Name of Organization: Lake Champlain Research Institute

Type of Organization: College or University

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Project Title: Altered trophic and contaminant pathways in the Great Lakes

Project Category: Exotic Species

Rank by Organization (if applicable): 0

Total Funding Requested ($): 84,660 **Project Duration:** 2 Years

Abstract:

Benthic-pelagic linkages are very important in large lake food webs. Although some information exists for the Great Lakes, our understanding of these linkages is very poor. The recent invasion of the zebra mussel (Dreissena polymorpha) into the Great Lakes region and subsequent alterations to benthic and pelagic trophic energy pathways, including effects on top piscivores, is a major research area of interest region-wide. This study will address the dynamics of benthic-pelagic food web pathways and contaminant transfer in two Great Lakes (Ontario, Erie) with emphasis on the role of zebra mussels in altering trophic linkages. We will use both traditional and innovative chemical methods (stable isotope and fatty acid analysis) to characterize food web pathways and contaminant (PCB) pathways between benthic and pelagic components of the lake food web. Only once linkages are identified and quantified can scientists begin to develop mass-balance models for complex systems such as the Great Lakes. The proposed research, to be conducted at the Lake Champlain Research Institute's state-of-the-art analytical research laboratory, will provide the empirical data to allow refinement of mass-balance models for energy flow and contaminants between benthic and pelagic food web compartments in the Great Lakes. Field samples will be collected in cooperation with existing lake sampling programs thereby reducing field costs dramatically and fostering interaction and comparison of the data with existing research and monitoring efforts. Through this research we will assess whether zebra mussels are accelerating, decelerating, or redirecting the transfer of contaminants and energy into the pelagic food web in the Great Lakes ecosystem.

Geographic Areas Affected by the Project

States:

- ☐ Illinois
- ☐ Indiana
- ☒ Michigan
- ☐ Minnesota
- ☒ New York
- ☒ Pennsylvania
- ☐ Wisconsin
- ☒ Ohio

Lakes:

- ☐ Superior
- ☐ Huron
- ☐ Michigan
- ☒ Erie
- ☒ Ontario
- ☐ All Lakes

Geographic Initiatives:

- ☐ Greater Chicago
- ☒ NE Ohio
- ☐ NW Indiana
- ☐ SE Michigan
- ☐ Lake St. Clair

Primary Affected Area of Concern: Not Applicable

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area: Not Applicable

Other Affected Biodiversity Investment Areas:

Problem Statement:

A sound understanding of processes involved in the transformation of energy or contaminants from basal resources through a complex food web is of utmost importance prior to attempting to manage natural resources in a large-scale system. The addition of an invasive species such as the zebra mussel further complicates our already poor understanding of trophic linkages in large lakes. Zebra mussels have demonstrated an ability to directly impact carbon, nutrient, and contaminant flow throughout the Great Lakes benthic zone. These impacts include the potential influence on trophic interactions among benthic communities and benthic/pelagic linkages in lake food webs. Of particular interest are the indirect effects on important commercial or recreational species such as salmon, lake trout, walleye, yellow perch, and other game fish. Zebra mussels have the potential to significantly influence energy and contaminant flow in these populations directly by limiting the amount of food, in the form of zooplankton, available to the larval stage of the sport fish and indirectly through impacts on forage fish.

Work to determine if and how the benthic zone alterations influence cycling of contaminants and energy to the pelagic food web is lacking. Knowledge of these benthic-pelagic coupling mechanisms would allow scientists to address unanswered questions about how contaminants and energy enter the higher food web. Examples of unanswered questions include: Does zebra mussel mediated accumulation of PCB's in the benthic zone reduce the amount of PCB's accumulating in components of the pelagic food web? Is PCB and energy cycling in the pelagic food web actually linked to mechanisms in the benthic zone? Are lower levels of the pelagic food web actually picking up PCB load via ingestion of single/multiple benthic sources? Is there a single primary energy or contaminant pathway linking the benthic and pelagic food web and if so are they the same pathways for both energy and PCB's? Are contaminants found in top level consumers in the pelagic food web (Trout, Salmon, Cormorants, Herring) linked to single/multiple sources within the pelagic food web? The proposed research cannot answer all of these questions but can provide vital information that will be very useful for making regulatory and management decisions that further reduce contaminant biomagnification. This type of information will also be very useful to stockholder efforts such as the LaMP's and scientific endeavors such as mass balance modeling efforts.

Proposed Work Outcome:

We propose to use chemical tracer methods to determine the impacts of zebra mussels on energy flow and contaminant pathways in the Lake Ontario and Lake Erie food web. We will address the research question, "What are the effects of zebra mussels on benthic-pelagic linkages in Great Lakes food webs?" by tracing trophic linkages along with PCB contaminant pathways through the major food web compartments. Chemical tracers (fatty acid analysis and stable isotope analysis) will be used to identify broad trophic classifications of taxa as well as the ultimate source of carbon and contaminants to the food web. Stable isotope methods are more commonly used while fatty acid profile methods, an

innovative new method using fatty acid compounds as biomarkers, are extremely accurate in tracing linkages between food web components. Using fatty acids as biomarkers compliments the isotope data by better defining animal/taxa links that carbon and contaminants actually take between trophic levels. Since both of these methods provide information on trophic pathways and are based on analysis of tissue samples, we will also determine PCB transfer pathways among major food web energy pathways during this study using split samples. Sample analysis for Fatty acids and PCB's will be analyzed using the newly rennovated analytical research laboratories of the Lake Champlain Research Institute (www.plattsburgh.edu/lcri) at Plattsburgh State University. This laboratory contains the latest analytical instrumentation and capability to conduct both fatty acid and PCB sample analysis. Stable isotope analysis will be sub-contracted to a suitable analytical laboratory.

Samples for analysis will be obtained through cooperation with existing lake monitoring efforts on lake Ontario and lake Erie, including GLNPO monitoring, LaMP's and other efforts. Once collected in the field, whole samples will be held at -20C and shipped to Plattsburgh State University, sorted by species, and split for chemical analysis using stable isotope (c-13 and n-15) and fatty acid tracers to describe trophic linkages between additional benthic and pelagic sub-web components in each lake and PCB analysis to trace contanimant pathways. Major linkages characterized will include benthic and pelagic bacteria-detritus, soft algae, diatoms, zooplankton, zebra mussels, invertebrates (Mysids, Diporeia) forage fish including rainbow smelt (Osmerus mordax) and Cisco (Coregonus artedii), and several piscivores including lake trout (Salvelinus manaycush), pike (Esox lucius), walleye (Stizostedion vitreum), and yellow perch (Perca flavescens) involving a total of 75-100 trophic pathways in each food web and 20-30 contanimant PCB pathways that will include the major energy pathways in each lake.

Fatty acid laboratory methods will follow standard procedures. Briefly, frozen samples will be freeze dried (for total FA), reweighed, and stored at -20C until extraction. Samples will be homogenized cold in a glass centrifuge tube or sonicated; subsamples will be weighed and extracted in (2:1) chloroform:methanol and mixed. Total FA levels (mg/g) will be quantified using the sulfophosphovanillin method with lineolic acid as a standard; quantitative FA composition will be based on this total. The chloroform phase will be dried under N2 , transmethylated, extracted in pet-ether, redried and dissolved in hexane. Methylated extracts will be determined via gas chromatography (HP5890) using a capillary column and FID detector, with peaks compared to known FAME standards. Split samples for each species will also be subcontracted for delta13C and delta15N analysis (@$24/sample) using standard methods for isotope ratio mass spectrometry. Congener-specific PCB concentrations in biological tissue samples will be determined using standard procedures of extraction and analysis. Ground, homogenized, and sonicated tissue will be soxhlet extracted into solvent. Concentrated extracts will be pretreated using gel permeation chromatography and solid adsorbent column clean-up techniquies. PCB congener identification and quantitation will then be performed using capillary column gas chromatography with electron capture detection, (HRGC/ECD). Analyte identity will be checked with second column confirmation GC/ECD and GC/MS techniques.

We anticipate the products of this research to include both a) identification of specific pathways and transfer rate models of PCB's that can be used in a mass balance approach to contaminant fate in the Great Lakes food web and b) an evaluation of the effectiveness of food web and bioaccumulation/biomagnification models developed prior to the zebra mussel introduction to post-zebra mussel conditions.

Project Milestones:	Dates:
Project Start	01/2001
Contact Lake Ontario monitoring programs	02/2001
Field collection/shipment- Lake Ontario	09/2001
Contact Lake Erie monitoring programs	02/2002
Chemical analysis-Ontario	03/2002
Field collection/shipment- Lake Erie	09/2002
Chemical analysis- Erie	01/2003
Project End	03/2003

☐ Project Addresses Environmental Justice

If So, Description of How:

☒ Project Addresses Education/Outreach

If So, Description of How:

Upon completion of the study for each lake, a trophic pathway model will be developed and an interactive website designed to demonstrate the energy and contaminant pathways and the implications of the results for lake management, mass-balance modeling, and food web dynamics. Also, an educational project outline, including the pathway model, will be made available to educational institutions via the website throughout the Great Lakes region for classroom use to discuss the impacts of the zebra mussel on ecosystem structure and function. Collaboration with Sea Grant and other Great Lakes organizations will facilitate distribution of the educational materials.

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	39,000	10,455
Fringe:	5,076	3,049
Travel:	2,250	0
Equipment:	0	5,500
Supplies:	6,000	2,000
Contracts:	4,800	0
Construction:	0	0
Other:	0	0
Total Direct Costs:	57,126	21,004
Indirect Costs:	27,534	7,381
Total:	84,660	28,385
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

The Institutional match ($28,385) will be provided from Plattsburgh State University. Organizations that fund existing Lake Ontario and Lake Erie sampling and monitoring programs will not directly be solicited to fund this project. However, through providing access to existing samples as they are collected, these organizations will be providing in-kind contributions to this research.

Description of Collaboration/Community Based Support:

This project will involve collaboration with existing Great Lakes monitoring programs making use of existing access to sample collection programs to obtain samples for chemical analysis. This will reduce the costs significantly versus a project requiring resources to conduct complete field and laboratory sampling independently. Investigators involved in this project will include scientists from two institutions as co-investigators (Tim Mihuc, Robert Fuller and Jeff Jones, Plattsburgh State University and James Thorp and Andy Casper, Clarkson University). In addition it will help foster interaction and collaboration among research and monitoring program staff involved in Lake Ontario and Lake Erie research. Implications of the results obtained and avenues explored for future research opportunities will extend to the entire Great Lakes community.