The Statewide Energy Efficiency and Renewables Administration and The Public Service Commission of Wisconsin

Environmental and Economic Research and Development Program

Executive Summary

October 2007

Mercury in Selected Fish Species over Time

Prepared by:

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This report in whole is the property of the State of Wisconsin and was funded through the FOCUS ON ENERGY program.

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Final Report
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EXECUTIVE SUMMARY

Date of Report: November 19, 2007

Title of Project: Mercury in Selected Fish Species Over Time

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Research Category: Measurement of mercury in Wisconsin environment

Project Period: November 1, 2002 to June 30, 2007

Object of Research: The goal of this project was to develop and implement a monitoring design to assess changes in mercury (Hg) concentrations in selected fish species over time. Measuring temporal trends of Hg in fish is important to better understand the sources and fate of Hg released to the environment including that from generation of electricity and other sources.

Summary of Results and Accomplishments:

Monitoring of Hg concentrations in walleye skin-on fillets is a useful tool for detecting trends of Hg in Wisconsin's lakes if known factors that affect Hg availability and bioaccumulation are incorporated into appropriate statistical analyses. Measuring temporal trends of Hg in Wisconsin walleye should allow for a better understanding of the sources and fate of Hg released to the environment.

We explored the Wisconsin Department of Natural Resources' (WI DNR) fish contaminant database to determine the availability and utility of historical (1970 - 2002) Hg records for different species and to identify lakes with historical Hg data. Walleye skin-on fillets were selected for further examination. This project supported processing and characterization of 310 additional walleyes from 36 lakes that were collected over the years 2003 to 2006. With these data, we created a dataset of 3,024 individual walleye records from 421 lakes spanning 1982 to 2005. We evaluated temporal trends over all lakes represented in this dataset using several different mixed effects models. We explored the relationships between Hg concentrations and a suite of lake chemistry, morphometry, and other variables.

Our analyses suggest that temporal trends in walleye Hg concentrations varied latitudinally within Wisconsin. Northern lakes exhibited slight average decreases (– 0.5% per year), central lakes showed no change, and southern lakes showed modest average increases in Hg concentration (+ 0.8% per year) over the period from 1982 to 2005. Individual lakes deviate from these population averages. Our finding that walleye Hg concentrations decreased in northern Wisconsin is consistent with other studies. While there are a number of possible explanations for our finding of increased walleye Hg concentrations in southern lakes, this finding warrants further study to verify the trend and to investigate possible mechanisms that would cause Hg to increase in southern Wisconsin waters.

Walleye Hg concentrations and the Hg-fish length relationship vary greatly among lakes. Lake latitude, lake area, and alkalinity explained some of the differences in Hg concentrations, but none accounted for differences in the Hg-length relationships. We also found that Hg concentrations vary by gender and season of collection. Walleye Hg was lower in females than in males of equal size. Mercury concentrations were highest in walleye captured in the spring and lowest in the fall.

Our analysis of walleye Hg records from non-riverine Wisconsin lakes suggests that the historical data is valuable and the current sampling strategy is appropriate for detecting changes in Hg concentrations over time. Variability in fish Hg concentrations within and among lakes and with increasing fish lengths can make data interpretation challenging, but continued sampling using the current design is sufficiently robust and capable of detecting temporal trends.

This project also supported the collection, processing, and analysis of young-of-year (YOY) and yearling yellow perch. Young-of-year yellow perch (n = 66 composites) were collected in 2003 and 2006 at seven lakes where samples had been collected in the past (1992 to 2000) to create a dataset of 121 composite YOY records. In addition, yearling and YOY yellow perch (n = 477 individual fish) were collected at 24 lakes over the four sampling seasons from 2003 to 2006.

In contrast to our conclusion that monitoring of Hg concentrations in walleye skin-on fillets is a useful tool, we are unable to draw a strong conclusion about the utility of young yellow perch for detecting Hg trends in Wisconsin's lakes. Our analysis of YOY from the seven northern Wisconsin study lakes found that the average length of the all YOY sampled from the lake (grand lake-mean length) best described Hg concentrations. This finding suggests that Hg concentrations in YOY yellow perch are primarily related to factors that differ between lakes, e.g. productivity, food availability, or other factors affecting YOY growth rates. The second best model suggests that Hg concentrations in YOY yellow perch decreased from 1992 to 2006 in the range of – 0.69% per year, a result consistent with the northern Wisconsin walleye trends. These differing results do not lead to a strong conclusion about temporal trends in Hg concentrations in YOY from the seven northern Wisconsin study lakes over the 15-year study period (1992 to 2006).

The inconclusive YOY findings may be affected by the limited number of lakes with historical (1992-2000) YOY Hg data. Obtaining samples from additional lakes and years may allow for better estimates of YOY Hg trends. After we completed an interim analysis of YOY Hg data, we recommended that additional lakes be included in this study. In addition, due to the short and dynamic life history characteristics of YOY, we recommended sampling of yearling (age 1) yellow perch to determine if yearlings would be better indicators than YOY.

As follow-up to the above recommendation, individual yearling yellow perch were collected from 24 Wisconsin lakes. The limited yearling yellow perch collected to date suggest that Hg concentrations are as variable in yearling as they are in YOY. At this time, our datasets are too limited to determine if Hg concentrations changed over time in YOY or yearling yellow perch from Wisconsin lakes. Recently, Harris et al. (2007) demonstrated that Hg concentrations in YOY yellow perch responded to controlled artificial Hg spikes and that most of the increase was from Hg deposited directly to the lake but that the YOY increase was not proportional to the loading increase. These authors predict, that while biota will respond quickly to reductions, response rates will vary among lakes. Hrabik and Watras (2002) attributed reduced Hg concentrations in yellow perch from one northern Wisconsin lake to decreases in atmospheric deposition of H_2SO_4 and Hg from 1994 to 2000. Rodger et al. (2006) found no statistically significant changes in Hg deposition measured from 1998 to 2005 at a limited number of monitoring stations. If deposition to the yellow perch study lakes did not change, then we would expect no change in yellow perch Hg concentrations. Based on monitoring conducted to date and these key studies, additional yearling yellow perch should be collected and analyzed before conclusions are made regarding the utility of yearling yellow perch to indicate temporal trends of Hg in Wisconsin lakes.