry analysis Shipping fees ($100): ship samples to stable isotope processing lab (overnight courier)
Equipment/Tools/Supplies - MNDNR	$5,100	Supplies - Lab&Field: ice [$480], ethanol [$500]. Non capital equipment: Freezer [$600], PPE [$400], tools for lab processing such as forceps, scalpels, trays, squirt bottles [$250], D-net [$170], mask and snorkel [$50], vials and bottles [$1675], coolers [$200], Ekman sampler with wash bucket [$775]
Equipment/Tools/Supplies - NRRI	$2,330	Lab and field supplies: Beach seine for small fish capture: $750; Field microbalance to weigh small fish: $250. Supplies for stable isotope sample preparation $1200 (2000 tin capsules $600, 200 well plate trays $150; 1000 drying pans $250; 1000 vials $200). $130 for misc field supplies incl. boat gas.
Capital Expenditures over $5,000	-	NA

Travel Expenses in MN - MNDNR	$22,240	Travel - MN: Fieldwork (visit each lake twice to sample invertebrates and assist with fish sampling; 2 days per visit * 2 ppl* 12 lakes (3 in year 1, 9 in year 2); Total based off 12,193 miles@$0.55/mi + 96 lodging nights@75/night + 120 days of meals @$36/day (meal estimate based on DNR maximum; actual costs will be reimbursed)= [$18,240]). Travel to in-state conferences (MN AFS), stakeholder workshops, and DNR large lakes meetings (1 person to 6 meetings/conferences/workshops @$400 each)[$2400], 5 DNR PIs travel to 1 project team meeting in Duluth in year 1 [$1600].
Travel Expenses in MN - NRRI	$9,923	In-state travel: Field year 1 [$1,725] for travel to lakes to sample fish and invertebrates, 3 ppl visit 3 lakes, 2 days per visit. Field year 2 [$7,242] for 3 ppl and 10 visits (6 visits are 2 days/visit; 4 visits are 3 days/visit). Conference year 2 [$957] for PI/co PI to present results - registration $300; lodging $145/night *2 nights, meals for personnel (traveling employees): $64 for full, $48 for 2 partial days, 350 mi RT*$0.535/mi, $20 vehicle fee for University car. Meal expense is no greater than the amount provided for in the University of Minnesota travel policy.
Other	$ -	NA
TOTAL ENRTF BUDGET:	**$ 198,700**	

Explanation of Use of Classified Staff: NA

Explanation of Capital Expenditures Greater Than $5,000: NA

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 1.53 (0.5 MNDNR, 1.03 NRRI)

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0.23

B. Other Funds:

Source of Funds	$ Amount proposed	$ Amount Spent	Use of Other Funds
Non-state			
U.S. National Park Service funds (in kind)	$30,533	$	NPS staff salary+fringe in support of project objectives; this is not intended to be a required match for LCCMR purposes.
State			
NRRI- UMN unrecovered indirect (in kind)	$43,541	$	Facility and administrative costs, calculated as 53% MTDC 7/1/17-6/30/18 ($26,202 base); 54% MTDC 7/1/18-6/30/19 ($54,915 base); this is not intended to be a required match for LCCMR purposes.

MNDNR - Game and Fish fund (in kind)	$157,362		MNDNR staff salary + fringe ($156, 362), supplies ($1000); this is not intended to be a required match for LCCMR purposes.
TOTAL OTHER FUNDS:	**$231,436**	**$**	

VII. SUB-PROJECT STRATEGY:

A. Sub-Project Team/Partners:

Minnesota Department of Natural Resources: Dr. Gretchen Hansen (Project lead), Dr. Tyler Ahrenstorff, Bethany Bethke, Dr. Will French, Jodie Hirsch, Dr. Heidi Rantala. Hansen, Ahrenstorff, and Bethke will be responsible for study design and coordinating and carrying out fieldwork for Activity 1. Hansen, French, and Ahrenstorff will collate MNDNR historical growth data for activity 2. Hansen, Ahrenstorff, Bethke, French, Rantala, and Hirsch will analyze data and produce presentations and publications. Hirsch will serve as zooplankton expert and Rantala will serve as benthic invertebrate expert. The MNDNR is proposed to receive $117,584 to purchase supplies and equipment, pay for stable isotope sample lab analysis, travel, and publication fees, and support two summer interns. MNDNR co-PI salaries are provided in-kind.

Natural Resources Research Institute, University of Minnesota-Duluth (NRRI): Dr. Katya Kovalenko, Josh Dumke, Dr. Valerie Brady, Dr. Donn Branstrator (UMD Biology). Kovalenko, Dumke, and Brady will be responsible for portions of activities 1-3 as described above for each activity and outcome, including sampling, data analyses and delivery. Dumke will serve as YOY fish expert and organize field crews. Brady will serve as zooplankton expert. Kovalenko and Brady will analyze isotope data. Branstrator is spiny water fleas expert serving in advisory role. The NRRI is proposed to receive $81,117 for partial support of co-PI and technician salaries (NRRI researchers and staff are not UM faculty and are largely supported by grants), and to pay for travel, supplies, and lab analyses.

Voyageurs National Park (VNP): Ryan Maki will be responsible for fieldwork on Rainy and Kabetogama lakes, data analysis, presentations, and publications. VNP is proposed to receive $8,760 of the MNDNR portion of this request for partial support of a summer Biological Science Technician, travel to project team meeting, and supplies, and co-PI salary is provided in-kind.

B. Sub-Project Impact and Long-term Strategy:

Understanding the impacts of invasive zebra mussels and spiny water fleas on fish and on whole lake food webs is critical for walleye management. For example, although it is suspected that walleye declines in Mille Lacs are at least in part due to the combined effects of zebra mussels and spiny water fleas, the impacts of these invasive species on various food resources for walleye has not been assessed. Understanding how these invasive species disrupt food resources of walleye will allow managers to set realistic goals for future walleye production and harvest and to assess the likely impacts of future invasions. This project will provide a critical component to the existing MNDNR large lakes program by incorporating the community and ecosystem-level data required for understanding the impacts of invasive species. We plan to incorporate tissue collection and archiving for future stable isotope analyses as a part of regular MNDNR and NPS sampling following the completion of this project in order to understand the impacts of future ecosystem-level stressors. This project is part of a larger research effort led by the PIs to characterize and mitigate ecosystem-level effects of AIS in Minnesota's lakes. We anticipate that future funding requests may be submitted to MAISRC or LCCMR to continue to track food web changes in invaded lakes, especially Leech Lake and Mille Lacs.

C. Spending History:

Funding Source	**FY17**
DNR Game and Fish fund - FY2017 is an estimate and includes estimated project team salary in FY2017 to prepare for this project for entire FY2017, supplies purchased by MNDNR in FY2017 to prepare for sampling in July 2017.	$3,596

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): N/A

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: N/A

XI. RESEARCH PROPOSAL: Please see attached research proposal.

XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than January 31, 2018; July 31, 2018; and January 31, 2019. A final report and associated products will be submitted within two months of the anticipated sub-project completion of June 30, 2019.