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**Type of Organization:** College or University

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**Project Title:** Zebra Mussel-Induced Changes in PCBs in Saginaw Bay

**Project Category:** Exotic Species

**Rank by Organization (if applicable):** 0

**Total Funding Requested ($):** 190,384 **Project Duration:** 2 Years

**Abstract:**

Saginaw Bay is one of the most productive areas in the Great Lakes, is an AOC, supports commercial and world-class sport fisheries, and contains the largest watershed in Michigan. It also has a substantial PCB contamination problem in the Saginaw River, which has led to fish contamination advisories. Zebra mussels entered the bay around 1991, and extensive studies of their impacts on the lower food web were performed by NOAA GLERL and CGLAS. Walleyes and forage fishes collected during 1990, prior to the arrival of zebra mussels, were analyzed for congener-specific PCBs (Giesy et al. 1997). Another companion study (Van Hoof et al. 1997) on PCB cycling in the food web was initiated during 1993-95 (lower food web) and 1993 and 96 (fish). Data from GLERL studies and MDNR data suggest some dramatic changes have occurred in the food web, including increased water clarity and a shift in dominance from pelagic to benthic species. These changes include: an increase in Gammarus in the zebra mussel-encrusted beds, potential Hexagenia rebound, decline in zooplankton, rotifers,and oligchaetes, an increase in benthic algae and macrophytes, a shift toward more benthic fish species, and possibly increased growth of top predators, such as yellow perch and walleyes. We were asked to submit a grant to National Sea Grant to study how these changes affected benthos, larval fish, and adult fish and suggest that this is an opportune time to also determine how PCB cycling has changed now that zebra mussels have resided in the bay for almost 10 yrs. Therefore, we propose to compare the bioaccumulation of PCBs in components of benthic and pelagic food webs to determine if shifts in diet, species populations, or contaminant transfer occurred as a result of zebra mussels. We can also track congener-specific PCBs in the Saginaw River sediments and TSS and determine which are transferred to bay fish and lower food web organisms.

**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:** Saginaw River, MI

**Other Affected Areas of Concern:**

***For Habitat Projects Only:***

**Primary Affected Biodiversity Investment Area:**

**Other Affected Biodiversity Investment Areas:**

**Problem Statement:**

Saginaw Bay is representative of many areas of the Great Lakes undergoing oligotrophication, toxic substances declines, and exotic species introductions (e.g., zebra mussel). A considerable amount of information exists on the bay due to early work on eutrophication, fisheries, and toxic substance contamination in the Saginaw River. More importantly, some extensive studies were conducted by NOAA GLERL on the chemistry and lower food web and by CGLAS on larval fish and water chemistry responses induced by the zebra mussel in the early 1990s. Contaminant work on walleyes and forage fishes in 1990 (Giesy et al. 1997) and the lower food web (1993-1995) and fish in 1993 and 1996 (Van Hoof et al. 1997) provide historical data sets. These investigators were testing the hypothesis that zebra mussels would remove algae and organic matter from the water column and deposit contaminants in feces and pseudofeces, hence changing PCB bioaccumulation in the food web. They found, based on 1993 data, that zebra mussels were not enhancing the accumulation of PCBs in the benthos. For both benthic and pelagic components of the Saginaw Bay food web, a singular exponential relationship between trophic level, based on stable isotopes, and PCB concentration, was found. Others have shown dramatic effects on food web dynamics and large increases in PCB levels due to exotic species and it has been shown recently that zebra mussels do enrich the sediments and benthos with contaminants. We believe there may not have been enough time elapsed for some of the changes in Saginaw Bay to be manifested. Therefore, we propose to examine these relationships 10 yrs later and to track congeners present in the river and see which are being transferred to aquatic organisms in the bay.

**Proposed Work Outcome:**

Our proposed work will build on and duplicate most of the previous sampling to determine how long-term impacts of zebra mussel infestation changed PCB bioaccumulation, particularly in longer lived fish species. Our objectives are to determine if 10 yr. after zebra mussels were introduced into Saginaw Bay, whether changes have occurred in PCB cycling due to the dramatic effects registered in other components of the bay that may not have been fully manifested early in the colonization of zebra mussels. This is especially true of top predators, which live at least 5-10 years. As noted, there have been declines in zooplankton and increases in benthic species and MDNR has noted shifts in forage fish species from pelagic species, such as alewife and gizzard shad, which are the most important prey of walleyes, to benthic species, such as trout-perch and yellow perch. We have been requested to submit a full proposal to National Sea Grant to study how zebra mussels have impacted the biological components, and, if funded, we could collect all the samples required for the PCB/stable isotope analyses. In addition, detailed diet studies, which are part of the proposal, would provide verification of the stable isotope findings. We therefore propose to collect net algae, zooplankton, Gammarus, and zebra mussels from three stations, three times during 2001. Fish (white sucker, walleye, yellow perch, white perch, trout-perch, alewife, rainbow smelt, and spottail shiner) will be collected from one station in fall, 2001. Congener-specific PCBs and stable isotopes (15N/14N) will be measured in each food web component to relate trophic position to PCB accumulation.

Results will be compared with the walleye and forage fish data from 1990 and data on the fish and lower food web from 1993 to 1996. A covariance analysis of the two curves (PCBs vs. trophic position) will show whether a shift in PCB levels or position in the food web has occurred between 1993 and 2001. In addition, PCB data are available (Jude and DeBoe 1999) from a recently submitted report to EPA, which documents the congener patterns in the Saginaw River sediments and TSS. These data will be used to determine which PCB fractions become transferred in food webs and if that fraction is associated with the TSS that are transported out of the Saginaw River. This proposed study will provide the information necessary to determine how contaminant relationships were impacted by zebra mussels and provide a way of measuring clean-up and response of the PCB declines on uptake by key species in Saginaw Bay. Pat Van Hoof, formerly of GLERL, and John Giesy, Michigan State University, will be co-principal investigators, while Brian Eadie, GLERL, will act as a cooperator and advisor.

| **Project Milestones:** | **Dates:** |
|---|---|
| Project Start | 01/2001 |
| Collect lower food web samples | 05/2001 |
| Collect lower food web samples | 07/2001 |
| Collect lower food web & fish samples | 09/2001 |
| Analyze samples for PCBs/stable isotopes | 10/2001 |
| Obtain data and begin synthesis | 02/2002 |
| Prepare reports/papers | 06/2002 |
| Project End | 12/2002 |

☐ Project Addresses Environmental Justice

**If So, Description of How:**

☐ Project Addresses Education/Outreach

**If So, Description of How:**

We will use our media services at NOAA and UM to disseminate the results of our studies. We will also present this information at a national meeting and prepare a manuscript describing the results of the study.

**Project Budget:**

| | Federal Share Requested ($) | Applicant's Share ($) |
|---|---|---|
| **Personnel:** | 76,149 | 5,218 |
| **Fringe:** | 20,083 | 1,461 |
| **Travel:** | 3,000 | 0 |
| **Equipment:** | 0 | 0 |
| **Supplies:** | 2,500 | 0 |
| **Contracts:** | 24,350 | 0 |
| **Construction:** | 0 | 0 |
| **Other:** | 0 | 0 |
| **Total Direct Costs:** | 126,082 | 6,679 |
| **Indirect Costs:** | 64,302 | 3,406 |
| **Total:** | 190,384 | 10,085 |
| **Projected Income:** | 0 | 0 |

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

Our department (CGLAS) and the Office of the Vice President for Research will contribute match for this study (see budget). We have submitted a grant to National Sea Grant to work on the effects of zebra mussels on the essential fish habitat in Saginaw Bay and if it is funded, we will be able to collect some of the samples in conjunction with that study. MDNR is also cooperating with us in that study and will be collecting fish we could also use for contaminant and stable isotope samples if necessary.

**Description of Collaboration/Community Based Support:**

The MI DEQ and other management agencies across the Great Lakes and Canada are concerned with ways zebra mussels might change contaminant relationships in various habitats. This will be a collaborative effort among NOAA's Great Lakes Environmental Research Laboratory, Michigan State University, and the University of Michigan. The MI DNR has pledged to assist us with ship time, fish data, and specimens and USGS will perform diet studies necessary to corroborate the stable isotope data in the National Sea Grant study. This information will be useful to show how zebra mussels may have changed contaminant relationships and enriched uptake in benthic fish, which may cascade to top predators, yellow perch and walleyes in Saginaw Bay. Results should be applicable in other areas impacted by zebra mussels.