WATERSHED YIELD OF MERCURY TO ONONDAGA LAKE: LESSONS FOR THE MOHAWK WATERSHED

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Onondaga Lake is located in the Oswego River drainage basin in Onondaga County adjacent to the City of Syracuse in central New York. Two major creeks, Onondaga Creek and Ninemile Creek, and the Metropolitan Syracuse Wastewater Treatment Plant (Metro) supply most of the water to the 1,200 hectare lake with several minor tributaries supplying the remainder. Percent contribution to mean daily flows in 1992 were as follows: Onondaga Creek 32.5, Ninemile Creek 30.9, Metro 18.0, Ley Creek 8.3, Bloody Brook 5.6, Harbor Brook 2.0, Sawmill Creek 1.5, Tributary 5A 0.7, and East Flume 0.5 (TAMS 2002). Onondaga Lake is a culturally eutrophic lake and is on the National Priorities List (NPL) due to industrial contamination. Two major remedial programs are underway at the lake: upgrades to Metro to bring the lake into compliance with surface water quality standards for ammonia, phosphorus, and oxygen, and remediation of contaminated sediment by Honeywell under the direction of New York State Department of Environmental Conservation (NYSDEC). Additional work is being undertaken by both Metro and Honeywell to address upland sources of contamination (Metro – nitrogen and phosphorus, Honeywell – hazardous chemicals) to the lake.

From 1992 to 2001, Onondaga Lake was the subject of a comprehensive remedial investigation to ascertain the nature and extent of contamination. Mercury was a major focus of the investigation due to elevated mercury concentrations in Onondaga Lake fish and the historical presence of two mercury cell chlor-alkali plants near the lake. Tributary loading of total mercury and methylmercury to the lake was determined based on water sampling and flow rate measurements in the tributaries from April through November of 1992. With the exception of Bloody Brook and Sawmill Creek for which only limited mercury data were collected, loading calculations were determined using the FLUX model (Walker 1987) for May 25 to September 21, 1992, the period for which substantial data on all mercury sources, sinks, and cycling processes were available (TAMS 2002). For a simple estimate of annual load, the calculated loads were extrapolated to an annual basis and the results are shown in Table 1. Tributary 5a and the East Flume were not included because they constituted only 1.2 percent of mean daily flow in 1992. This approach may overestimate loads because it emphasizes data from periods of the year when more flow is recorded. It may also underestimate loads because it does not include data from spring runoff when substantial mercury loading has been observed in other systems.

Calculation of specific yield is based on the annual load and the area of the drainage basin for each tributary. As shown in Table 1, Ninemile Creek clearly has a higher specific yield for total mercury than the other tributaries. Ninemile Creek is the receiving water body for historical discharge from one of the mercury cell chlor-alkali facilities, the LCP Bridge Street site, which has recently undergone remediation. Ninemile Creek itself is scheduled to undergo remediation within five years to remove and contain contaminated sediment. Harbor Brook has the second highest specific yield for total mercury. The

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lower reaches of Harbor Brook receive mercury-contaminated groundwater from the second mercury cell chlor-alkali facility (i.e., the Willis Avenue plant). This facility has been remediated and plans are underway to collect and treat contaminated groundwater and remediate Harbor Brook.

When considering specific yields, it must be noted that atmospheric deposition is generally the primary source of mercury to watersheds in the absence of point sources or mineral contributions. In comparison to specific yield values reported in the literature, Ninemile Creek and Harbor Brook are clearly outliers with respect to total mercury while Onondaga Creek and Ley Creek are within the range reported for urban rivers. The methylmercury specific yields from all four tributaries, however, are less than those reported for some pristine systems, particularly boreal forest wetlands. This finding is consistent with numerous studies that have shown little relationship between total mercury and methylmercury concentrations in water or sediment, primarily because the formation of methylmercury is a natural process subject to several site-specific factors (e.g., concentrations of dissolved oxygen, carbon, and sulfate). It also suggests that tributary loading of methylmercury to Onondaga Lake is not as important as in-lake sources of methylmercury with respect to bioaccumulation into fish tissue, a hypothesis that is supported by studies of methylmercury production and bioaccumulation within the lake.

Mercury data in fish tissue from the Mohawk River drainage basin (collected by NYSDEC) reflects a similar situation. Mercury concentrations in fish tissue within the rivers and creeks of the drainage basin are rarely elevated above levels of concern and no fish consumption advisories have been issued with respect to mercury. However, NYS Department of Health has issued fish consumption advisories based on mercury for Schoharie Reservoir, Pine Lake, Canada Lake, and Ferris Lake in the Mohawk River drainage basin, highlighting the importance of methylmercury production and bioaccumulation processes within lakes and reservoirs.

A watershed perspective on mercury transport can help to identify the potential for point source contamination as well as highlight the ubiquitous presence of mercury in water bodies due to atmospheric deposition. It also emphasizes the importance of watershed land use and in-lake or in-reservoir processes for methylmercury production and bioaccumulation.

TAMS. 2002. Onondaga Lake Remedial Investigation Report, Syracuse, New York. Prepared for New York State Department of Environmental Conservation, Albany, NY.

Walker, WW. 1987. Empirical methods for predicting eutrophication in impoundments. Report 4: Phase III: Applications Manual. Technical Report E-91-9. US Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Table 1. Specific Yield of Total Mercury and Methylmercury from Onondaga Lake Tributary Drainage Basins

Tributary	Area of Drainage Basin (ha)	Annual Total Mercury Load (g)	Total Mercury (ug/m^2-yr)	Annual Methylmercury Load (g)	Methylmercury (ug/m^2-yr)
Ninemile Creek	29,800	3890	13.1	149	0.50
Onondaga Creek	28,500	1060	3.7	64	0.22
Ley Creek	7,740	258	3.3	3	0.03
Harbor Brook	2,930	248	8.5	8	0.27
Metro	NA	1870	NA	129	NA

Note – Annual loads calculated by extrapolating from May-September 1992 loads provided in TAMS (2002). NA is not applicable.