

EPRI and Minnesota Power Conduct Innovative Study of Water Fluctuation Effects on Mercury in Reservoirs

During the relicensing process for its St. Louis River hydroelectric project, Minnesota Power (MP) agreed to initiate research into whether the daily and seasonal fluctuations in reservoir water levels supplying the project had any effect on the creation or mobilization of methylmercury within the reservoirs. With agreement from the two other major stakeholders—the Minnesota Pollution Control Agency (MPCA) and the Fond du Lac Band of Lake Superior Chippewa—MP requested that EPRI manage a collaborative study. It was the first integrated laboratory and field study to test the hypothesis that methylmercury creation and mobilization were associated with reservoir fluctuation. “It was believed by the resource agency and tribal regulators that fluctuating water levels in storage reservoirs could enhance bacterial activity in connected wetlands, thereby increasing mercury methylation and mobilization. This experiment demonstrated the relationship between water fluctuations and methylmercury isn’t nearly so simple,” said MP’s Kurt Anderson, Environmental Compliance Specialist. Instead, the results showed that the chemistry and mobilization of mercury are much more complex than the hypothesis indicated. Understanding these processes requires a comprehensive analysis of many factors operating throughout the surrounding watershed—analyses in which EPRI has extensive experience and proven tools. MP is now well positioned to consider this study’s results with regulators, supported by EPRI’s recognized scientific credibility and confidence of EPRI’s ability to help extend the research to a wider watershed scale if necessary.

“This experiment demonstrated the relationship between water fluctuations and methylmercury is far more complex than originally thought.”

~ Kurt Anderson, Environmental Compliance Specialist

Minnesota Power Asks EPRI to Examine Reservoir Fluctuation Effects

MP operates 11 hydroelectric power stations in northern and central Minnesota. Its St. Louis River hydroelectric project near Duluth has a history stretching back to 1905, when construction began on the first of four hydroelectric units on the river. The five headwater storage reservoirs that currently feed the St. Louis River project are subject to seasonal water level fluctuations to provide for winter generation. During lower flow months, a sixth peaking reservoir is also used to meet day-to-day energy needs with a daily drawdown and refill cycle over a 24 hour period. In the headwater storage reservoirs, a slow but steady seasonal drawdown is used to provide generation from freeze up in November until the spring thaw in April.

During the federal relicensing process for the St. Louis River project, which began in 1993, new research results from Canadian studies began to appear, showing that newly formed reservoirs for hydro projects were associated with increased mercury levels in reservoir fish tissues. As a



EPRI and Minnesota Power conducted a first-of-its-kind integrated laboratory and field study on the impacts of reservoir water level fluctuation on methylmercury production and mobilization.

Challenge

To meet hydropower facility relicensing requirements, Minnesota Power needed to research whether fluctuations in reservoir water levels affect the creation and mobilization of mercury within a reservoir.

Solution

Minnesota Power asked EPRI to manage this study based on EPRI’s past experience in mercury research and its knowledge of the environmental, utility and regulatory arenas.

Results and Benefits

Results did not demonstrate a simple relationship between water level fluctuation and mercury chemistry and mobilization, but rather revealed the complexities of the process and provided data for Minnesota Power’s continued discussions with regulators and further research.

result, the issue of mercury and its possible sources became part of regulatory considerations for the St. Louis River project relicensing. The MPCA and the Fond du Lac Band expressed concern that, although the project's headwater reservoirs were not new, fluctuating water levels in existing reservoirs might affect levels of mercury in fish tissues in ways similar to new reservoir construction. Several mercury scientists hypothesized that such fluctuations might increase biological activity of sulfate-reducing bacteria, or SRB, which in turn could increase mercury methylation rates in near-shore sediments in the reservoirs. Additionally, the flux of water between these wetlands and the reservoirs was thought to increase mobilization of methylmercury into the water column. However, no research had been conducted to examine this hypothesis. As part of its relicensing agreement, MP agreed to undertake research on this topic.

MP suggested that EPRI manage the study, citing EPRI's record of research in the western Lake Superior watershed in northern Minnesota on mercury biogeochemical cycling. With agreement from MPCA and the Fond du Lac Band, MP and EPRI undertook the study as a collaborative project. EPRI's research management experience was of immediate value. Lowell Neudahl, Senior Environmental Compliance Specialist, commented, "I can't say enough about how [EPRI's] Bob Goldstein helped with the contract negotiations between EPRI and the contractor that did the work."

With extensive help from Neudahl and Anderson, the contractor chose two reservoirs and a natural lake within the watershed for collection of field samples: Boulder Lake, an annual drawdown reservoir; Thomson Reservoir, a peaking reservoir; and Alden Lake as a control. The field work for the study established total mercury and methylmercury levels at the three sites. The laboratory research addressed three issues:

- Effects of water-level fluctuation on methylmercury production in the wetland soils
- Mobilization of total mercury and methylmercury from the wetland soils to the reservoirs' water column
- Effects of winter drawdown on methylmercury production in wetland sediments along the shores.

Results Show Complexity of Methylmercury Creation and Mobilization Processes

Results from extensive laboratory analyses did not support the simple hypothesis that increased water-level fluctuation increases methylmercury formation or mobilization. Results were in fact mixed, showing that

aquatic chemistry and mercury mobilization are much more complex than could be accounted for by the study design. However, the study laid the groundwork and clarified the possibilities for further research that could address the issue more thoroughly—for example, the role of wetland types, drawdown duration, and fluctuation frequency in methylmercury production and mobilization. MP can now use this information to continue discussions with its regulators and satisfy additional research or relicensing needs.

Bob Goldstein observed, "This was a highly original study, looking at things that hadn't been looked at before. It combined studies of microorganisms with chemical studies, and it built a good foundation for future research in this area. Lowell and Kurt were very active participants throughout the project, both to meet MP's needs and to help out other utilities facing similar issues. EPRI is pleased to recognize their genuine commitment to the industry with a 2009 Technology Transfer award."

Said Anderson, "Having someone like Bob who understands our perspective from a power generation standpoint has been really valuable. He understands the issues; he's knowledgeable about environmental concerns and also about what we'd have to do as a company if we were restricted on our water management. If we are required by our regulators to continue this research, EPRI's expertise will be very helpful in stepping it up to more of a risk-based, watershed-wide analysis."

Related EPRI Products

Title	Product ID
Applicability of Regional Total Maximum Daily Loads (TMDLs) for Atmospheric Deposition of Contaminants: Mercury and Nitrogen, 2009	1015581
TMDL Technical Evaluation Framework, 2009	1015580
Enhancement of Watershed Analysis Risk Management Framework (WARMF) for Mercury Watershed Management and Total Maximum Daily Loads (TMDLs), 2006	1005470

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com)

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