



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: An Assessment of Historical and Contemporary Atmospheric Deposition of Mercury to a New Hampshire Watershed and Lake

Duration: October 1, 1996 - September 30, 1997

FY 1996 Federal Funds: \$27,688

FY 1996 Nonfederal Funds: \$27,812

Principal Investigators:

Byard W. Mosher and Robert W. Talbot

Complex Systems Research Center

University of New Hampshire

Congressional District: NH, 01

Statement of Critical State and Regional Problems:

It is widely acknowledged that elevated concentrations of mercury in the aquatic environment represent a potentially serious ecological threat which must be addressed. While the effects of exposure to high levels of methylmercury (CH_3Hg), the most toxic form of mercury found in the environment, such as mental retardation and severe birth defects are well known, recent research suggests that exposure to much lower levels may cause more subtle neurological defects such as delayed development of motor skills and abnormal reflexes in children (Clarkson, 1994). Information concerning the magnitude and regional sources of mercury deposited in the New England region is an essential component of sound resource protection policy and at the present time this data base is very limited. A number of factors underscore the importance of obtaining reliable data concerning both historical and contemporary inputs of mercury to watersheds and fresh water lakes in New Hampshire: 1) the State of New Hampshire recently joined the states of Maine and Massachusetts in issuing an advisory concerning the consumption of fresh water fish due to elevated mercury levels (Dreisig and Dupree, 1994), 2) there has also been considerable controversy recently as to the role that local waste incinerators play in the deposition of mercury to New Hampshire lakes, 3) source/receptor models such as EPA's RELMAP (Regional Lagrangian Model of Air Pollution) suggest that some of the highest atmospheric deposition rates of mercury should be observed along the northeast corridor of the US, from New York to Maine (Bullock et al., 1994), and these models must be tested with actual data, 4) the National Institute of Environmental Health Sciences is currently conducting studies to determine whether a new, lower limit for allowable daily intake of methylmercury, perhaps as much as a factor of ten lower than

current World Health Organization "safe levels", should be established (US EPA, 1994) and, 5) recent data indicate that atmospheric deposition rates of Hg are increasing (Swain et al., 1992).

Expected Results and Benefits:

The over-riding objective of this research is to provide scientists and state and regional regulatory agencies with a clearer understanding of the magnitude, sources and processes by which the toxic pollutant mercury is deposited to aquatic ecosystems of the New England region. This primary objective will be addressed in the following manner: we shall 1) quantify Hg atmospheric wet deposition to a NH lake and watershed on an event basis for a period of one year, 2) measure the movement of Hg from the watershed into and out of the lake through streams, 3) place contemporary wet deposition measurements in a historical context through the examination of Hg accumulation in lake sediments, and 4) examine the regional source/receptor relationships for Hg through a) the use of 12-hour meteorological wind field analysis and b) the study of the historical Hg sediment deposition record in light of the operational history of potential local sources such as municipal and medical waste incinerators.

In the absence of point source inputs of mercury, wet deposition is the major process by which the pollutant Hg is delivered to aquatic ecosystems (Fitzgerald et al., 1994). This research program will produce a one-year record of the mercury content in precipitation at a lakeshore New Hampshire site. Based on climatological records we anticipate that roughly 100 precipitation events will be sampled over the course of the year. In addition, several dated sediment core records of mercury accumulation in lake sediments will be generated. An annual record of mercury input and output in the lake system via streams will also be assembled. The scope of this research project will not allow us to quantify all fluxes of mercury to and from the lake and surrounding watershed (e.g. volatilization of vapor phase mercury from the lake and watershed). However, information concerning stream borne mercury input and outflow, in combination with the sediment mercury accumulation rates, will allow us to constrain the mercury budget in the lake and watershed to a great degree. The rate at which mercury is removed from the atmosphere is a function of many parameters. High temperature processes such as the burning of coal and oil and municipal and medical waste incineration are important sources of mercury input to the atmosphere (US EPA, 1993a,b). These sources emit predominantly gas phase mercury in several oxidation states. Mercury in the elemental state is relatively insoluble and thus may persist in the atmosphere for some time and be transported relatively long distances before it is oxidized to a more soluble form and removed in precipitation. However, Hg^{+2} is much more soluble and therefore may be removed from the atmosphere much closer to the source. Thus the oxidation state in which mercury is emitted to the atmosphere plays an important role in the determination of pollutant residence time and deposition patterns. While oil and coal-fired power plants emit Hg^0 and Hg^{+2} in roughly equal proportions, emissions from municipal and medical waste incinerators appear to be predominantly in the form of the more readily removed Hg^{+2} (US EPA, 1993a). Thus incinerators may have a significant impact on mercury deposition locally. The location (see Figures 1 and 2) and operational history (dates of operation and tons of waste

incinerated) of incinerators in the State of New Hampshire are publicly available, as are Hg emission factors (g Hg emitted/ton of refuse incinerated). The sedimentary Hg accumulation record will be examined in light of this information in order to assess the relative importance of local sources and long range transport in the deposition of this toxic species to the lakes and watersheds of New Hampshire. Finally, 12-hour wind field analysis will be generated for the duration of the study. Central New England is a very dynamic region of the US meteorologically. Polluted air masses originating in the heavily populated regions along the east coast of the US as well as those from heavily industrialized regions of the Ohio River Valley regularly pass through this region (Parrish et al., 1993). The complete data set will provide information which will allow us to examine both the magnitude and regional source(s) of mercury in wet deposition here in New Hampshire on an individual event, seasonal and annual basis. Using the streamline flow analysis we shall examine mercury concentrations in precipitation events during maritime, Canadian, northeast corridor, and mid-west US flow regimes.

Information concerning the magnitude of the input and regional source(s) of important pollutants such as mercury are essential components of sound resource protection policy. At the present time this information is extremely limited in the New England region.