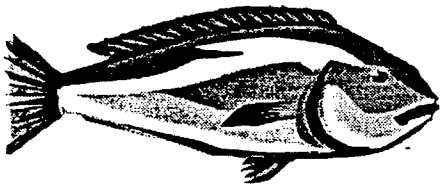
Land & Water Resources Council
1997 Annual Report

Appendix A:
Initial Evaluation & Recommendations on

Mercury in Maine



Submitted to the
Joint Standing Committee on Natural Resources
January 28, 1998

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Mercury is a naturally occurring metal that is commonly found in the environment in small amounts. It is released and dispersed throughout the globe by natural processes and human activities. Several forms of mercury can cause serious health problems in humans and wildlife. Methylmecury, an organic form of the metal, is of particular concern because it is readily taken up by living organisms. There it can persist for long periods of time and become more concentrated as it moves up the food chain.

Fish monitoring programs in Maine and other states have identified many water bodies where concentrations of methylmercury in fish are above levels that are considered safe for human consumption. Mercury-based advisories have been established in 38 states. Advisories in Maine, issued by the Bureau of Health in 1997, apply to all inland waters of the state. These advisories warn pregnant women, women who plan to become pregnant, and young children to avoid consuming any warm water fish species and to limit consumption of cold water species. The general public is warned to restrict consumption of warm water fish, but faces no restriction on consumption of cold water fish. The fish consumption advisories are aimed at minimizing potential human health risks from mercury, but do not remove the threat mercury poses to wildlife.

In 1997, in response to both the discovery of environmental mercury levels that pose a risk to the people and wildlife of Maine, and the presence of some significant mercury sources in Maine, the Maine Legislature, at the request of the Maine Department of Environmental Protection (DEP), passed a resolve to ***Direct the Land and Water Resources Council to Develop a Report and Proposed Actions to Control Mercury Emissions*** (the Resolve; please see Appendix 1) and to report to the legislature annually on progress under this initiative. This report represents the "initial evaluation and recommendations" requested in that Resolve.

Chapter II begins with a description of the monitoring work that has been done in Maine and elsewhere, to establish the levels of mercury that pose a concern to both humans and wildlife. It contains a description of the impacts that are beginning to be observable in Maine and elsewhere, and concludes with a discussion of the implications of mercury exposure for human health.

Chapter III contains a preliminary inventory of Maine's mercury sources, including emissions to air, discharges to water and to land. Each section concludes with key findings and recommendations. Chapter IV proposes an initial policy framework to guide subsequent work, through proposed objectives, strategies and actions.

The primary goal of this effort is to ensure that, over time, Maine people and wildlife are able to enjoy the full use of the state's waters and fisheries. In short, it is the intention of DEP's overall Persistent Toxics Initiative, under which the mercury activities fall, to make Maine's fish safe to eat and to protect our wildlife and other resources. Through reductions in mercury discharged by Maine sources, through collaboration regionally and nationally to reduce mercury coming in to Maine, and through an ever-better understanding of the impacts of mercury exposure, the overall goal is to restore Maine's rivers, lakes, streams and marine resources.

In reviewing the findings and recommendations contained herein, there are three issues that must be kept firmly in mind:

Some of the data on mercury are dated, incomplete and continuing to evolve.

Some of the data on which the findings and recommendations are based are old or incomplete. The year 1992 was chosen by the northeast states for their air emissions inventory because it represented the most complete data set then available. Some of the data is based on emissions factors that are being updated constantly, most recently with the December 1997 release of the EPA National Mercury Study (see Chapter III). As a result, it may be unrepresentative of current emissions levels. DEP is committed to continuing to collaborate with all sources, to refine and/or use both actual data as it is made available to us, and more recent emissions factors as they are appropriate.

This absence of extensive and reliable data has several implications. The existing fish consumption advisories, for example, are based on very limited fish sampling in the state. Current data suggest that additional sampling could lead to less restrictive waterbody-specific advisories. Throughout this report, references are made to the need for better monitoring, more comprehensive data and research to better understand the implications of both present and new data.

Emerging data on Maine fish and wildlife point to airborne mercury as the source of deposition and contamination of key facets of our environment, a finding supported by the EPA's recently issued report to Congress. EPA's comprehensive national study of mercury along with a soon-to-be-published analysis of mercury emission and deposition sources in the Northeast provide the first-ever basis for understanding the major human activities that are causing mercury contamination in Maine.

Present mercury concentrations in Maine freshwater fish and wildlife represent a call for aggressive action.

Elevated mercury concentrations have been found in Maine wildlife, including eagles, loons, and mussels. Research has documented concentrations of mercury both in loons and their fish prey which exceed thresholds where adverse reproductive and health effects are predicted. Linkages between lower reproductive rates in eagles and elevated levels of toxic contaminants, including mercury, have been established. The reproduction of Maine's bald eagles has remained at 15-40 per cent below all other major populations of eagles in the United States. Mercury in Maine mussels contains significantly more mercury in their tissues than other mussels collected from either the east or west coast of the United States.

While mercury in lake sediments throughout Maine are generally below thresholds of concern for freshwater environments, lake sediments in the Orrington area exceed statewide average concentrations. Sediments in Maine's major industrial rivers and coastal waters show the effects of local historical and ongoing human activity. The Upper Penobscot Estuary and River at Orrington have mercury concentrations that exceed--by orders of magnitude--any others found in the state. In fact, the DEP has been unable to identify any areas in the country with higher concentrations.

Mercury concentrations in some wildlife and sediments exceed the thresholds where adverse ecological effects are predicted. In some cases, Maine levels are among the highest in North America. This information prompts a call for aggressive action to identify and control the sources of mercury deposition affecting Maine's environment.

There are many aspects of our understanding of the science of mercury in the environment which are in their infancy and require further study. These include the relationship between sources and deposition, the science of mercury transport, thresholds for ecological effects, and strategies which will lead to reduction of concentrations and effects in the ecology. While we must continue to press forward with research efforts on a state, regional, and national level, we must also move aggressively with source reduction strategies wherever technology allows.

Maine sources are contributing to Maine's mercury challenge.

Maine's most significant source of historical and ongoing mercury pollution is HoltraChem Manufacturing Corporation, a chlorine manufacturer which utilizes mercury in its production process, located in Orrington on a bluff above the Penobscot River. The industrial site and adjacent river sediments have the highest known concentrations of mercury in the state. The company is the only permitted wastewater discharger of mercury in the state, pursuant to a 1971 statutory exemption, and the largest or one of the largest emission sources. While the company's self-reported air emission estimates have dropped dramatically in the last year, neither DEP nor EPA has been able to verify these levels.

Mercury also continues to be utilized in a variety of commercial and consumer products in Maine. As a result, it remains in our waste stream and ends up in landfills, leachate from landfills, and in the air emissions of waste to energy facilities. State, regional, and national action is needed to reduce mercury in such products.

Acknowledgments

In the following pages are detailed discussions of these issues, findings and recommendations and strategies to implement these recommendations. This report represents the culmination of more than six months of concentrated effort to fulfill the directives of the Resolve. As will become clear in reviewing the sections that follow, however, mercury has been a concern of DEP's for considerably longer. DEP extends its thanks to all who have participated in this initial effort, and looks forward to continuing the extensive collaboration that has begun in the years ahead.

II. BACKGROUND ON MERCURY

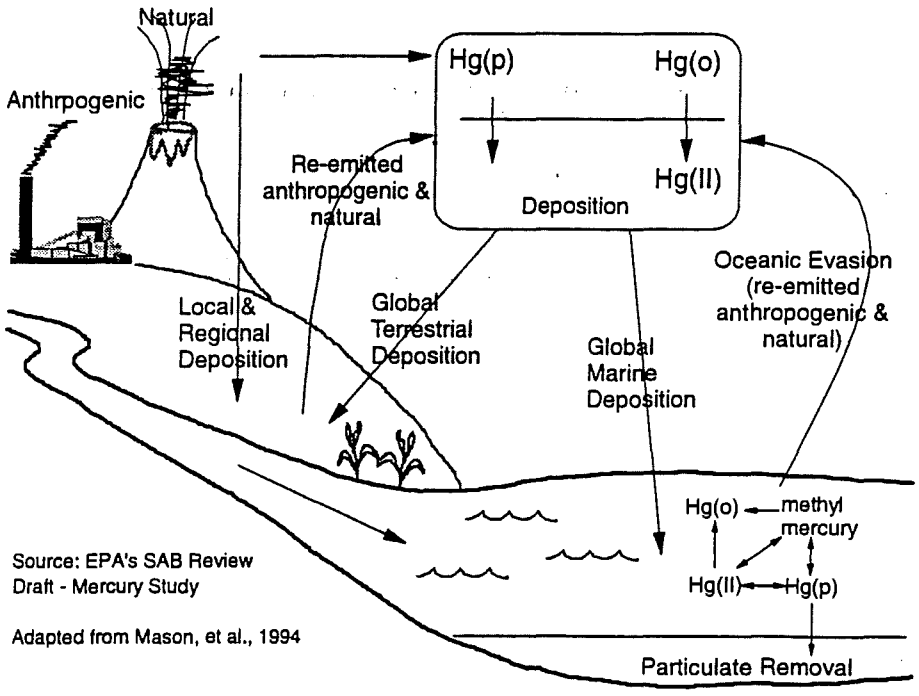
A. FORMS OF MERCURY

Mercury is a naturally occurring element formed in the earth's crust. There are several forms of mercury that can persist in the environment and can cause serious health problems in humans and wildlife. The specific form of mercury affects how it is transported in the atmosphere and deposited back to the earth. The amount of the various forms of mercury that exists in the air, soil, water, and organisms depends on the amount released, on the extent of mixing with other chemicals, and on the way it is transported.

Elemental or metallic mercury (Hg0) is in a liquid form at room temperature and vaporizes very readily. Elemental mercury has a boiling point of 357°C (675°F). It is commonly used in thermometers and other similar instruments because it has high surface tension and expands uniformly with temperature. Elemental mercury also has low viscosity and forms highly mobile droplets that combine when they collide, which may be why mercury is nicknamed "quicksilver".

Elemental mercury vaporizes and cycles through the global atmosphere (see ***Figure II-1, Mercury Cycling in the Environment)***. Three forms of mercury exist in the atmosphere: Hg(p) - particulate Hg; Hg(0) - elemental gaseous; and Hg(II) - divalent (oxidized). Elemental mercury can circulate the earth several times before being deposited, and is commonly referred to as "global background" mercury. Mercury in the atmosphere can be deposited to earth in dry form or wet form (i.e., precipitation). Elemental Hg needs to be oxidized to a divalent form to be dry-deposited or wet-deposited.

Figure II-1 **Mercury Cycling in the Environment**



Elemental mercury is insoluble but it combines with other chemicals to create compounds that are soluble and have toxic effects on organisms. When mercury enters soils and water, it can change form through oxidation, reduction, methylation, and demethylation. Organic mercury compounds (i.e., containing carbon) such as methylmercury (HgCH3+) are created in surface waters and soils, and are important because they accumulate in the tissue of wildlife, and humans that consume fish.

The methylation process is affected by many natural factors, including dissolved oxygen, sulfur, pH, and clay or organic material. More methylmercury is formed when dissolved oxygen is limited. Bacteria that depend on sulfur may help the methylation process. Increases in methylation occur in low pH waters, such as soft (low alkalinity) water, colored (high dissolved organic carbon) waters and lakes impacted by acid rain. Conversely, methylation is limited if mercury attaches to clay particles.[1]

Even as mercury cycles through the environment and changes form, it is persistent and does not degrade. Precipitation, surface runoff and groundwater transport mercury from land surfaces to waterbodies where it accumulates in sediments and biological tissues. Since the harm caused by mercury depends on its chemical form, scientific researchers need to better understand how mercury changes forms and how it cycles throughout the global environment. This will help create a better understanding of the conditions that create the levels of mercury that have been found in Maine's environment, as discussed in the following sections.

Sidebar: MERCURY BASICS
CHEMICAL SYMBOL: Hg (based on its ancient name: Hydragyrum)
Atomic number: 80 Atomic weight: 200.6

Physical Description: Elemental mercury is a silver-white, heavy, mobile, liquid metal at ambient temperatures. Other forms of mercury such as mercuric acetate and mercuric chloride are white, heavy powders or crystal solids. (US Dept. HHS, 1989)

Forms of Mercury		Organic mercury compounds:	
Elemental Mercury	Hg 0	Methylmercury	HgCH3+
Inorganic Mercury	Hg +1 or Hg +2	Dimethylmercury	Hg(CH3)2

[1]For further information, see Mercury in Massachusetts: An Evaluation of Sources, Emissions, Impacts and Controls.

B. SCIENTIFIC UNCERTAINTY AND DATA GAPS

While attention to mercury and its dangers is growing, there remain significant uncertainties about the most appropriate and effective ways to proceed. There are at least four areas where considerable debate still reigns:

The Toxicity of Mercury - A key consideration in determining the course of action is the nature of the public health threat that mercury poses. While a number of studies are proceeding in an attempt to provide better guidance, there remains significant disagreement among federal agencies and public health experts about the threshold at which adverse human health effects will be experienced. Similarly, there is no agreement about the levels at which mercury will cause adverse effects in wildlife. Studies determining threshold concentrations are few and variable. The state of present research is discussed more fully in Chapter II.

Level of Emissions - There are three reasons for concern about present emissions data:
First, some of the data available for this report are significantly dated. The northeast states mercury inventory data are most complete for 1992, yet it is safe to assume that many facilities may well have changed their operations significantly since then.

Second, the National, Northeast, and Maine mercury inventories rely heavily on emissions factors. These are published by EPA and derived from the average emissions of specific categories of sources. Where Maine has facility-specific stack test data, comparability of testing methodologies may interject uncertainty into those data, and undermine their comparability against published emissions factors. Yet, legitimate questions may be raised about the representative nature of the national emissions factors given the specific size, fuel sources and operating circumstances of Maine's facilities.

Finally, mercury testing methodologies have changed. Mercury testing is extremely susceptible to contamination and false positives are common. Clean testing methods may not have historically been utilized.

All of these sources of uncertainty and/or imprecision must be kept in mind when reviewing the inventory data in Chapter III.

Emissions vs. Deposition - As is discussed further in Chapter II, the mercury concentrations that come out of a given stack or facility are not necessarily informative about what reaches the ground. Depending upon the specific form in which the mercury is emitted, it may be deposited locally, regionally, or it may cycle in the upper atmosphere for considerable periods of time. At present, there is at best an incomplete understanding of the rates of mercury deposition, from either specific point sources or from global mercury cycling. Considerable additional research is needed to clarify this picture.

Mercury in Maine's Waste Stream - At this time Maine has limited information on the actual levels of mercury in products used by Maine citizens and businesses. As is discussed more in Chapter III, section C., until Maine has completed a more thorough characterization of the specific mercury-containing components of the state's solid waste stream, it is necessary to assume that regional and national averages apply to Maine.

Timeframes for Ecological Response – To date, there is no definite scientific foundation for estimating the time required for reduction of mercury levels in fish and wildlife once sources are reduced or removed. (See Chapter II for discussion of those impacts).

C. MERCURY IN MAINE'S ENVIRONMENT

Maine state agencies, the University of Maine, and other parties in the state have been monitoring mercury levels in fish and wildlife in Maine for more than two decades and have established a solid foundation of data. Monitoring has been conducted on mercury concentrations in lake, river, marine and estuarine sediments as well as in fish, shellfish and wildlife.

Monitoring Activities in Maine

Monitoring in Fish and Wildlife -- High levels of mercury in freshwater fish from Maine have been detected since the late 1970's, but the early studies were limited in scope and geographic extent.

Elevated levels of mercury were first found in lake trout (*Salvelinus namaycush*) from four lakes in remote areas of northern Maine in 1978.[2] Other researchers[3] later confirmed elevated levels of mercury in lake trout, burbot (*Lota lota*), and lake whitefish (*Coregonus clupeaformis*) from two of these lakes, and one other northern Maine lake. In its National Contaminant Biomonitoring Program, the US Fish and Wildlife Service (USF&WS) found moderate concentrations of mercury in fish from three industrial rivers in Maine from 1969-1984[4]. The Maine DEP Bioaccumulation Monitoring Program (BAMP) found high levels of mercury in fish from three lakes and five rivers[5]. In its National Bioaccumulation Study (NBS) from 1984-1986, EPA measured levels of mercury in five lakes, ponds, and rivers in Maine[6] that approached the FDA action level of 1.0 ppm in effect at that time.

Linkage between elevated levels of toxic contaminants including mercury, and lower reproductive rates in eagles in 1991 and 1992 led to additional interest in sampling. The International Toxics Monitoring Program (ITMP) was developed in 1992 as a pilot project to compare mercury concentrations in fish along a gradient from the Maritime provinces of Canada to southern New England. This extensive study showed that mercury concentrations in fish were highly variable and dependent upon a number of factors and that an intensive study was necessary to characterize mercury levels in any specific region.[7] Notably, this study found that concentrations of mercury in snow pack and sphagnum moss followed a trend, showing increased concentrations moving from the northeast toward the southwestern part of the region. This pattern of increase suggests that the sources of airborne mercury are upwind of Maine, either in or beyond the south and/or western portions of New England.

---

[2]Normandeau Associates, Inc., 1977. Northern Maine mercury investigations. US Army Corps of Engineers, Waltham, Mass.

[3]Akielaszek, J. J., and T. A. Haines (1981). Mercury in the muscle tissue of fish from three northern Maine lakes. Bull. Environ. Contam. Toxicol. 27: 201-208.

[4]Carr, Kenneth, 1980. Unpublished data, US Fish & Wildlife Service, Concord, NH; Schmitt, C.J., and W. G. Brumbaugh, 1990. National Contaminant Biomonitoring Program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium, and zinc in freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:731-747; Schmitt, C.J., J. L. Zajcek, and P.H. Peterman, 1990. National Contaminant bio-monitoring Program: Residues of organochlorine chemicals in US freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:748-781.

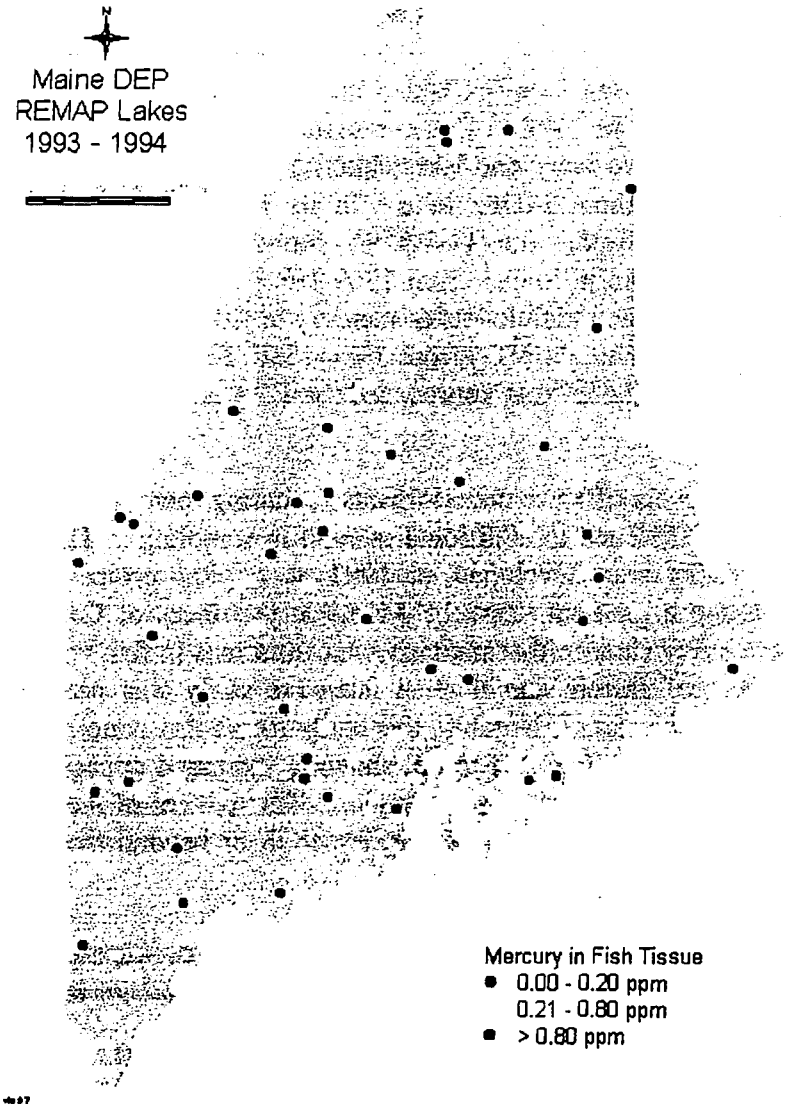
[5]Mower, B., 1987. Maine Bioaccumulation Monitoring Program. Maine Department of Environmental Protection, Augusta, Maine. 22 pp.

[6]EPA, 1992. National Study of Chemical Residues in Fish. Vol I, EPA 832-R-92-008a, Vol II, EPA 823-R-92-008b. US Environmental Protection Agency, Office of Science and Technology, Washington, D.C.

[7]Mower, B., 1994. Unpublished data. Maine Department of Environmental Protection, Augusta, Maine.

Following the ITMP, in 1993-94 Maine conducted an extensive study of contaminants in fish from Maine lakes in cooperation with DIFW, EPA, Maine Health and Environmental Testing Lab (HETL), and the University of Maine Department of Zoology and Sawyer Environmental Research Laboratory (REMAP study). This study found high levels of mercury in fish that were widely distributed around Maine in no particular geographic pattern (see ***Figure II-2, Distribution of Mercury in Fish Tissue REMAP 1993-94)***[8]. Mercury concentrations varied by trophic level (i.e. predators, omnivores, etc.) and by species within each trophic level sampled. Some concentrations were high enough to pose a significant risk to both humans and wildlife that consume fish[9].

Figure II-2



[8]DiFranco, J. L. Bacon, B. Mower and D. Courtemanch, 1995. Fish Tissue Contamination in Maine Lakes, Data Report. Regional Environmental Monitoring and Assessment Program (REMAP), Maine Department of Environmental Protection, Augusta, Maine. 400pp.

[9]Mower, B., J. DiFranco, L. Bacon, D. Courtemanch, V. Schmidt, and J. Hopek, 1997. Fish Tissue Contamination in Maine Lakes. Maine Department of Environmental Protection, Augusta, Maine.

Beginning in 1994, Maine's Surface Water Ambient Toxics Monitoring Program (SWAT)[10] has collected fish samples from additional rivers and streams all over Maine. In 1996, the SWAT program also collected fish samples from lakes downwind of some of the largest sources of air emissions of mercury in Maine, to determine if higher levels in fish there are related to these local sources. In addition, the SWAT program has collected samples of white perch from all over the state to develop a more specific consumption advisory for this species. These findings are discussed in Chapter II, section C on mercury's human health effects.

In 1997, DEP also began collaborating with the Maine Audubon Society, US Fish and Wildlife Service, and BioDiversity Inc. on a study that focuses on contamination in common loons[11]. This study is titled "Determining mercury exposure in Maine's fish-eating birds" and is funded by a Maine Outdoor Heritage Fund grant. The effects shown in this study are discussed below in the section on ecological effects.

On the coast, mercury has been measured in blue mussels since 1986[12]. Mussels were chosen because water concentrations of mercury are generally so low that they are not detectable. Mussels filter large quantities of water and accumulate mercury and other contaminants present in surrounding water. Seventy-five sites between New Hampshire and New Brunswick have been monitored. Lobsters have also been monitored since they feed on the bottom. Lobster tissue therefore reflects the biologically available portion of contaminants in sediments. Tomalley has been found to be especially useful for this purpose. The work has provided DEP with the ability to identify areas of concern due to mercury contamination (see the following section on ecological effects).

Monitoring Aquatic Sediments -- Bottom sediment is a key component of our aquatic ecosystems. Sediments are where important chemical reactions occur that drive the ecosystem. Rooted plants and burrowing animals that feed on the organic matter in sediment are dependent on these reactions and processes. They also accumulate much of their body burden from the sediment and associated water. The build up of toxic contaminants can lead to a collapse of those systems.

Monitoring sediments is an important tool for determining environmental trends (as well as exposure). Unlike fish tissue or water, sediments retain contaminants to provide a historical record of inputs, especially in depositional environments such as lakes and quiet coastal waters. This is less valid in rivers and streams that are typically erosional at some point each year so that their sediments are in a regular state of motion. Several studies have been conducted over the past several years by DEP to characterize sediment quality.

---

[10]Sowles, J. W., et al, 1996. Surface Water Ambient Toxic Monitoring Program, 1994 Technical Report, Maine Department of Environmental protection, Augusta, Maine. 70pp.

[11]BioDiversity, 1997. A comparison of mercury exposure between artificial impoundments and natural lakes measured in common loons and their prey, sediments, and gamefish. Submitted to Central Maine Power Co., Augusta, Maine, and Union Water Power Co., Lewiston, Maine.

[12]Sowles, J. W. (1998). A decade of monitoring toxic contaminants along the Maine coast. In Prep.

In lakes, the Regional Environmental Monitoring and Assessment Project (REMAP) monitored sediments in 125 lakes and found mercury concentrations between 0.001 and 0.42 ppm [13].

In coastal waters, the Coastal Baseline Project (1987-1989) collected sediment from "reference" areas and presumed contaminated areas[14]. Reference concentrations were found to range from "non-detect" to 0.14 ppm.

In estuarine Merrymeeting Bay, mercury concentrations range from 0.04 to 0.25 ppm. This may seem low given the industrial discharges in rivers that lead to the Bay. However, since Merrymeeting is at the base of the Kennebec and Androscoggin, it is an erosional environment that flushes out the fine particles on which many metals attach.

Maine coastal areas of concern are mostly associated with rivers and include the Piscataqua Estuary, Penobscot Estuary, Presumpscot Estuary, Inner Cobscook Bay, Boothbay Harbor, Sheepscot Estuary, Royal River, Portland Harbor, and Union River. Although most of these areas do not contain levels that warrant a human health consumption advisory, they warrant periodic monitoring to assure that levels are not increasing. The Union River and Inner Cobscook Bay are associated with impoundments and thought to be influenced by the "drawdown effect" that mobilizes mercury. The Royal, Presumpscot and Sheepscot are associated with historical mercury exposure from the pulp and paper process and coal ash.

The Penobscot, Boothbay, Piscataqua, and Portland Harbor sites show significantly elevated levels of sediment mercury sufficient to warrant further investigation and, in some cases, action. Specifically:

- Efforts should be made to rapidly initiate a feasibility study of cleanup alternatives in the Penobscot River in the area of HoltraChem, even while the remedial investigation continues. Remedial action should be taken to lower the concentrations in the sediment and to halt off-site migration at the earliest possible time to prevent further contamination.

- In Boothbay Harbor, where the source(s) is (are) not known, remedial investigations are needed to determine if an ongoing source is present. If found, it should be corrected. Furthermore, the areas of most contamination should be re-tested to see if the levels of mercury continue to be as high as they were found to be in the last dredging done in 1986.

- The Piscataqua contamination is being addressed by the Portsmouth Naval Shipyard Superfund Project. Once that is complete and the recommendations followed, a second round of sampling should be done to determine if the remediation worked.

- In Portland Harbor, implementation of the Casco Bay Estuary Project's Environmental Monitoring Plan should provide the necessary information to determine whether further work is needed.

---

[13]Mower, B., J. DiFranco, L. Bacon, D. Courtemanch, V. Schmidt, and J. Hopek, 1997. Fish Tissue Contamination in Maine Lakes. Maine Department of Environmental Protection, Augusta, Maine.

[14]Sowles, J. W. (1998). A decade of monitoring toxic contaminants along the Maine coast. In Prep.

Ecological Effects of Mercury Contamination

Ecological Effects in Fish and Wildlife -- Although there have been a larger number of studies conducted on the human health effects of mercury, there is a limited body of scientific information on mercury's ecological effects. Besides the wildlife studies cited previously, plants have also been studied for mercury accumulation. While sensitivities vary among species, plants generally do accumulate mercury. Significantly, it has been found that aquatic plants accumulate mercury more efficiently than terrestrial plants[15]. Terrestrial invertebrates also concentrate mercury. This observation has led to the suggestion that earthworms be used as a means to bioremediate soils contaminated with mercury[16]. Mercury poisoning was suspected as the cause of death of at least one Florida panther, and environmental mercury may have contributed to the severe population decline experienced by this endangered species[17].

Direct effects of mercury contamination in fish have been documented in several ways. Fish kills, such as those reported in Minamata Bay in Japan, have occurred at very high levels of methylmercury contamination. Concentrations from 5-52 ppm in fish have been associated with lethality[18]. Golden shiners fed an artificial diet of 1 ppm mercury for 90 days showed an accumulated whole body mercury concentration of just over 0.5 ppm at the end of the exposure[19]. The fish showed behavioral effects that were highly significant and likely to increase vulnerability to predation.

Birds: Most wildlife impacts have been the result of consumption of contaminated fish by piscivorous birds or mammals. Various critical levels for wildlife have been reported. One study[20] found significantly decreased reproduction of mallard ducks fed a diet contaminated with 3.0 ppm mercury, but there was no impact at 0.5 ppm mercury in the diet. Another study[21] reported decreased reproduction of common loons when fed a diet of fish contaminated with 0.3 ppm mercury considered a critical level for loons, and zero reproduction at 0.4 ppm mercury.

Mammals: Some researchers[22] observed that concentrations 1.8 ppm and 2.0 ppm methylmercury in fish fed to mink and otters, respectively, were acutely lethal; lower concentrations would be expected to

---

[15]John, M. K. (1972). Mercury uptake from soil by various plant species. Bull Environ. Contam. Toxicol. 22:258-264. World Health Organization (WHO) (1989). Mercury, environmental aspects. Environmental health criteria, Volume 86. World Health Organization, Geneva, Switzerland.

[16]World Health Organization (WHO) (1989). Mercury, environmental aspects. Environmental health criteria, Volume 86. World Health Organization, Geneva, Switzerland

[17]Roelke, M. G. (1990). Florida panther biomedical investigation: Health and Reproduction. Final report, endangered species project E-1 II-E-67506. Florida game and fresh water fish commission, Gainesville, Florida.

[18]Haines, T. A., 1997. Personal communication. US Geological Survey, University of Maine, Orono, Maine.

[19]Webber, Hannah. 1998. Effects of methylmercury on the predator avoidance behavior of a freshwater forage fish, golden shiner (Notemigonus crysoleucas). Master of Science Thesis, University of Maine.

[20]Heinz, G., 1974. Effects of low dietary levels of methylmercury on mallard reproduction. Bull. of Environ. Contam. & Toxicol 11(4):386-92.

[21]Barr, J. F., 1986. Population dynamics of the common loon (Gavia immer) associated with mercury-contaminated waters in north western Ontario. Can. Wildl. Serv. Occas. Pap 56.

[22]Wren, C. D. and P. M. Stokes, 1986. Mercury levels in Ontario mink and otter relative to food levels and environmental acidification. Can. J. of Zool. 64(12):2854-59.

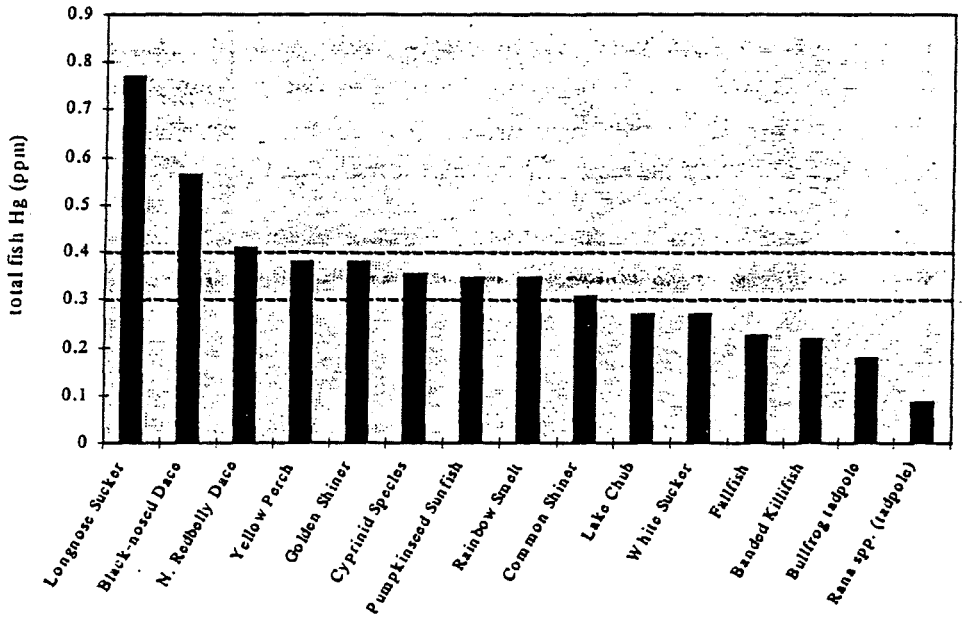
cause sub-lethal impacts. EPA considered 0.02 ppm a critical level for piscivorous birds and 0.1 ppm a critical level for piscivorous mammals[23].

Studies documenting effects on fish and wildlife resources in Maine are limited, but there is strong evidence that impacts are likely to be occurring. More than 99% of the samples of fish captured from the REMAP lakes study contained mercury that exceeded EPA's critical levels for piscivorous birds (0.02 ppm) and mammals, 11-65% of the samples showed levels exceeding the .3 ppm critical level for loons. Some concentrations of mercury in game fish even exceeded the lethal levels for mink and otter[24]. More specifically, the SWAT sampling done from 1994-1995 confirms that fish from Maine rivers and streams have similar concentrations to those from lakes and ponds[25].

Loons: A recent study of mercury in prey of loons from Maine lakes identified several species of fish with mean concentrations exceeding the critical level (0.05 ppm) for loons As shown in ***Figure II-3: Mercury Concentrations in Fish Prey of Common Loons***[26], nine species commonly ingested by loons exceed the level of 0.3 ppm for deceased reproduction. Three species showed levels exceeding 0.4 ppm, the threshold for zero reproduction in loons. These 2 critical levels are shown in Figure II-3.

Figure II-3

Total Hg in small loon prey composites from selected natural lakes and reservoirs in Maine and New Hampshire, 1996



[23]Yeardley, R. B., J. M. Lazorchak, and S. G. Paulsen, in press. Elemental fish tissue contaminants in Northeast U.S. lakes: Evaluation of an approach to regional assessment. Environmental Protection Agency, Cincinnati, Ohio.

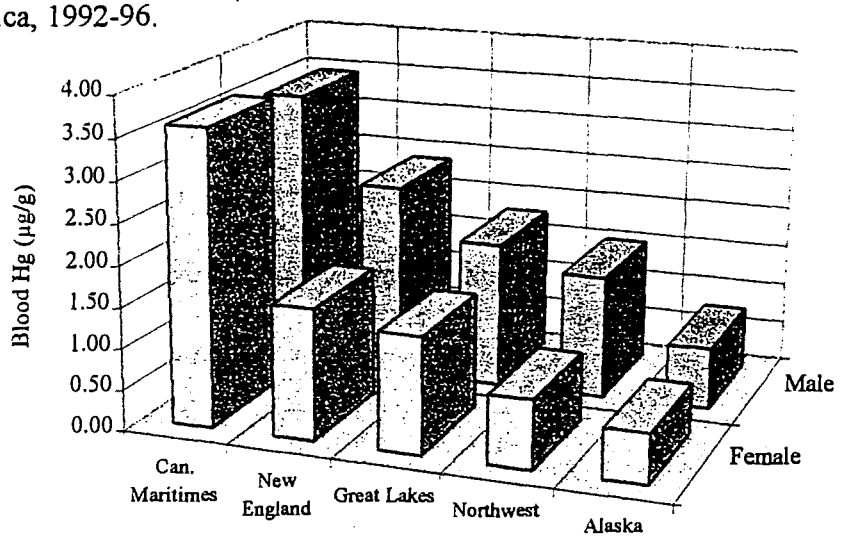
[24]Mower, B., J. DiFranco, L. Bacon, D. Courtemanch, V. Schmidt, and J. Hopek, 1997. Fish Tissue Contamination in Maine Lakes. Maine Department of Environmental Protection, Augusta, Maine.

[25]Sowles, J. W., et al, 1997. 1995 surface Water Ambient Toxic Monitoring Program, Technical Report, Maine Department of Environmental protection, Augusta, Maine. 82pp.

Results of the North American Loon Biomonitoring Program also show increasing concentrations of mercury in blood and feathers of loons on a west to east gradient from Alaska to the Northeast US and Maritime Canada[27] (***Figure II-4***). Feathers from 5 and 22 of 27 loons captured from lakes in Maine and New Hampshire in 1996 exceeded the critical levels of 20 ppm[28] and 11 ppm[29] respectively. Yet the loon population in the northeast appears to be slightly increasing (~6000 breeding loons)[30]. Of approximately 430 loon carcasses from New England examined in the last nine years, mercury concentrations in all that were measured (160) exceeded a threshold (10 ppm in liver) associated with adverse effects in lab studies.[31] To date, no direct study on the reproductive success of loons in Maine has been conducted.

Figure II-4

Mean mercury concentrations in Common Loon blood at selected sites in North America, 1992-96.



[27]Id.

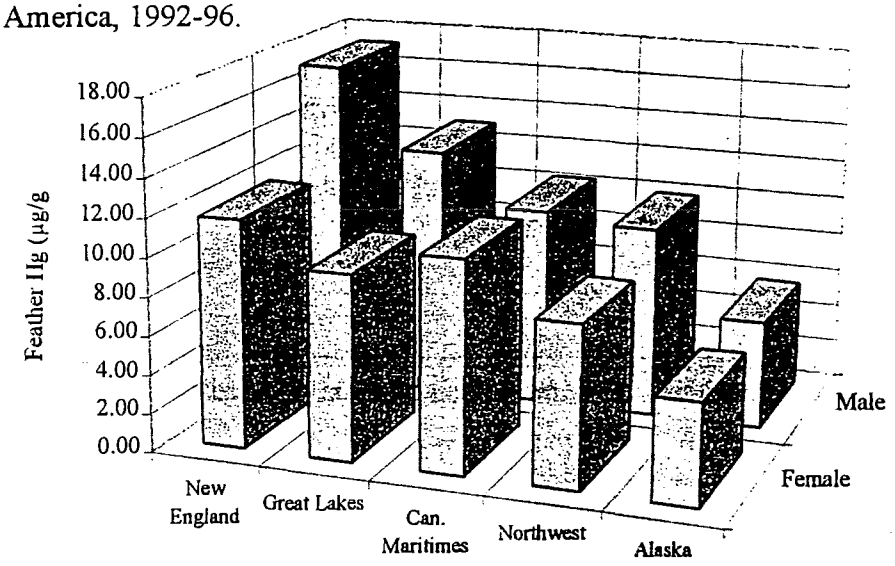
[28]Barr, J. F., 1986. Population dynamics of the common loon (Gavia immer) associated with mercury-contaminated waters in north western Ontario. Can. Wildl. Serv. Occas. Pap 56.

[29]Weimeyer, S.N., J. F. Moore, and B. M. Mulhern, 1984. Formalin preservation of avian blood for metal and DDE analysis. Bull. Environ. Contam. Toxicol. 33:525-32.

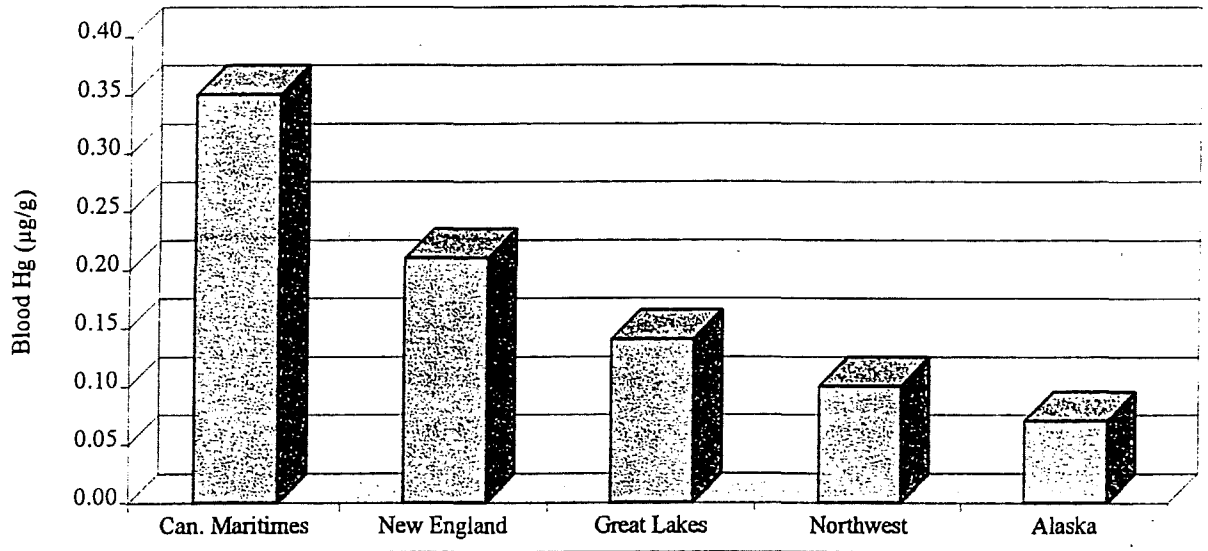
[30]North American Loon Fund, 1998. Gilford, New Hampshire. Personal Communication.

[31]Pokras, M., C. Canley, and Z. Gordon (1998). Liver mercury and methylmercury concentrations in New England Common Loons. Env. Asses. and Toxicology (In Press).

Mean mercury concentrations in adult Common Loon feathers at selected sites in North America, 1992-96.



Mean mercury concentrations in juvenile Common Loon blood at selected sites in North America, 1992-96.



Eagles: Mercury may be affecting Maine's bald eagle populations. Although the number of nesting bald eagles (*Haliaetus leucocephalus*) has increased since DDT was banned in 1968 and the bald eagle was designated as endangered in 43 states in 1978, the reproduction of Maine's bald eagles has remained at 15-40% below all other major populations of eagles in the US[32].

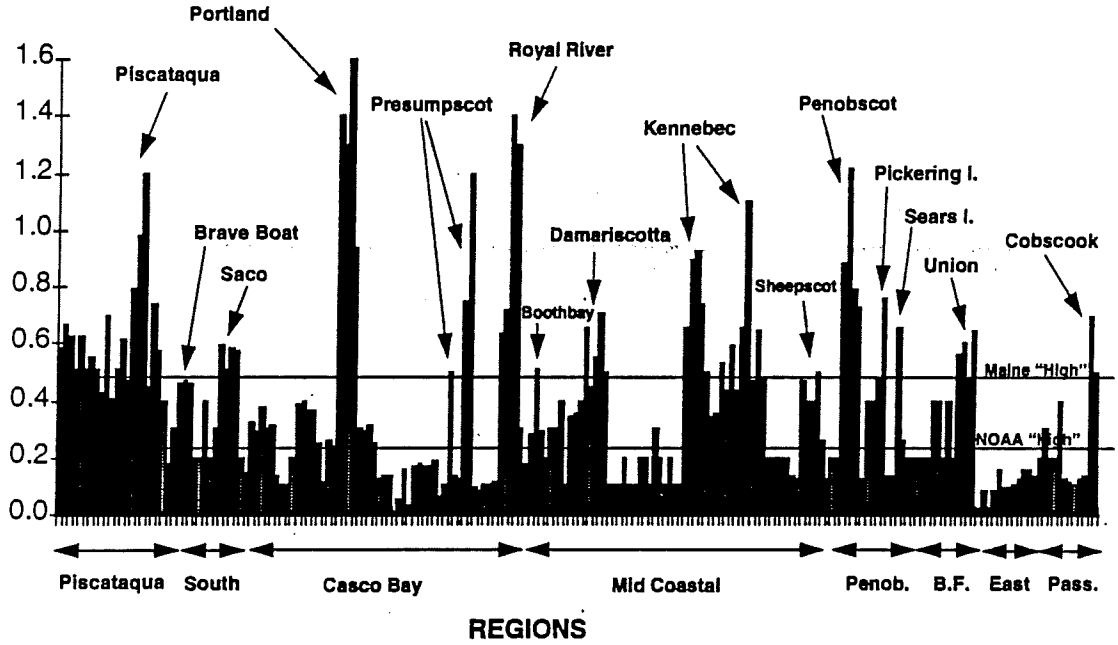
[32]Welch, L. J., 1994. Contaminant burdens and reproductive rates of bald eagles breeding in Maine. MS thesis, U. Maine, Orono, Maine. 86 pp.

Significant levels of numerous contaminants often associated with reduced reproductive rates were found in bald eagle eggs within Maine during the 1970s and 1980s. Follow-up studies of mercury, PCBs, DDT, and dioxins in bald eagle eggs and blood and feathers of nestling eaglets conducted in 1991 and 1992 found significantly elevated levels, that often exceeded those associated with reduced reproduction[33]. For example, six to eight week-old fledgling eagles had an average concentration of 20 ppm mercury in their feathers, a concentration associated with decreased reproduction in loons[34]. Some feathers had concentrations as high as 37 ppm compared to 'background" levels of 2 to 3 ppm. Higher concentrations were found in inland eagles than in coastal eagles and were correlated with lower recruitment of young inland eagles as compared to coastal eagles. Freshwater fish make up a greater proportion of the diet of inland eagles than of coastal eagles. In some samples of eagle eggs, the mercury concentration was greater than 0.5 ppm, a concentration considered sufficient to prevent hatching[35].

Shellfish: In marine mussels, concentrations of mercury collected from reference sites that are not influenced by heavy human activities contain, on average, 0.19 ppm (dry wt.). In contrast, mussels containing mercury in excess of 0.48 ppm (dry wt.) are considered to have elevated concentrations (upper line in Figure II-5: *Mercury Contamination in Blue Mussels*). Thus Maine levels frequently exceed the levels where effects would be expected in the birds and mammals consuming these species.

Figure II-5

Mercury Concentrations (ppm dry wt.) in Blue Mussels Along the Coast of Maine



[33]US Fish and Wildlife Service, 1992. The status of contaminants in Maine eagles, An Interim Report. Rpt FY92-NEFO-1-EC, US Fish and Wildlife Service, Concord, NH/Orono, Maine. 21pp.

[34]Barr, J. F., 1986. Population dynamics of the common loon (Gavia immer) associated with mercury-contaminated waters in north western Ontario. Can. Wildl. Serv. Occas. Pap 56.

[35]Wemeyer, S. N., J.F. Moore, and B. M. Mulhern, 1984. Formalin preservation of avian blood for metal and DDE analysis. Bull. Environ. Contam. Toxicol. 33:525-32.

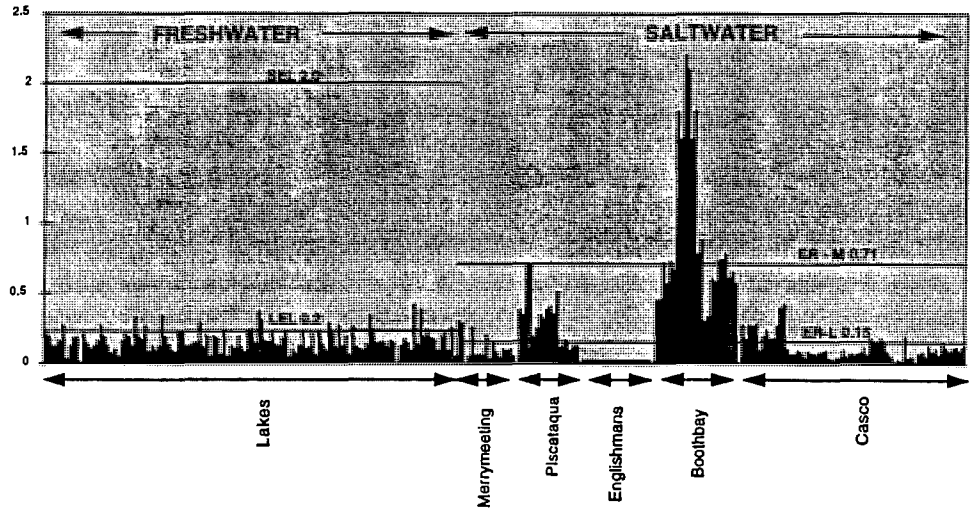
Of broader ecological significance, a preliminary comparison of Maine data with those of the National Status and Trends Musselwatch Program indicates that Maine mussels contain significantly more mercury in their tissues than other mussels collected from either the east or west coast of the United States. On a national basis, the National Status and Trends Program determined "high" value of 0.24 ppm dry wt. derived from about 100 sites located on both the Pacific and Atlantic coasts. Therefore, Maine's reference population nearly exceeds the national "high." Although this needs to be further studied, there appears to be strong indication that Maine's marine environment is similar to its inland waters in that levels of mercury are abnormally high for North America. This makes sense in that all of Maine's inland waters drain to the coast.

Ecological Effects in Aquatic Sediments -- Sediments containing toxic substances can seriously disrupt ecological processes by reducing productivity, shifting biological communities and eliminating species. Burrowing invertebrates that process sediment for food are most at risk, as is the microbial community that is key to recycling nutrients. At what concentration effects are measured depends on many factors, including whether mercury is the sole contaminant, its chemical form, species involved, life stage, other environmental stressors, and availability of the mercury due to sediment type. Effects can range from subtle sub-lethal effects, such as reduced feeding activity to acute mortality. Generally, concentrations below 0.14 ppm are considered background levels. Adverse biological effects on animals living in and on sediment have been documented in sediment with mercury concentrations as low as 0.15 ppm. As concentrations approach and exceed 0.71ppm[36], the probability of more severe biological impacts becomes more likely.

Figure II- 6: *Mercury Concentrations in Aquatic Sediments*, shows the distribution of mercury in various Maine sediments in relation to these effects levels. Overall, most sediment concentrations are below a level that concerns us. However, the figure also shows that there is cause for concern in some parts of Maine.

Figure II-6

Mercury Concentrations (ppm dry wt.) in Aquatic Sediments excluding Penobscot Sediments



[36]Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. . 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical concentrations in Marine and Estuarine Sediments. Environmental Management, Vol. 19, No.1, pp. 81-97.

In lake sediment, the Regional Environmental Monitoring and Assessment Project found concentrations that varied between 0.001 and 0.42 ppm. As a group, most lakes had concentrations that were below the Lowest Effect Level (LEL on the graph) used for freshwaters. The highest concentration, 0.42 ppm, is well below the Severe Effects Level at which effects are likely to be measured (SEL on the graph) but nevertheless worthy of attention.

Most sediments of concern are located in Maine's industrial coastal waters such as embayments and estuaries of major river systems. With one significant exception, the Upper Penobscot Estuary, these areas are shown in Figure II-5 on page 16. The Upper Penobscot is so atypical that it dwarfed the rest of the data and could not be included. Average concentrations in the Upper Penobscot are 17.6 ppm with one sample reported as 460 ppm. The other areas, in order of concern include: Boothbay Harbor (2.2 ppm), Piscataqua Estuary (0.71 ppm), and Portland Harbor (0.42 ppm). Areas away from large rivers and human activity, for example (Englishman's Bay (less than 0.04 ppm) are well below the lower effects range (ER-L).

Findings and Recommendations

Findings

1. Mercury concentrations in fish in many Maine lakes, ponds, rivers and streams exceed levels that pose a risk to human health. (Fish consumption advisories issued by the Bureau of Health as a result of those levels are discussed in the following section.)

2. Mercury in wildlife, particularly loons and eagles, exceeds the critical levels where reproductive and other adverse health effects are predicted.

3. Mercury in sediments in certain Maine waterbodies exceeds thresholds where adverse effects in aquatic species are predicted.

4. In sediments and wildlife, Maine has -- in certain areas of the state -- some of the highest concentrations found in the country.

5. Significant mercury contamination seen in mussels and sediments in specific coastal areas is thought to be associated with historical or recent industrial activity in Maine. It is, therefore, more easily addressed and/or remediated by Maine's actions than is contamination due to global deposition.

Recommendations

1. Because mercury in certain Maine fish, wildlife and sediments exceed concentrations where a variety of adverse health effects are predicted along the food chain, action should be taken on various fronts.

2. Sources of mercury causing deposition in Maine's environment should be reduced.

3. To date, only limited research has been aimed at determining whether adverse health effects are occurring in Maine fish and wildlife. Additional research should be undertaken in this area .

4. Because sediments in several parts of the state are contaminated with mercury, Maine should undertake efforts to gain expertise in relevant remedial action alternatives. A collaborative effort involving state agencies, EPA, the University of Maine and other states should be initiated to lay the groundwork for cleanup work in the state. Funding sources should be identified for such work. Wherever possible, responsible parties should fund such investigative work.

5. Advancing investigative and cleanup work at sites with highest contaminated sediments should be given priority.

D. HUMAN HEALTH EFFECTS OF MERCURY

As noted above, mercury exists in three different forms in the environment and in commercial products: elemental or metallic mercury, inorganic mercury, and organic mercury. All forms of mercury are toxic. However, the nature and severity of the toxicity that may result from mercury exposure is a function of both the magnitude and duration of exposure, the pathway of exposure, the form of the mercury on mercury compound, and individual susceptibility.

In this section, pathways of exposure and toxicity of the several forms of mercury are discussed. The discussion then focuses on Maine's fish consumption advisories due to organic mercury.

Mercury Toxicity and Pathways of Exposure

Elemental or metallic mercury is perhaps the best known form of mercury due to its use in thermometers, blood pressure manometers and dental fillings. It is also the most commonly encountered form of mercury at hazardous waste sites[37]. In recent years there has been an increasing number of elemental mercury spills and contamination involving school children, prompting EPA and ATSDR to jointly issue a National Alert. The September 1997 Waterville mercury spill was one such incident. Over 60 pounds of mercury were spilled on the floor of a room in an abandoned building, purportedly by children playing in the building in which the mercury had been left stored in glass jars. In the end, over 100 children had to be screened for mercury exposure, several families were temporarily relocated from their residences, and four homes had to be decontaminated. Smaller spills have occurred in schools and medical offices.

Dermal and oral intake of elemental mercury, such as may be handled or swallowed from a broken thermometer, is poorly absorbed across the skin or digestive tract and is generally thought to be of no toxicological consequence[38]. Elemental mercury can volatilize into a vapor at ambient temperatures, and most human exposure is consequently by inhalation. Mercury vapor readily crosses the lung surfaces and has an affinity for kidney tissue, red blood cells, and the central nervous system[39]. The major effects associated with chronic exposure to mercury vapor is central nervous system toxicity. EPA has recommended that ambient air levels of mercury vapor to which the public could be exposed should not exceed 0.3 micrograms of mercury per cubic meter of air ($\mu g/m^3$).

Inorganic mercury refers to a group of mercury compounds including salts, sulfides and oxides. Poisoning from inorganic mercury was common in the hatting industry during the 19th century because of the use of mercurous nitrate (a mercury salt) in the felting process[40]. Inorganic mercury can be found at hazardous waste sites, though not as commonly as elemental mercury[41]. Ingestion is

---

[37]ATSDR (1997) Toxicological Profile for Mercury, U.S. Department of Public Health and Human Services, Agency for Toxic Substances and disease Registry (ATSDR), Draft Report for Public Comment, August (1997).

[38]Goyer, R. A. (1996) Toxic Effects of Metals in Toxicology: The Basic Science of Poisons, 5th Edition, McGraw-Hill, New York, NY, pp 709-714

[39]Id.

[40]Parkinson, D. K. (1996) Mercury in Environmental and Occupation Medicine, 2nd Edition, Ed. W.N. Rom, Little, Brown and Co., Boston, MA, pp. 759-766.

[41]Id.

typically the primary exposure pathway of concern for inorganic mercury (e.g., ingestion of contaminated water or soil) – as some absorption can occur across the digestive tract (considerably more than elemental mercury). Dermal exposure can result from use of various consumer and medicinal products containing inorganic mercury. Certain skin lightening creams, soaps and laxatives contain inorganic mercury, as do some medicinal products such as various topical antiseptic and disinfectant agents (e.g., mercurochrome). Mercuric sulfide and oxide may be used to color paints. Because inorganic mercury cannot cross the blood:brain barrier or the placenta, the kidney is both the major site of accumulation and of toxic injury following exposure to inorganic mercury.

Organic mercury, and more specifically methylmercury, is thought to be the primary mercury form to which the general population is exposed. The toxicity of methylmercury has been extensively studied and there is a substantial literature documenting its ability to impair the human nervous system and kidney function. There is also substantial evidence that the unborn fetus and young children are more susceptible to mercury toxicity than adults, primarily because of the high sensitivity/vulnerability of their actively developing nervous systems. Current understanding of the toxicity of methylmercury comes from three lines of evidence: incidents of large scale poisoning in Iraq and Japan, studies of populations with high dietary intake of fish containing low to moderate levels of mercury, and animal toxicological studies[42,43,44]. While studies provide clear evidence of the adverse health risks from high levels of methylmercury exposure, or from long-term exposure to moderate mercury levels, there remains uncertainty in evaluating the toxicological significance of the lower more typical environmental exposures.

Fish Consumption Advisories

The major exposure pathway for methylmercury is consumption of marine and freshwater fish. Methylmercury is produced from bacterial transformation of inorganic mercury present in aquatic sediments and anoxic waters. Methylmercury concentrates in fish – particularly in older, predatory fish -- to levels tens of thousands of times above levels in the surrounding water. Ingested methylmercury is almost completely absorbed across the digestive tract, has a tendency to concentrate in brain tissue and can cross the placenta.

The U.S. Food and Drug Administration (USFDA) has recommended that pregnant women and women of childbearing age who may become pregnant limit their consumption of shark and swordfish to no more than one meal a month, and that the general public limit intake of these two marine species to about one serving per week[45]. USFDA has established a 1 ppm ceiling on allowable levels of methylmercury in commercially sold fish. Maine, like most northeast states, currently has a statewide consumption advisory for all inland waters due to elevated levels of methylmercury in recreationally-caught fish.

---

[42] Northeast States/Eastern Canadian Provinces Mercury Study. External Peer Review Copy, November (1997).

[43] Mercury Study Report to Congress. United States Environmental Protection Agency, EPA-452/R-96-001b, SAB Review Draft, June (1996)

[44] ATSDR (1997) Toxicological Profile for Mercury. U.S. Department of Public Health and Human Services, Agency for Toxic Substances and disease Registry (ATSDR), Draft Report for Public Comment, August (1997).

[45] Northeast States/Eastern Canadian Provinces Mercury Study. External Peer Review Copy, November (1997).

Maine Fish Consumption Advisories due to Methylmercury Contamination -- The Bureau of Health has issued the following advisory due to mercury contamination of sport-caught fish that is applicable to all inland waters:

Pregnant women, women who plan to become pregnant, and children under 8 years of age:

- Should not consume warm water fish species from any of Maine's inland waters;
- Should limit intake of cold water fish species to no more than one meal per month.

All other individuals (the general public):

- Should limit consumption of warm water fish species to 2 to 3 meals per month.
- Do not need to limit consumption of cold water fish species.

This advisory is based on a policy that if fish can be safely consumed at a level of one 8-ounce fish meal per week or more, then no advisory is warranted. If fish cannot be consumed at a level of at least one meal per month, then an advisory to avoid consuming *any* fish is warranted. In between these two extremes, advisories to restrict consumption are issued. Consequently, in determining the need for consumption advisories, the Bureau of Health computes the number of fish meals that can safely be consumed for a given level of mercury in fish. In deriving these advisories, several key factors were considered:

- The unborn fetus and young child are more sensitive to the toxic effects of mercury than the adult. Thus advisories are derived for two distinct populations: a *sensitive population* (pregnant women, women planning to become pregnant, children under 8 years old) and a *general population* (children older than 8 years and adults).

- Warm water fish species (e.g., bass, pickerel, perch) tend to have higher levels of methylmercury than cold water fish species (e.g., trout, salmon). Thus, separate advisories are issued for warm versus cold water fish species.

- Data on mercury levels in fish is limited to only 150 of Maine's nearly 6000 lakes and ponds; there is considerable lake-to-lake variation in fish mercury levels even when comparing identical fish species and lakes situated in close proximity; current scientific knowledge cannot predict levels of mercury in fish for a given lake without actually testing fish from the lake. Thus, statewide advisories must be based on making statistical extrapolations from results obtained on a random sample of 150 lakes.

- Mercury levels in fish from rivers and streams are similar to those in lakes and ponds. This finding prompted a broadening of the 1994 mercury consumption advisory that was limited to lakes and ponds to include rivers and streams as well.

Consideration of Sensitive versus the General Sub-populations -- The difference in sensitivity of the unborn fetus and young child as compared to the adult is accounted for through the use of subpopulation-specific *reference doses* when computing the number of fish meals that can be safely consumed. A reference dose (RfD) is an estimate (with uncertainty spanning perhaps an order of a magnitude) of a daily intake for humans, including sensitive populations, that is likely to be without deleterious effects throughout a lifetime. An oral RfD is normally expressed as the mass of a

toxicant ingested per unit body weight per day. EPA revised its RfD for methylmercury downward in May 1995 from a daily intake of 0.3 micrograms mercury per kilogram body weight per day (μg/kg/day) to 0.1μg/kg/day. The prior RfD of 0.3 μg/kg/day was based on protecting adults from subtle neurotoxic effects due to methylmercury exposure – specifically paraesthesia, which is a tingling sensation in extremities. The revised RfD of 0.1 μg/kg/day is intended to protect the unborn fetus. The Bureau of Health uses the 0.1 μg/kg/day RfD in assessing the number of fish meals that can be safely consumed by the sensitive population (pregnant women, women planning to become pregnant, children under 8 years old), and the 0.3 μg/kg/day RfD for the general population.

The use of 3-fold different RfD's for the sensitive versus the general population results in a 3-fold difference in the fish tissue action levels that trigger advisories. The level of methylmercury in fish that triggers a fish consumption advisory (i.e., level at which a fish meal cannot be safely consumed weekly) for the sensitive population is 0.2 parts per million (ppm).[46] The action level triggering a "do not consume fish" for the sensitive population is 0.9 ppm of mercury in fish tissue. The corresponding action levels for the general population are 0.7 ppm to restrict eating fish and at 2.6 ppm to avoid eating fish.

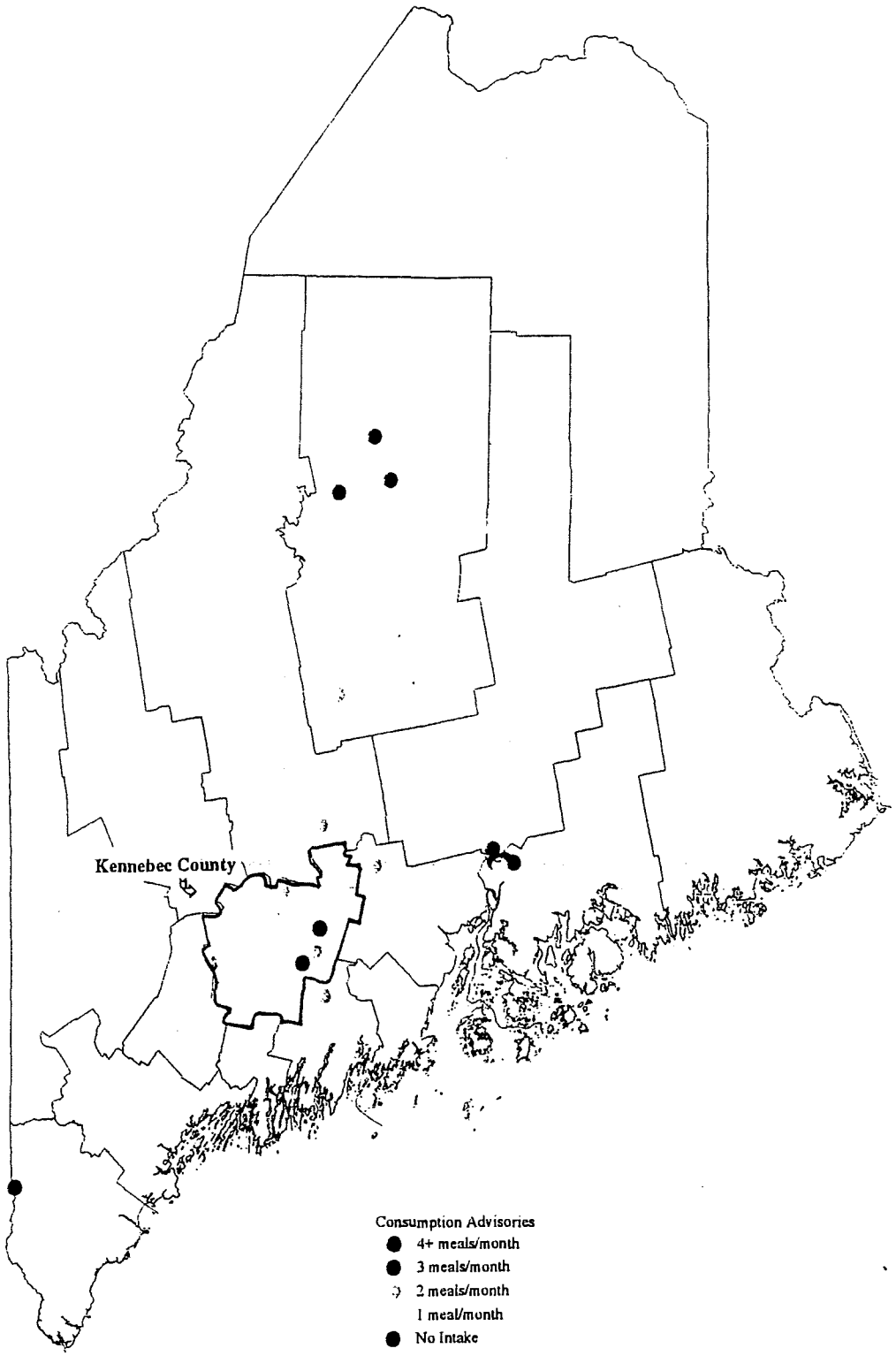
Differences in Mercury Levels of Warm Water versus Cold Water Species -- Analysis of data on average levels of methylmercury in fish collected from about 150 Maine lakes showed significant differences between warm water fish (e.g., bass, perch, pickerel) and cold water fish (e.g., trout, salmon). Warm water fish species tend to have significantly higher levels of methylmercury in tissue than cold water fish species. For example, the average level of mercury in warm water fish species was 0.62 ppm, while the average for cold water fish species was nearly 2–times lower (0.36 ppm). More than 10% of samples of warm water fish had levels exceeding USFDA's standard of 1 ppm mercury in fish tissue, and 23% had levels exceeding the Bureau of Health's "do not consume fish" action level for the sensitive population. In contrast, less than 2% of samples of cold water fish species had levels in excess of 1 ppm, and only about 3% exceeded the Bureau of Health's "do not consume" action level.

Need for Statistical Extrapolations -- The Bureau of Health has current data on mercury levels in fish from less than 3 percent of Maine's inland water bodies. Furthermore, science has not progressed to the point where we can predict with any degree of confidence levels of mercury in fish from a lake without direct measurement. Indeed one of the remarkable features of mercury fish contamination is the substantial variation in fish mercury levels among lakes in close proximity and with the same fish species. This feature is illustrated in ***Figure II-7: Consumption Advisories for White Perch.*** This map shows how variation in mercury levels for white perch collected from 34 lakes translates into differing restrictions on recommended intake. Note that within Kennebec County, lakes in close proximity can have average mercury levels in white perch ranging from levels warranting severe restrictions on intake to levels where no restrictions are needed.

[46] A part per million (ppm) is a unit of measure denoting one part of the substance in question per million parts of matrix being measured. So 1 ppm of mercury in fish tissue is the same as 1 microgram of mercury per gram of fish tissue.

Figure II-7

Fish Consumption Advisories for White Perch

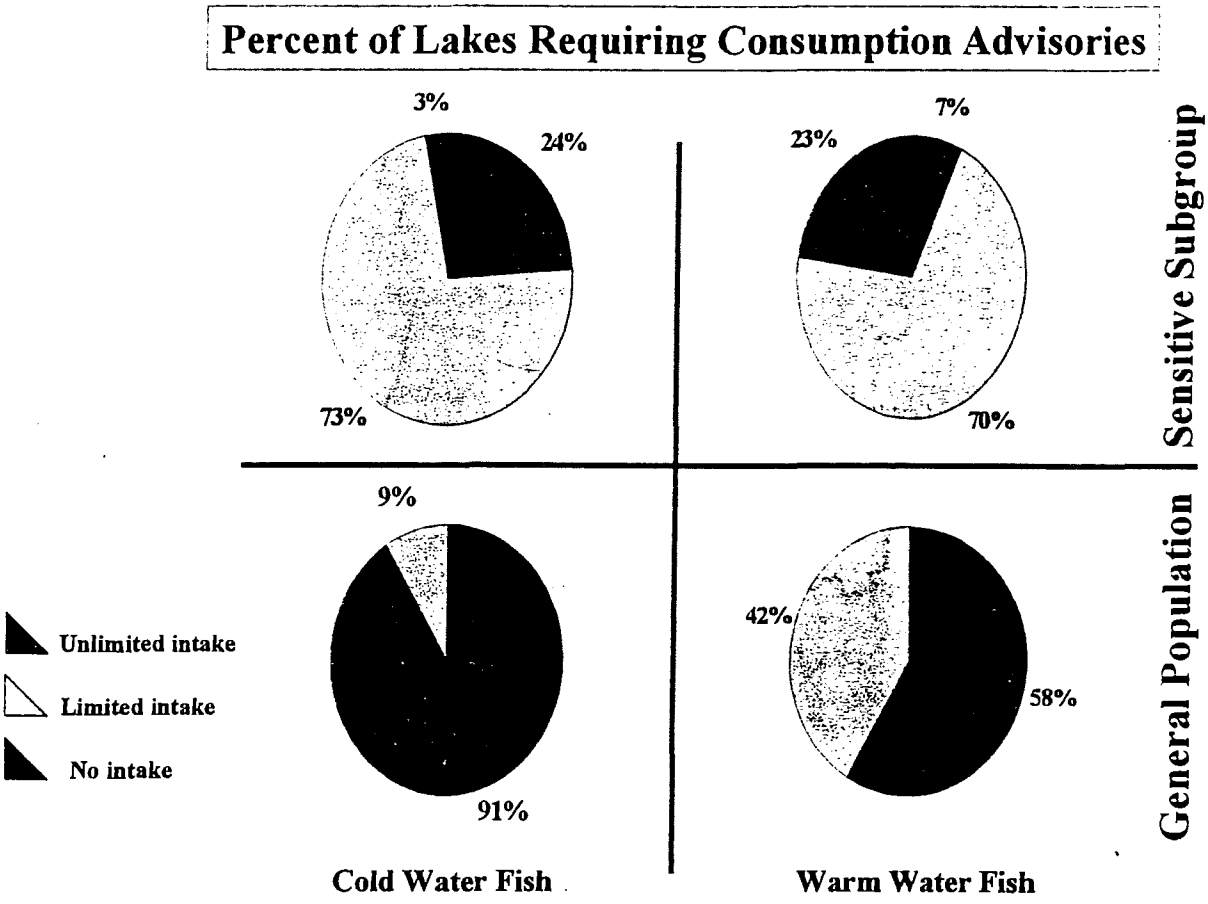


Source: Maine Bureau of Health

Limited data, combined with an inability to make reliable predictions, requires that some type of extrapolation be made from those waters where current data exist, to those waters where it does not. The alternative approach, taken by some states, is to issue advisories only on waters where data are available. **Appendix 5** includes a summary of the fish monitoring and consumption advisories activities of several states. Wisconsin is an example of a state that has issued lake-specific advisories.

The primary data base with which to make extrapolations are results from a 1993 sampling of Maine lakes and ponds conducted by the EPA Regional Environmental Monitoring Program (REMAP) (described in Chapter II., section B). This sampling effort determined average levels of mercury in fish from a random sample of Maine's approximately 2000 surveyed lakes and ponds. Using these data, it is possible to directly compute the percentages of sampled lakes requiring some level of consumption advisory. ***Figure II-8: Percentage of Lakes Requiring Consumption Advisories*** illustrates these results.

Figure II-8



Inspection of Figure II-8 reveals that 23% of lakes sampled for warm water fish species had methylmercury levels sufficiently high to warrant an advisory for the sensitive population to avoid eating any fish. Since the data come from a random sample of lakes, the Bureau of Health extrapolates these findings statewide, concluding that on average, about 1-in-4 lakes with warm water fish will have average levels too high for consumption by the sensitive subgroup. This observation, along with the inability to *a priori* identify the 1-in-4 lakes with high levels of mercury, forms the basis for the advisory that the sensitive population should not consume any warm water fish from Maine's inland waters.

Similarly, about 4-in-5 lakes with cold water fish species is expected to have levels of mercury sufficient to warrant limited consumption by the sensitive population. Thirty-five percent (35%) of lakes sampled warrant advisories to restrict intake to 1 meal per month. The picture is considerably different for concern over intake of fish by the general population, for which the percentage of lakes with fish mercury levels above action levels for limiting intake was considerably lower. Hence, the less restrictive consumption advisories.

The downside of making statewide extrapolations based on the current data base is that the advisories are overly, though prudently, restrictive. For example, while 23% of lakes sampled for warm water fish had levels sufficient to warrant an advisory to avoid consuming any fish by members of the sensitive population, nearly 80% of lakes would have allowed some level of consumption. Yet because it is not possible to identify which lakes have fish that are unsafe for consumption by the sensitive population, and given a 1-in-4 chance that fish could be unsafe, a public health policy decision is made to extend the "do not consume any warm water fish" advisory to all lakes.

What could change current consumption advisories -- There is very limited information to tell how fast methylmercury levels in fish will drop following reductions in emissions. However, given that mercury is a natural occurring element and a significant global source in emissions, it is expected that levels in fish will go down very slowly. In other words, Maine will probably be living with advisories for a very long time.

What could change the nature of our advisories? An aggressive sampling of lakes might modify conclusions based on current statewide extrapolations from the sample of 150 lakes. It also might allow Maine to begin issuing some form of lake-specific advisories for certain waters (e.g., identify those water bodies that do not require any advisories), as is currently done by several states (see **Appendix 6** Fish Research: A Summary of Activities in Other States). In this regard, it is noteworthy that almost 60% of the lakes sampled for warm water fish had mercury levels low enough that no advisory is needed for the general population and that almost 80% would allow at least some consumption by the sensitive population (see Figure II-8). About 1-in-4 lakes sampled for cold water fish would allow unlimited consumption even for the sensitive population. These findings argue strongly in favor of lake-by-lake testing to allow lake-by-lake advisories with the goal of opening up Maine's surface waters to not only catching but eating sport-caught fish.

Another factor that could modify advisories is a change in the understanding of the levels at which methylmercury is toxic. It is important to emphasize that the precise level at which methylmercury will cause adverse effects remains uncertain. There is an order-of-magnitude uncertainty surrounding current levels thought to be of concern. Maine is currently using a recently revised EPA reference dose as its basis for deriving fish consumption advisories. This toxicological benchmark underwent extensive external peer review and was recently reaffirmed by EPA's external Scientific Advisory Board. However, scientific studies on the toxic effects of mercury on humans exposed through consumption of fish are on-going and some results have already been published. Two recent studies of children exposed to methylmercury prenatally and postnatally due to fish consumption by their mothers have yielded conflicting results. A study conducted in the Seychelles Islands did not see any significant neurotoxic effects on children when examined out to 29 months of age[47]. A study conducted in the Faroes Islands with a similar cohort of children examined at 7 years of age did see effects on the nervous system associated with mercury exposure[48].

Based on results from the Seychelles Islands data, the U.S. Agency for Toxic Substances Disease Registry (ATSDR) recently proposed a draft acceptable daily intake (referred to as a *minimal risk level*) for methylmercury 5-times higher than the current EPA value. It is noteworthy that based on ATSDR's proposed acceptable daily intake for methylmercury, Maine's apparent fish mercury problem would appear greatly deminished. Whether ATSDR's 5-fold higher reference dose will remain after public comment is unknown. The EPA strongly disagrees with ATSDR's proposal. Furthermore, ATSDR's proposal was made before the publication of the Faroes Island study that reportedly did see mercury related effects at exposure levels supportive of EPA's RfD. ATSDR has recommended that states do not revise current fish consumption advisories using their draft minimal risk level. The Bureau of Health currently has no plans to modify its use of EPA's RfD for methylmercury.

Finding and Recommendations

Findings

1. All forms of mercury are toxic, with the central nervous system and kidney the major sites of toxic effects. The nature and severity of the toxicity that may result from mercury exposure is a function of both the magnitude and duration of exposure, the pathway of exposure, the form of the mercury or mercury compound, and individual susceptibility. The unborn fetus and young child are especially sensitive/vulnerable to the toxic effects of mercury.

2. Exposure to elemental mercury is primarily by inhalation. Exposure pathways of most concern are spills within buildings that result in mercury vapors reaching levels of concern.

3. Exposure to inorganic mercury is likely to occur primarily by dermal absorption of applied cosmetic and medicinal products.

---

[47]Davidson et al, (1995) Longitudinal Neurodevelopmental Study of Seychellois Children Following In Utero Exposure to Methylmercury from Maternal Fish Ingestion: Outcomes at 19 and 29 months. Neurotoxicology, 16(4): 677-688

[48]Grandjean, P. et al., (1997). Neurotoxicology, 20(1)

4. Methylmercury, an organic mercury form, appears to be the primary mercury form to which the general population is exposed. Consumption of fish and shellfish are the major sources of exposure to methylmercury.

5. Levels of methylmercury in Maine sport-caught fish are of concern, especially levels in warm water fish species such as bass, pickerel and perch. This has prompted the Bureau of Health to issue state-wide fish consumption advisories applicable to all inland waters.

6. Maine currently has data on mercury levels in fish from less than 3 percent of the states approximately 6,000 lakes and ponds. This limited data base has required extrapolations to be made from waters where we have data to those where we do not. Because of an inability to make reliable predictions of mercury levels in fish from lakes yet to be tested, it has been necessary to extend advisories to waters that in all likelihood do not have elevated mercury levels in order to protect public health.

7. Additional data on mercury levels in fish from lakes yet tested will improve confidence in current fish consumption advisories and would, over time, result in identification of water bodies either not requiring any advisories or at least less restrictive consumption advisories.

Recommendations

1. State agencies should undertake a more extensive sampling program to characterize mercury levels in sport-caught fish with the two goals of 1) improving confidence in making state-wide extrapolations from empirical data, and 2) opening up the fishery resource.

2. State agencies with leadership from the Bureau of Health should develop procedures for issuing and communicating waterbody specific fish consumption advisories.

3. The State should take an active role in advocating that Federal agencies strive for consensus on a single toxicological threshold that should be used in assessing the need for fish consumption advisories due to mercury contamination.

III. SOURCES OF MERCURY TO MAINE'S ENVIRONMENT

A. AIR EMISSIONS

National, regional and state research on mercury point to air emissions as the most significant pathway for mercury contamination of Maine's environment. As a result, DEP has focused most of its research and regulatory attention to date on the major air emission sources in the state and region.

Sources and Deposition of Mercury

Mercury is released to the atmosphere from natural processes (e.g. volcanoes, forest fires) and human activities (also called anthropogenic sources). (please see ***Figure II-1: Mercury Cycling in the Environment on page 4***). While mercury levels in Maine fish are believed to be due primarily to deposition of mercury, emissions in a geographical area do not account for all deposition in that area. Deposition patterns of mercury depend upon the mercury form emitted. For example, the particulate Hg(p) and divalent HG(II) forms of mercury will deposit locally or regionally, whereas elemental mercury or Hg(0) is subject to global transport before deposition. Generally, long-range transport of mercury is primarily responsible for mercury deposition in rural areas, and local point sources are primarily responsible for deposition in an urban environment. However, rural areas with significant local sources may also experience deposition from those sources.

Current estimates from the scientific literature indicate that 30-60% of annual mercury emissions are from natural sources, 30-90% are from anthropogenic sources[1]. Mercury emissions originally deposited from both anthropogenic and natural sources are also re-emitted from vegetative, terrestrial, and aquatic surfaces. The amount of these re-emissions is largely unknown, but the aquatic component has been estimated to be 25-40% of annual mercury emissions; no estimates exist for land surfaces.[2]

For any given location, deposition of mercury from the air to land and water surfaces originate from local, regional and global sources. The rate at which mercury is deposited can be determined by monitoring or modeling. DEP is monitoring wet deposition of mercury at four sites in Maine: Bridgton, Greenville, Acadia, and Freeport. However, these sites have only recently been set up and therefore little data are currently available. As a result, the only tool currently available to estimate deposition in Maine is modeling.

During the past few years, several efforts have been underway to identify the major sources of mercury in the United States and to gain an understanding of their impact on the environment. Three major studies are of particular importance to Maine and are discussed in further detail below. While estimating emissions is important, it is estimates of deposition and the sources causing that

---

[1] Baker, Joel E., Thomas M. Church, Steven J. Eisenreich, William F. Fitzgerald, and Joseph R. Scudlark, Relative Atmospheric Loading of Toxic Contaminants and Nitrogen to the Great Waters, Prepared for Melissa McCullough, EPA Great Waters Program Coordinator, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 15, 1993. pg. 79.

[2] Ibid, pages 79-81.

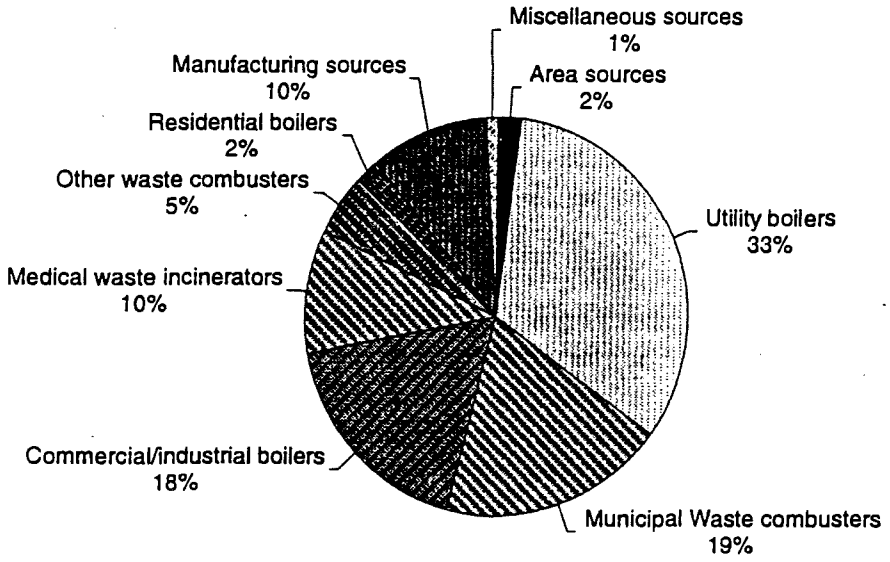
deposition, that have more direct relevance for determining the impacts of mercury from human activities on fish and wildlife.

National Mercury Study -- In response to the 1990 Clean Air Act Amendments, EPA has developed the Mercury Study Report to Congress, (the "National Mercury Study"). This report describes mercury emission sources, the deposition of those emissions, the subsequent health and environmental impacts of the deposition, and the availability and cost of control technologies. Controversy regarding the health impacts of mercury deposition delayed the Mercury Study beyond its due date of November 1994 until December 19, 1997, when it was finally released by EPA under court order.

EPA's National Mercury Study indicates that in 1994-1995, approximately 158 tons of mercury were emitted nationally from anthropogenic sources.[3] Combustion of waste and fuel by medical and municipal waste facilities, utilities, and commercial/industrial boilers was responsible for 87% of these emissions (see ***Figure III-1: National Mercury Emission Estimates 1994-95)***

Figure III-1

National Mercury Emission Estimates (1994-1995)



Source: U.S. EPA, Mercury Study Report to Congress

Nationally the larger sources of mercury from combustion are utility boilers, which are responsible for 33% of the nation's annual emissions. Municipal waste combustors (MWC's) are responsible for 19%, commercial and industrial boilers 18%, and medical waste incinerators (MWC's) 10%. Manufacturing sources (e.g. chlor-alkali, cement production, and pulp and paper) were responsible

[3]EPA, Mercury Study Report to Congress, Volume I, Executive Summary, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, and Office of Research and Development, Research Triangle Park, North Carolina, Table 3-1, December, 1997

for approximately 10% of the total national emissions[4]. Other sources exist, but were deemed unquantifiable by EPA. For example, wood stoves have the potential to emit a relatively large amount of mercury in states like Maine where stoves are widely used for heating.

The National Mercury Study used a computer simulation to determine where air emissions are depositing on the earth's surface. This simulation indicated that the northeast was one of three areas in the U.S. that have the highest amount of mercury deposition.

Northeast Study – Recognizing that EPA's emissions inventory for the Northeast was not as refined as each state's inventory, the Northeast states embarked in 1996 upon a more in-depth study, which will be released in February 1998. The Northeast States/Eastern Canadian Provinces Mercury Study (the "Northeast Mercury Study") was a multi-media effort that involved three interstate organizations -- the Northeast Interstate Water Pollution Control Commission (NEIWPCC), the Northeast States for Coordinated Air Use Management (NESCAUM), and the Northeast Waste Management Officials' Association (NEWMOA) – as well as the eastern Canadian provinces and Environment Canada. NEIWPCC, NESCAUM, and NEWMOA are regional associations of state environmental agencies for water, air and waste respectively, and represent the New England states and New York.

The Northeast Mercury Study is intended to be an information resource for the state and provincial governments as they continue to address the mercury issue and coordinate their efforts. The Study will be used as a foundation for a regional Mercury Action Plan and other regional initiatives to reduce health and environmental impacts associated with mercury deposition in the northeast.

The Northeast Mercury Study compiled an inventory of mercury levels in fish throughout the northeast, summarized the health information from state fish consumption advisories, compiled a northeast air emissions inventory for mercury, and, with EPA's assistance, used the emission estimates to model source-specific contribution to deposition in the northeast. A study of federal and state programs affecting mercury in the solid waste stream was also conducted.

Emission inventories, which were continually refined during compilation of the Northeast Study, indicate that total emissions in the Northeast are approximately 18 tons[5]. A breakdown of emissions categories is provided in ***Figure III-2:*** *Sources of Northeast Mercury Air Emissions.* Approximately 45% of the emissions are from municipal waste combustors, 7% from manufacturing (chlor-alkali, mercury product recycling, and cement and lime production); 18% from non-utility fuel combustion; 13% from utilities, 11% other waste combustion (sewage sludge and medical waste) and 6% from area sources (e.g. paint and lamp bulb breakage)[6].

---

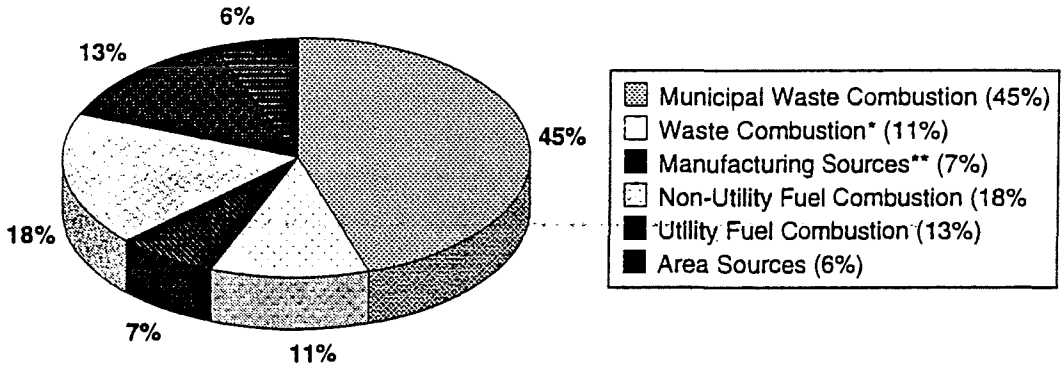
[4] Ibid, Table 3-1, December, 1997

[5] NESCAUM, DRAFT Northeast States/ Eastern Canadian Provinces Mercury Study. Prepared by New England Interstate Water Pollution Control Commission, Northeast States for Coordinated Air Use Management, Northeast Waste Managment Officials Association, The Canadian Ecological Monitoring and Assessment Network, November 1997, Table V-1, pg. V-6

[6] Ibid, Table V-1, pg. V-6

Figure III-2

Northeast States/ Eastern Canadian Provinces Mercury Study, Sources of Northeast Mercury Air Emissions



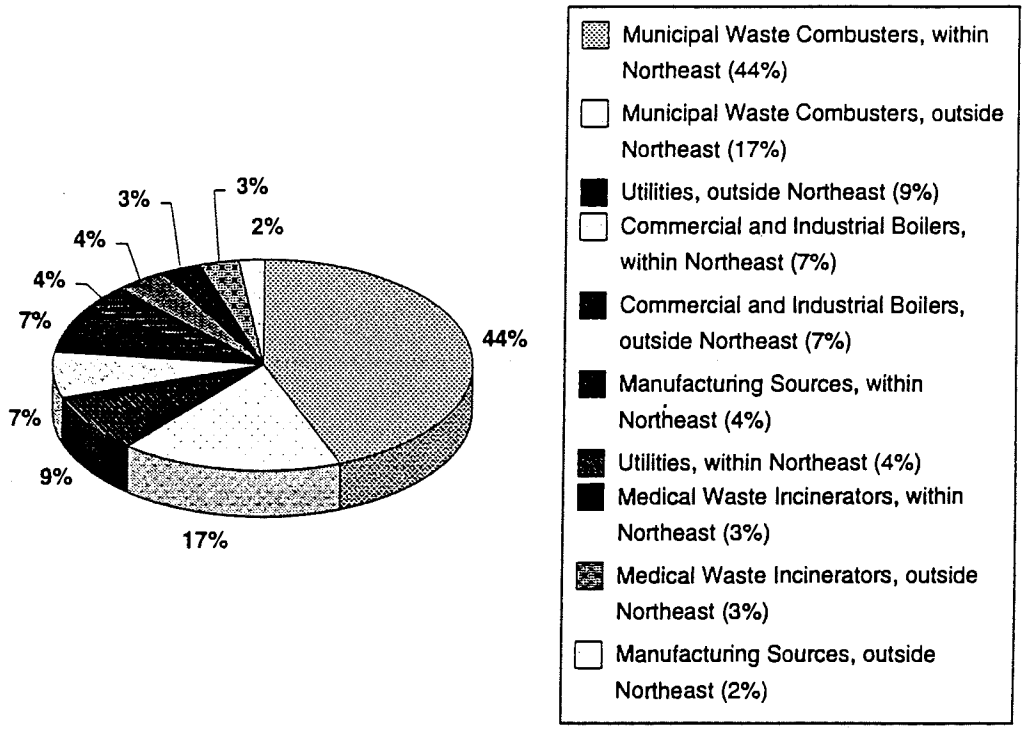
*Medical waste, sewage sludge incineration
**Primary lead smelters, secondary mercury (mercury recycling), chlor-alkali and cement production
Total may not add to 100%

Comparing national emissions to northeast emissions reveals some important differences. Nationally, utilities represent the largest source of mercury emissions (33%), while in the northeast, utility emissions are roughly one-third of that amount(13%). Municipal waste combustion in the northeast is more significant, contributing more than two times (45%) the national percentage for this source.

The Northeast Study also modeled deposition of mercury as shown in ***Figure III-3:*** *Northeast Mercury Deposition.* Overall, this modeling estimated that 47% of the deposition of mercury that is occurring in the northeast is due to sources located within the northeast region. Other U.S. sources contribute 30% of the Northeast's deposition, while deposition due to global background is 23%. It is unknown how much of this "global background" is due to U.S. sources originally.

Figure III-3

Northeast States/ Eastern Canadian Provinces Mercury Study, Northeast Mercury Deposition



This model also found that 42% of the anthropogenic deposition in the Northeast is due to municipal waste combustors in the northeast, and 17% is due to municipal waste combustors outside of the northeast. The third most significant source is utilities located outside of the region (9%).

Maine Emission Inventory -- In 1996, DEP began developing an inventory of air emissions of mercury in Maine. This inventory, which constituted a significant contribution to the Northeast Mercury Study, developed estimates of Maine mercury emissions by using EPA "emission factors". Emission factors are developed using data from specific sources to determine how much mercury is emitted per ton of waste or fossil fuel burned. However, emission factors are not available for all air emission sources, so emissions could not be quantified for some sources.

DEP did not use emission factors for two sources for which other data sources were available. For HoltraChem Manufacturing, a chlor-alkali plant in Orrington, DEP relied on the company's report to the EPA Toxic Release Inventory. (See Chapter III. D. for a more detailed discussion of this source.) For municipal waste combustors (MWCs; also referred to as resource recovery facilities, or waste-to-energy plants), DEP relied on stack tests performed by the facilities to quantify their emissions of mercury.

It should also be noted that emissions from wood stoves, furnaces, and fireplaces were quantified using a less reliable emission factor due to limited data. This estimate therefore should be considered to be qualitative. DEP is pursuing ways to determine a more accurate estimate.

Based on this analysis, DEP estimates that Maine's total mercury emissions are 2-3 tons per year. The major sources of mercury in Maine are area sources (e.g. wood stoves, labs), the chlor-alkali facility, municipal waste combustors, and commercial/industrial boilers. See ***Figure III-4:*** *1992 of Mercury Emissions for Maine* for further details on Maine's mercury emissions.

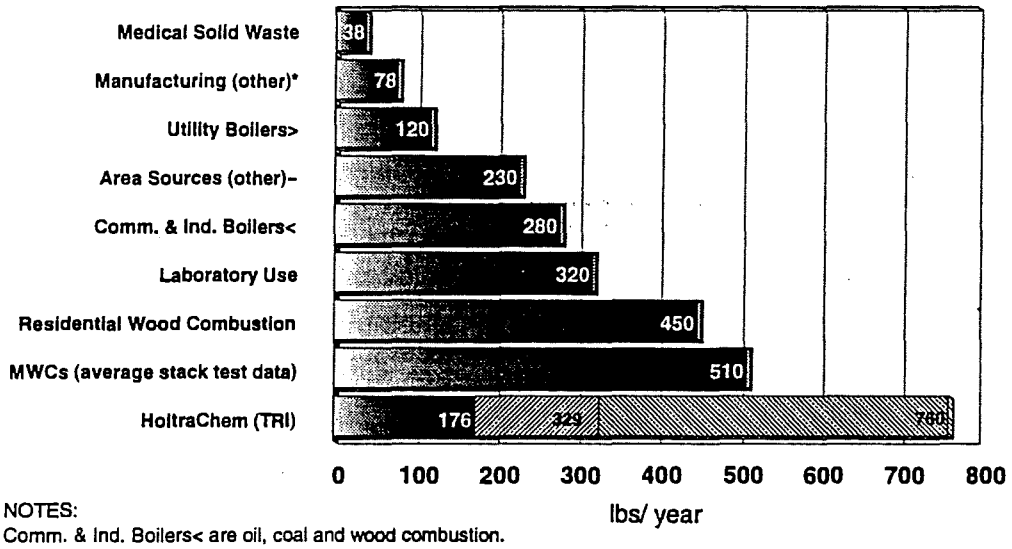
Industrial boilers which have the largest impact are those which utilize coal as a fuel source. Many of these are expected to convert to natural gas as that fuel becomes more widely available in the state.

Deposition of mercury to Maine by all northeast sources, U.S. sources, and global background was calculated as part of the Northeast Mercury Study. Deposition due to Canadian sources is unknown, but limited monitoring and Canada's preliminary mercury inventory indicates a high probability of deposition. The Northeast Mercury Study finds that approximately 78% of Maine's anthropogenic deposition is due to emissions that originate in the northeast, with the remaining 22% from other U.S. states outside the region (see ***Figure III-5:*** *Deposition of Anthropogenic Mercury in Maine*).

The Northeast Mercury Study also indicates that deposition overall in Maine is due to northeast sources (35%), other U.S. sources (10%), and global background (55%)[7] *(see* ***Figure III-6:*** *Overall Deposition of Mercury in Maine)*[8]. It is unknown what percentage of deposition in Maine is due to Maine sources.

Figure III-4

1992 Mercury Emissions for Maine - 2786 pounds



NOTES:
Comm. & Ind. Boilers< are oil, coal and wood combustion.
Area Sources (others)~ are paint use, lamp breakage, dental prep., cremations, mobile sources, residential coal and oil combustion.
Utility Boilers> are oil, coal and wood combustion.
Manufacturing (other)* is cement production and asphalt paving.
Mercury emissions from HoltraChem are based on models used by the company to estimate emissions. HoltraChem reports emissions of 760 lbs.(1992), 329 lbs.(1996), and 176 lbs.(1997). None of these estimates have been verified by DEP.

[7] Ibid, pg. ES-7, ES-8 and VI-20, Table VI-4

[8] Ibid, Section VI

Figure III-5

Deposition of Anthropogenic Mercury in Maine

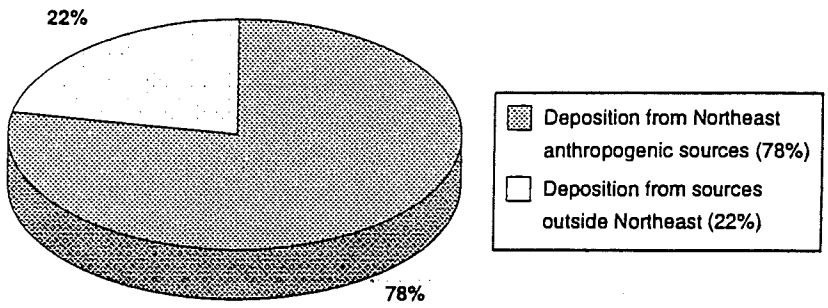
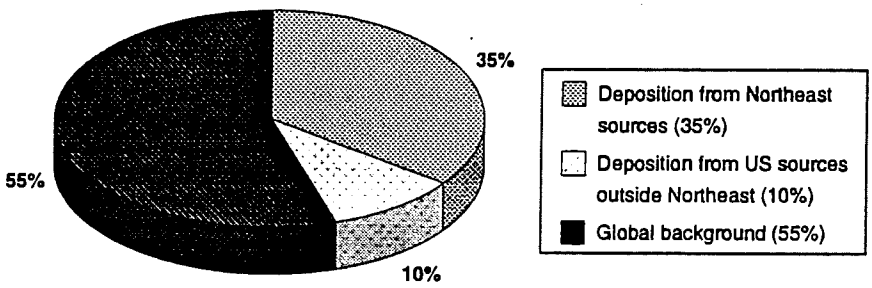


Figure III-6

Overall Deposition of Mercury in Maine



Legal Authority to Control Mercury Air Emissions

There are two types of air pollution standards: ambient air standard and emissions limitation standard. An ambient air standard is a level (usually a concentration of a given pollutant) based on a human health standard that cannot be exceeded. Compliance with this type of standard is verified through modeling where emissions go after release from the stack, in addition to monitoring levels in the air. An emissions limitation standard allows only a set amount of pollutant to leave the stack, and is usually expressed in the mass that is allowed to be emitted over a given period of time. Compliance with this type of standard is usually established through stack testing or some other type of emissions monitoring.

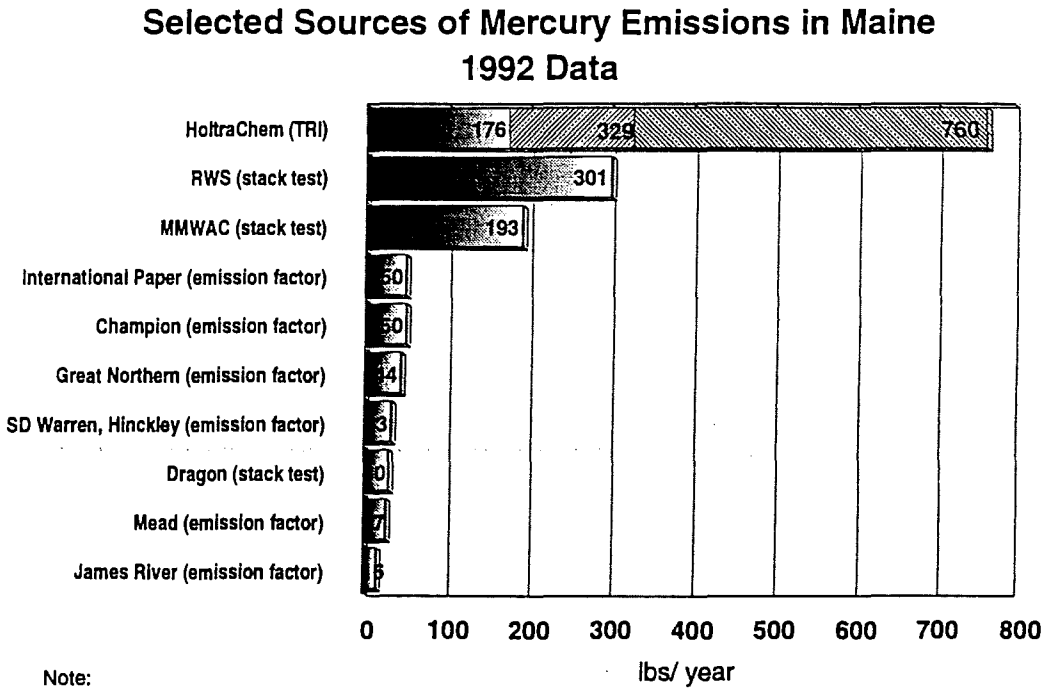
There are no state or federal ambient air standards that apply specifically to mercury, although EPA has derived a Reference Concentration (RfC) that can be used as a guideline for determining if ambient concentrations are of concern. Municipal waste combustors (MWCs) are required to test for mercury emissions in their stack as a matter of state law. Two of the four Maine MWCs -- Mid Maine Waste Action Corporation (MMWAC) and Maine Energy have binding mercury limits in their existing permits: The other two Penobscot Energy Recovery Company (PERC) and Regional Waste System (RWS), have non-binding mercury estimates cited in their permits. The different treatments of the four facilities results from timing differences in their permit renewal cycles. New federal regulations will require MWCs to meet an emission limitation standard which should result in at least an 85% reduction in mercury emissions for those sources subject to the federal rules. At that time the three larger facilities will be subject to the same standard.

State authority exists to limit mercury emitted to the air. Under 38 MRSA § 585-B, the Board of Environmental Protection (BEP) may establish emission standards for hazardous air pollutants, whether or not ambient air quality standards have been established for that particular pollutant. Regulatory authority exists in Chapter 115 for the BEP to require installation of more efficient or reliable equipment when it determines that previously uncontrolled emissions should be controlled, or when previously uncontrolled emissions should be controlled to a greater efficiency. Historically, these authorities have been used infrequently.

Requirements Applicable to Chlor-alkali Facility – As shown in ***Figure III-7: Sources of Mercury Emissions in Maine,*** Maine's individual largest mercury source as of 1992 was HoltraChem Manufacturing, of Orrington. This facility is currently meeting federal air emission requirements. The current federal rule allows HoltraChem to emit up to 1,850 pounds of mercury per year.

Although mercury is one of the hazardous air pollutants regulated under federal law with a Maximum Achievable Control Technology (MACT) emissions limitation standard, chlor-alkali plants are not "major" sources of hazardous air pollutants (HAPs). "Major" sources of HAPs are those sources that emit more than 10 tons per year of any single HAP, or more than 25 tons per year of any combination of HAPs. Because MACT standards are generally applied to major sources, the EPA suspended its work to promulgate controls in this area. However, EPA has recently indicated it intends to revise its rules which establish overall emissions limits for chlor-alkali facilities by the year 2000.

Figure III-7



Note:

1. Estimates from the individual paper mills are based on 1992 data and do not reflect changes in operations or emissions that have occurred since then.
2. Mercury emissions from HoltraChem are based on models used by the company to estimate emissions. HoltraChem reports emissions of 760 lbs.(1992), 329 lbs.(1996), and 176 lbs.(1997). None of these estimates have been verified by DEP.

EPA has authority under the Clean Air Act (Section 112(c)(6)) to apply controls for sources that contribute to 90% of the aggregate emissions of mercury in the U.S., but it is not clear whether chlor-alkali controls would be promulgated to meet this requirement of the Act. DEP will continue to urge EPA to promulgate controls on industrial mercury sources such as HoltraChem, while working with both the sources and EPA to reduce any potential for "double jeopardy".

HoltraChem also has a state permit which has historically been based on the federal standard. DEP has directed HoltraChem to apply for a permit renewal, requiring the company to perform an analysis to determine the best technology currently available to control emissions.

Requirements Applicable to Waste Combustors (Municipal and Medical) -- Currently, of the mercury sources identified, EPA rules will only control emissions from medical and municipal waste incinerators. Municipal waste combustors (MWCs) are currently a major contributor of mercury emissions to the atmosphere. As indicated above, nationally, MWCs are responsible for almost 20% of man-made emissions to the environment each year[9]. In the northeast, 45% of the man-made mercury emissions are from MWCs.[10] Two of Maine's MWCs were the second and third

[9] EPA, Mercury Study Report to Congress, Volume I, Executive Summary, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, and Office of Research and Development, Research Triangle Park, North Carolina, Table 3-1, December, 1997

[10] NESCAUM, DRAFT Northeast States/ Eastern Canadian Provinces Mercury Study. Prepared by New England Interstate Water Pollution Control Commission, Northeast States for Coordinated Air Use Management, Northeast Waste Managment Officials

largest point sources of mercury air emissions in Maine in 1992, and are responsible for approximately 25% of Maine's mercury emissions.[11]

While amount of emissions is important, a critical factor in the amount and rate of mercury deposition is the type of mercury released from specific air emission sources. Municipal waste combustors emit a large amount of the form of mercury that deposits on a local or regional level. Because of this, and because the quantity of MWC emissions is high in the northeast region, 60% of the deposition derived from human activity is due to municipal waste combustors (42% due to northeast MWC facilities, and 17% due to other U.S. MWC facilities).

Of Maine's four municipal waste combustors, two contribute a relatively small amount of mercury from this category of source. Maine Energy Recovery in Biddeford, and PERC in Orrington, each process roughly 1000 tons of municipal solid waste per day. Both facilities show stack test results totaling roughly 10 pounds of mercury per year, per facility. Both of these facilities are expected to meet the coming MACT standard for MWCs without requiring any further levels of control.

The two other facilities, Regional Waste Systems (RWS) of Portland and Mid-Maine Waste Action Corporation (MMWAC) of Auburn, have emissions that will require additional levels of control. RWS will face a requirement to install controls to meet federal Maximum Achievable Control Technology (MACT) standards, which Maine is in the process of adopting in state rule. These standards will require at least an 85 per cent reduction of mercury emissions in roughly two years. MMWAC is currently not subject to this federal standard. DEP intends to initiate a rulemaking process to establish controls for this facility. Potential federal requirements will be considered to avoid subjecting the facility to a double standard. (See Chapter IV.)

Medical waste facilities are not considered significant sources in Maine. However, they will be required to meet federal MACT standards. Few if any are expected to continue operations after the deadline for compliance with these standards in three years.

Requirements Applicable to Fossil Fuel Combustion Sources -- There are currently no federal requirements for limiting mercury emissions from fossil fuel combustion. EPA will examine mercury emissions from fossil fuel combustion associated with commercial and industrial boilers, and investigate potential regulatory controls, by the year 2000.

Nationally, utilities are the primary contributor of anthropogenic mercury emissions to the atmosphere. Their relative significance will increase after MACT controls for the municipal waste combustors are installed. Nevertheless, EPA has studied utility emissions of hazardous air pollutants (including mercury) from utilities, and has not yet decided whether to regulate this sector for HAP emissions.

Association, The Canadian Ecological Monitoring and Assessment Network, November 1997, Table V-2, pg. V-7, pg. V-10 thru V-12

[11] Maine DEP, DRAFT Technical Report Regarding Mercury Emissions in Maine, 1990 to 1992, Maine Department of Environmental Protection, Air Toxics Section, Division of Air Quality Control, August 26, 1997. pg. 27 Table 6.

Findings and Recommendations

Findings

1. Scientific understanding of deposition patterns in Maine and globally is in its infancy. Monitoring of deposition in Maine has just begun.

2. Much of Maine's air emission inventory necessarily relied upon EPA emission factors to generate annual emissions. Stack test data, the preferred technical approach, were only available for municipal waste combustors and portions of the chlor-alkali facility. Emission factors may under or overestimate actual emissions. Stack testing is costly and may be impractical for certain sources such as wood burning stoves.

3. Air deposition of mercury in Maine comes from air emission sources within the state, within the northeast region, and within the United States as well as from worldwide sources. Thus, control strategies must be pursued at state, regional, national, and international levels.

4. The most significant sources most likely causing deposition in the northeast are municipal waste combustors in the region and utilities inside and outside the region. Commercial and industrial boilers within and outside the region, manufacturing sources within the region, and medical waste incinerators within and outside the region are also significant contributors.

5. A industrial source of significance in Maine is HoltraChem Manufacturing Corporation in Orrington. Data are not currently available to conclusively establish the environmental impact of this operation, although certain areas of the plant site show elevated levels of mercury. DEP sampling of fish in the Orrington area downwind of this facility indicate elevated levels of mercury concentrations relative to lake fish in other parts of the state. This may be due to elevated mercury levels in lake sediment from earlier and/or present operating periods.

6. Municipal waste combustors are the largest category of Maine sources. Two facilities in Maine -- RWS in Portland and MMWAC in Auburn – generate significant levels of emissions.

7. Utilities and industrial boilers in Maine are of relatively minor size as individual sources, although as a group they have significance.

8. Residential wood combustion appears to be a substantial source of mercury in Maine, based on calculations using emissions factors in EPA's Mercury Report to Congress. These emissions factors are based on very little data, and estimates developed for residential wood combustion are considered to be qualitative in nature.

9. EPA has developed regulatory requirements for large municipal waste combustors, medical and hazardous waste incinerators. Maine has also initiated rulemaking for municipal waste combustors.

10. Neither EPA nor Maine has initiated rulemaking to address the mercury emissions from any other sector.

Recommendations

1. Maine should act aggressively to consider cost-effective controls on its major in-state air emission sources for two reasons:

   ⇒ First, elevated levels of mercury have been found in fish and wildlife throughout the state, and Maine based air sources are likely contributing to the problem.

   ⇒ Second, Maine should establish a "clean hands" policy to provide the foundation for state officials' call on other states and regions, to control their mercury emissions contributing to deposition in Maine.

2. Maine should target the two municipal waste combustors contributing substantially to Maine's mercury emissions and Maine's single chlor-alkali facility for aggressive controls.

3. Fuel switching should be encouraged for industrial boilers that use coal. The opportunity for switching to natural gas will be increased with construction of new natural gas pipelines in Maine.

4. Other northeastern states should be encouraged to go beyond existing federal MACT standards to control emissions from existing municipal waste combustors.

5. Maine should strongly urge EPA to promulgate control requirements for significant source sectors currently unregulated for mercury emissions. These include utilities, particularly coal fired sources, and industrial sources such as chlor-alkali producers in the region and outside. DEP should continue to work with EPA to avoid imposing a double standard on HoltraChem.

6. Current monitoring efforts should continue, while stack testing for any facilities likely to be significant (e.g. industrial boilers using coal) should be required to improve the accuracy of the Maine inventory.

7. While a small source for Maine, there is significant information available to medical waste facilities regarding mercury-free or reduced-mercury products. Any that intend to operate before or after Maximum Available Control Technologies (MACT) controls become effective should be encouraged to employ such strategies.

8. Additional research should be conducted to refine data on sources and deposition.

9. Maine should explore the legal viability and overall effectiveness of other states' prohibition or restrictions on the sale of non-essential mercury-containing products, and pursue if legally viable.

B. WATER DISCHARGES

Sources of Mercury Discharged to Water

HoltraChem Manufacturing -- HoltraChem Manufacturing, a chlor-alkali plant in Orrington, is the only facility licensed to discharge mercury into Maine's waters. This facility measures its discharge daily from its waste water treatment plant to the Penobscot River. Total mercury discharged from this source amounts to 6 pounds per year.[12] The surface groundwater discharges from the facility contain an estimated 9 lb./yr. of mercury as well.[13] For a more detailed discussion of this facility, please see Chapter III. D.

Other Discharges to Water -- Unpermitted discharges of mercury may exist. State effluent toxics regulations require all dischargers to test for toxic pollutants, including mercury, and to report test results to DEP. While there are instances where some discharges have tested positive for mercury at or near the detection level, DEP staff have judged the results to be unreliable because of the likelihood that samples became contaminated with mercury at the lab. When a facility's test results show an exceedence for mercury, DEP requires them to retest using "clean techniques." Such resamplings seem to be showing no exceedences, but this is an area that DEP will continue to monitor closely.

Surface run-off contributes an unknown amount of mercury to Maine waters.

Marine Deposit of Mercury – In 1944, the Vessel Empire Knight sank off the coast of York, Maine, one and a half miles from Boon Ledge in 260 feet of water. Included in the cargo was 16,800 pounds of mercury. Survey work around the hull found somewhat elevated levels of mercury in the immediate vicinity of the vessel. The United States Coast Guard (USCG) conducted an emergency removal action which confirmed the presence of the mercury.

Due to the depth of the wreck and condition of the cargo, the Coast Guard was able to retrieve only approximately 1,200 pounds of the mercury. At $42 million, the cost of further removal was deemed prohibitive. Rather, the USCG recommendation was that, assuming the wreck remains undisturbed, the low risk created by "no action" strategy would be the appropriate response. In 1995, the USCG instituted a permanent 1,000 yard radius safety zone around the wreck which prohibits dredging, diving, anchoring and fishing.

Legal Authority to Address Discharges to Water

Since 1971, Maine law has prohibited new discharges of mercury to waters of the state (38 MRSA § 420). Discharges that existed prior to this law, however, are permitted unless the DEP commissioner finds that mercury concentrations are causing a threat to public health. As indicated above, only one such licensed mercury discharge exists in the state -- HoltraChem Manufacturing in Orrington. The mercury discharge limits for this permit are based on federal standards for

[12] Camp Dresser & McKee, Site Investigation Report HoltraChem Manufacturing Site Orrington, Maine, Volume IV, Appendix D, December 22, 1995.

[13] Ibid .

technology and water quality (40 CFR part 415, subpart F). The discharge cannot exceed water quality standards. However, whether or not an exceedence occurs is determined by calculating the dilution that the effluent will receive in the receiving water. With the exception of run-off, any other discharges of mercury to Maine waters are addressed by the effluent toxics rule discussed above.

Findings and Recommendations.

Findings

1. HoltraChem Manufacturing enjoys a statutory exemption for the discharge of mercury into Maine's waters, an exemption that has allowed this discharge for 30 years. HoltraChem Manufacturing Corporation, while operating within its permit limits is discharging approximately 6 pounds of mercury per year into state waters. Additional mercury loading to the Penobscot occurs from surface run-off and leachate from unlined landfills

2. It is possible that there are other unpermitted discharges to state waters, principally in the form of run-off from contaminated sites and/or disposal of small, unregulated amounts of mercury-containing wastes into the waste waters of the state. (see following section on Mercury Disposal).

3. The Empire Knight, a ship containing 15,000 pounds of mercury lies in waters off the Maine coast.

Recommendations

1. The law which allows HoltraChem to discharge mercury into state waters should be modified to sunset at some point in the future.[14]

2. Unpermitted discharges of mercury should be identified and targeted for either pollution prevention and/or compliance activities.

3. The status of the Empire Knight should be reviewed with EPA and Coast Guard to ensure that the "no action" alternative remains appropriate.

[14]Department of Economic and Community Development Commissioner, Thomas McBrierty supported the goal of this recommendation, but preferred the use of permit or regulatory mechanisms rather than legislation, to achieve it.

C. LAND DISCHARGES AND MERCURY IN THE WASTE STREAM

Sources of Mercury to the Land and the Waste Stream

Mercury-Contaminated Sites -- Mercury has been used in a variety of ways by Maine industries for well over a century. Pulp and paper mills, saw mills, wood processing operations, lighting component manufacturers, ship yards and the military have used mercury in some manner in their operations. Schools, public and private, as well as salvage operations have had access to elemental mercury either by use in laboratory classes or through collections of thermostats, thermometers, switches or other mercury-containing relays. Discharges of mercury to the environment have occurred at some of these facilities. Some of these spills were recorded and cleaned up, while others may have gone undetected and unaddressed.

Mercury had been used by the pulp and paper industry as a biocide, and through the mercury cell process to produce chlorine bleach. These uses of mercury no longer occur at the mills. (The mercury cell process still is used at HoltraChem Manufacturing in Orrington, as discussed in Chapter III. D. of this report.)

Several mercury-contaminated sites have had some measure of mercury soil remediation activity performed by the responsible party, with DEP involvement. **(see list in Appendix 4: Historic Sites)** At those sites, the contamination has been cleaned up and no longer poses a threat to the environment or to the health and safety of the public. However, there are other sites, including a prior chlor-alkali facility in Rumford, where contamination may still exist. In the case of the Rumford site, on April 5, 1995, the EPA sent Boise Cascade a letter stating that no further actions would be taken towards listing the site as a National Priorities List site.[15] DEP is actively working with the responsible parties in each case to continue the development of site assessment, feasibility studies, and remedial plans for the eventual clean-up of the facility grounds and affected areas. The naval facility at Portsmouth has two mercury burial vaults in its Jamaica Island landfill. Remediation activities this year removed one of the vaults. A second vault is scheduled for removal next year after a site investigation.

DEP and the Bureau of Health are working together to educate the public, municipal officials and business operators on the dangers of mercury and the proper handling and disposal of mercury and mercury-contaminated products. The Wolman Steel site in Waterville, where an abandoned junk yard was vandalized by neighborhood kids and mercury removed, demonstrated the dangers of mismanaging mercury-containing materials. Extensive remedial action was required at the site, and homes were abandoned due to vapor concentrations in excess of safe levels. This incident was a wake-up call to many in Maine; since that event, DEP staff have recovered large volumes of elemental mercury that private citizens had been collecting.

Mercury in Municipal Solid Waste -- DEP has limited information regarding the volume of mercury in Maine's solid waste stream or the amount in products used by households or businesses. Until Maine has completed a thorough characterization of its municipal solid waste stream, it is necessary

[15]The letter also states that this decision does not necessarily mean that there is no hazard associated with the site, or that further actions may be taken by other federal, state or local programs.

to rely on analyses by EPA and the Northeast Mercury Study which indicate that the products contributing the most mercury are electric lighting, switches and other electrical products. See *Figure III-8: Total Mercury Content of Products Manufactured in the U.S.*.[16] With the on-going decline in the mercury content of batteries, DEP's emphasis for further removals from the solid waste stream will be focused on electrical lighting and electronics, the two sectors estimated to be increasing in their contribution of mercury to the solid waste stream.

Figure III-8
Total Mercury Content of Products Manufactured in the U.S. Estimates for 1985-1994 (Metric Tons)[(a)]

Product	1985	1986	1987	1988	1989	1990	1991	1993[(b)]	1994
Paint	169	179	198	197	192	22	6	0	0
Other/chemical/allied products[(c)]	61	90	59	86	40	33	18	18	25
Electric lighting	40	41	45	31	31	33	29	38	27
Wiring devices & switches	95	103	131	176	141	70	25	83	79
Batteries	952	750	533	448	250	106	78	10	6
Dental equipment/ supplies	50	52	56	53	39	44	27	35	24
Other[(d)]	20	31	34	55	35	25	26	103	110
Total	**1387**	**1246**	**1056**	**1046**	**728**	**333**	**209**	**287**	**271**

Source: U.S. Department of the Interior, 1995
(a) Year of manufacturing of a product is not the year of disposal, which is a function of the life cycle of the product.
(b) No data was reported for 1992.
(c) Includes pigments, pharmaceuticals, catalysts for plastics and miscellaneous catalysts (A portion of this category may not be disposed as MSW and may be managed as hazardous waste).
(d) Includes other electrical and electronics uses, other instruments and related products and unclassified uses for 1993 and 1994.

Mercury in Batteries -- In 1992, Maine passed the Battery Management Act. The Maine Waste Management Agency had responsibility for its implementation. This law:

- requires manufacturers to establish a collection system for mercuric oxide batteries and rechargeable batteries;
- bans disposal of these battery types by government agencies and industry, communications and medical facilities employing 15 or more persons;
- controls mercury content in batteries by prohibiting the sale of batteries that do not meet mercury content requirements;
- requires rechargeable batteries to be manufactured so the battery pack may be easily removed; and
- requires rechargeable batteries to be labeled to indicate that the battery must be recycled or disposed of properly.

Prior to its abolition, MWMA published a battery management plan (see Maine Used Dry Cell Battery Management Plan, November 1993) that recommended against expanding the law to require

[16]Draft Northeast States/Eastern Canadian Provinces Mercury Study, October 1997.

collection of other battery types. MWMA found that new collection programs were not warranted given the industry trend toward manufacture of batteries that contain no added mercury. Manufacturers of rechargeable batteries have established the required collection system and have begun advertising its availability.

Since passage of the 1992 battery law and the 1996 federal Mercury-Containing and Rechargeable Battery Management Act (described below), the mercury content of batteries sold and/or in use in Maine has continued to decline. According to the National Electrical Manufacturers Association[17] there are only two types of batteries now manufactured that contain mercury. Only one US company, Alexander Batteries, still sells mercuric oxide batteries in the US. Alexander provides collection for its users, primarily hospitals and the military.

The second remaining mercury-containing battery is button cell batteries. These batteries contain small amounts of mercury to control gassing caused by impurities. The total amount of mercury in all the button cells sold in the US in a single year is estimated to be 2 tons. This suggests that Maine's share of mercury from button cells is roughly 10 pounds per year. [18]

In general, batteries in widespread use are only a concern in terms of mercury content if they were manufactured prior to 1992. Some of these may still be in homes and businesses, although they are at the end of their "shelf life". To keep as many as possible from being incinerated, DEP began planning a one-time collection following the ice storm of January 1998. During that extended state-wide power outage, battery use was exceptionally high, raising the likelihood that many of the spent old type batteries would subsequently enter the waste stream. The one-time collection would divert then away from incinerators to safe disposal.

Mercury in Landfills -- Municipal, commercial and industrial landfills have received mercury contaminated soils over a long period of time. In many cases no records exist as to the quantity of the deposit. In other cases, the quantity and location within the landfill is known. Disposal of mercury-containing products in a landfill can lead to release of mercury to the environment through volatilization to the atmosphere ("offgassing"), and through leaching and leachate treatment. Land application (also called landspreading) of mercury-containing sludge and other residuals such as wood ash also can be a source of mercury emissions.

Currently, only waste meeting the definition of solid waste may be landfilled legally in Maine. Mercury-containing waste that meets the definition of hazardous waste must be shipped out-of-state for disposal as there are no licensed hazardous waste landfills in the state. Maine's operating solid waste landfills are licensed by DEP. DEP rules require that the landfills be lined and that leachate be collected for treatment.

Leachate collection systems allow for the leachate to be tested for many substances, including heavy metals. Leachate from licensed landfills in Maine is monitored for the presence of mercury, but no attempt has been made to quantify cumulative mercury emissions from landfills. If properly run,

[17] Rick Erdheim, National Electrical Manufacturers Association, conversation, January 1998.

[18] Ibid

however, these landfills can be expected to effectively isolate most of the mercury in disposed waste.

Maine has nearly 400 unlined, unlicensed municipal landfills that have ceased operations. These landfills have no leachate collection systems, but have monitoring wells that can be sampled periodically to test for mercury contamination. Studies of landfills elsewhere suggest that landfill emissions are low relative to other mercury emission sources such as incineration and energy generation.[19]

Mercury in Hazardous Waste – Unlike the situation in Maine for solid waste, it is possible to determine how much mercury-containing hazardous waste is generated each year. Maine law requires hazardous waste generators to report waste volumes and to manifest waste shipments. Records show the following totals for mercury-containing waste. (*See Figure III-9: Sources of Mercury in Maine's Hazardous Waste*) Please note that these figures report the number of pounds of mercury-containing waste, not the quantity of mercury. Finally, as Maine has no hazardous waste disposal facilities in-state, all of this waste is shipped out of state.

Figure III-9

Sources of Mercury in Maine's Hazardous Waste

	1994	1995	1996
HoltraChem[(a)]	2,322,000	1,916,200	1,517,560
Portsmouth Naval Shipyard	203,125	123,798	13,581
Fluorescent lights	9,970	26,659	16,055
Mead Oxford	---	50,035	---
Pen-Bay Medical Center	---	---	31,752
Other	28,657	42,133	41,480
Total	**2,563,752**	**2,158,825**	**1,620,428**

(a) Note: From manifest data, 1994 through 1996.
For HoltraChem, the values include hazardous waste categories D009 (toxic for mercury), K071 (brine purification muds from mercury cell process), and K106 (wastewater treatment sludge from mercury cell process). All other companies include D009 values only.

Federal Mercury Stockpile – The Northeast Waste Management Officials' Association (NEWMOA), an interstate organization of the state environmental directors from the New England states and New York, with the concurrence and approval of the environmental commissioners from those states, petitioned the Secretary of the Department of Defense (DOD) and other ranking federal officials to stop the sale of approximately 11 million pounds of surplus DOD mercury, out of concern for the ultimate use and disposal of that mercury. To date, after a lapse of six months, the DOD has stopped its active request for proposals on the sale of this surplus and it is presumed that the DOD is developing a strategy to dispose of the material in a safe and environmentally sound manner. It is the intention of NEWMOA to keep a watchful eye on this topic.

Mercury and Waste Land-Spreading – DEP also regulates the landspreading of septage and sewage treatment plant sludge. DEP rules prohibit spreading of any material that has a residual mercury

[19]Mercury in Massachusetts: An Evaluation of Sources, Emissions, Impacts and Controls, Massachusetts DEP, 1996, Chapter 4, pages 4-6.

concentration of 10 mg/kg or more. Mercury concentrations in most residuals approved for landspreading are below the detection limit of 1 mg/kg.

Legal Authority Regarding Mercury Discharged to Land, in Solid Waste and Products

Laws Governing Mercury in Products

1. ***Battery Management Act*** (38 MRSA §§2165 and 2166). The law was administered by the Maine Waste Management Agency (MWMA) until that agency was abolished in 1995, at which point its responsibilities were transferred to the Maine State Planning Office.

2. ***Reduction of Toxics in Packaging Law*** (32 MRSA §1731 through 1739). This law seeks to reduce toxicity of packaging waste by prohibiting the unnecessary addition of heavy metals, including mercury, in packaging and packaging components. Effective April 1, 1994, the total concentration of lead, cadmium, mercury and hexavalent chromium in packaging may not exceed 100 ppm by weight.

   The law was enforced by the Department of Agriculture until 1996 when oversight was transferred to DEP. The DEP Office of Innovation and Assistance administers the program. Program administration is assisted on a national basis by the Environmental Council of States and by independent test laboratories. To date, 40 companies have received Certificates of Compliance from independent labs documenting conformance to the law.

3. ***Toxic Use Reduction Act*** (38 MRSA §2301 through 2312) This law establishes reduction goals for mercury-containing substances (as listed in 40 CFR Parts 355 and 372.65). Companies using and releasing mercury are required to identify and report the amount and processes where it is being used or released. They must also meet reduction goals for mercury release and waste generation. DEP has a technical assistance program to help businesses comply with these requirements.

4. ***Mercury-Containing and Rechargeable Battery Management Act.*** This 1996 federal law bans sale of button cell mercuric oxide batteries; sets limits on the mercury content of certain battery types; requires the battery pack of rechargeable batteries to be easily removed; establishes battery labeling requirements; requires that collection, storage and transportation of batteries be managed according to the federal Universal Waste Rule; and prohibits states from adopting standards different than those in the Universal Waste Rule. The law is administered by the EPA.

Laws Governing Mercury Waste Disposal

1. ***Hazardous Matter Control Law*** (38 MRSA §1317 through 1319-A). In 1980, the Maine legislature enacted laws prohibiting the discharge of hazardous matter onto land or water unless licensed or authorized under state or federal law. In 1981, the BEP adopted a rule (Chapter 800) identifying those substances that qualify as hazardous matter, including several mercury-containing substances.

In general, discharges of hazardous matter "in any quantity and under any circumstances" must be reported and removed immediately. There are two exceptions: 1) discharges of hazardous matter being used in normal household activity are exempt (see Chapter 800(4)(C)); and 2) discharges covered by a spill prevention, control and clean-up plan must be reported only if the discharge exceeds the applicable reportable quantity as specified in federal regulations under CERCLA (see 38 MRSA §§1318-B and 1318-C).

The hazardous matter law is administered and enforced by staff in the DEP Bureau of Remediation and Waste Management. The bureau maintains the capability to respond to prohibited discharges and administers the Hazardous Waste Fund to pay the costs of spill response.

2. ***Hazardous Waste Management Law*** (38 MRSA §1319-O through 1319-Y) and ***Solid Waste Management Law*** (38 MRSA §1301 through 1310-AA)
Since 1973, it has been unlawful to establish, construct, alter or operate a "waste facility" without a permit from DEP. A waste facility is any structure, dump or other land area used for handling hazardous, biomedical or solid waste. The BEP has adopted comprehensive rules governing licensing of solid waste facilities (chapters 400-409) and hazardous waste facilities (chapters 850-857). Under these rules, waste containing 0.2 mg/l or more of mercury, as determined by a specified test, is considered hazardous waste. This waste may not be placed in the trash for disposal as solid waste unless the waste was derived from a household (including multiple residences, hotels and motels). Non-household waste that exceeds the 0.2 mg/l limit for mercury must be disposed in a licensed hazardous waste facility. Since there are no such licensed facilities in Maine, this waste must be shipped out of state for disposal.

Mercury-Containing Lamp Policy -- In 1996, as an interpretation of the hazardous waste law and rules, DEP issued a mercury-containing lamp policy. This policy is intended to facilitate removal of fluorescent lamps, high pressure sodium lamps and other lighting devices from the solid waste stream. Many of these lamps contain levels of mercury exceeding the threshold for characterization as hazardous waste and therefore are subject to the requirements of the DEP Hazardous Waste Management Rules. The lamp policy eases the burden of compliance through liberal consolidation procedures that allow lamps to be stored on site prior to shipment to a reclamation facility for recycling. Non-household mercury-containing lamps that are not managed in accordance with the policy remain subject to the more stringent requirements of DEP rules.

As is shown in Figure III-8, mercury-containing lamps are estimated to increase in their mercury contribution to the waste stream. This is particularly likely given the continuing trend toward greater use of energy-saving fluorescent lamps as part of strategies to reduce utility emissions of mercury, NOx greenhouse gases and other utility emissions. DEP currently is conducting an outreach effort to inform Maine citizens about the policy and the need to properly manage mercury-containing lamps. This educational effort will be followed by enforcement of the DEP rules in situations where the policy is not followed. The National Electrical Manufacturers

Association estimates that 85% of all mercury containing lamps are from non-household sources such as businesses and government[20]

Pending Federal Legislation on Mercury

A federal bill, known as the Mercury Environmental Risk and Comprehensive Utilization and Reduction Initiative (MERCURI) has been introduced in Congress. The bill, co-sponsored by Maine Congressman Tom Allen, deserves focused analysis to determine whether modifications are needed to accommodate any Maine-specific issues.

As presently written, the proposed bill would:

- require battery retailers to collect a deposit on mercury-containing batteries, which would be refunded when the battery is returned to the retailer for disposal..
- prohibit retailers from disposing of the battery in a solid waste landfill or incinerator.
- require landfills and incinerators to separate mercury-containing items (e.g., batteries, florescent bulbs, electrical switches and thermostats) from the waste stream prior to disposal or incineration.
- require landfills and incinerators to either recycle the separated items or handle them as hazardous waste.

Two provisions of the proposed bill have sparked significant debate. As currently drafted, the proposed bill imposes a tax on mercury emissions, which some argue would be better placed on the manufacturers of mercury-containing products. Municipal waste combustors regard the proposed requirement on landfills and MWCs to separate mercury from solid waste uneconomic, and technically problematic. Others who see some forms of source separation as a viable alternative.

Findings and Recommendations

Findings

1. Mercury-containing products are still in use in Maine and the region, causing continued generation of air emissions from incinerators, disposal in landfills, and the resulting release to the environment via off-gassing and leachate generation.

2. The legal mechanisms are in place to address spills and site contamination. Most known historical sites where land-based contamination has occurred have been remediated. Those known sites which still have mercury contamination are being investigated or remediated through appropriate state and federal authorities.

3. Maine already has a policy aimed at facilitating proper disposal of mercury-containing lamp bulbs, one of the mercury-containing products expected to increase in use. Efforts are being made to ensure compliance via education and assistance. Enforcement authorities will be invoked as appropriate.

[20]Ric Erdhein, National Electrical Manufacturers Association, January 16, 1998.

4. Until Maine has completed a state-specific characterization of its solid waste stream, it will be necessary to rely on regional and national data regarding the amounts of mercury-containing products in Maine's solid waste stream.

5. Maine state law prohibits the sale of batteries containing mercury above specified levels. Reportedly, manufacturers have discontinued the sale of mercuric oxide batteries in the state, but compliance is not currently enforced. The Maine Waste Management Agency recommended that the law be amended to require battery manufacturers to disclose the content of batteries sold in Maine.

Recommendations

1. DEP should pursue a pollution prevention strategy directed at reducing the use of mercury by industries that generate waste to landfills and incinerators or residuals for landspreading. The strategy should target the sectors in the state that are most likely generating the largest quantities.

2. DEP & SPO should work together to review the 1993 Battery Management and its recommendations in light of the composition of today's batteries.

3. Maine should participate in regional strategies aimed at commercial source reduction and recycling of mercury.

4. DEP and SPO should begin to educate the public about steps consumers and businesses can take to reduce use and disposal of mercury. Information about non-toxic products should be made available to businesses and consumers in Maine, the region, and beyond. Municipal waste combustors should contribute to this education program

5. Maine should work with its congressional delegation to refine and gain passage of HR 2910, a mercury bill pending before the US Congress.

6. State or national laws should be passed to require reduction and possible elimination of mercury from consumer and commercial products sold nationally and in Maine.

D. HOLTRACHEM MANUFACTURING CORPORATION

HoltraChem is one of the most significant sources of mercury releases to the Maine's environment. Its significance is heightened by a unique statutory exemption given to the plant in 1971 (See Section III.C.). The HoltraChem facility is a chlor-alkali plant located adjacent to the Penobscot River in Orrington, Maine. The facility was first constructed in 1966 by IMC Corp. which operated the facility until 1982 when it was purchased by LCP Corp. (a division of Hanlin Group). LCP operated the plant until April 1994 when it was purchased by HoltraChem, (while LCP was in bankruptcy.)

The plant manufactures chlorine, caustic soda, hydrochloric acid, and chloropicrin. The majority of the chlorine is shipped out of state for use by chemical manufacturers in the production of a variety of chemicals and pharmaceuticals, water and waste water treatment and bleach. The caustic soda is used in the pulp and paper mills in Maine and in bleach manufacture as well as in other chemical manufacturing processes. Hydrochloric acid is shipped to a major manufacturer of gelatin used in photographic film, and steel pickling. Chloropicrin, a pesticide replacing the banned methyl bromide, is all shipped out of state for use as a soil fumigant in the growth of fruits, vegetables and tobacco.

The main raw material used in manufacturing these chemicals is sea salt that is dissolved into a concentrated brine solution. The brine is treated to remove impurities (the primary source of the hazardous waste produced), circulated through electrolytic cells where electrical energy separates the chloride atom from the sodium atom, and the depleted brine solution containing mercury is returned for resaturation. The cell room contains a series of electrolytic cells that use liquid elemental mercury. All brine waste and wastewater is treated in a recently commissioned waste water treatment plant to remove mercury and adjust neutrality before discharge to the Penobscot River. The brine mud and wastewater mud is the hazardous waste referred to in Figure III-9 on page 47.

Because air emissions from chlor-alkali facilities are fugitive, it is very difficult to make a reliable estimate of their actual mercury discharges. The state of Wisconsin has tried to compensate for this by requiring its chlor-alkali plant to conduct an annual mass-balance. This is a process whereby the amount of mercury in use on-site is accounted for as it moves through the process. The amount of mercury in the cells at the beginning of the year, plus the amount added during the year should compare well with the amount remaining in cells at the end of the year, added to the amounts lost in product, in waste streams, in air emissions, and in other process outputs. In 1996 HoltraChem stated in the Toxics Release Inventory that it shipped 2453 pounds of mercury in hazardous waste off-site[21], had 329 pounds of mercury in fugitive air emissions, 22 pounds in stack air emissions, discharged 6 lbs. of mercury to the Penobscot River, and had 1 pound of "other" mercury disposal. What is not clear is how much of the mercury added to the process during the year is thus accounted for. Without a full accounting of the amount of mercury on-site and its ultimate disposition, it is impossible to have confidence in the mercury emissions figures calculated for the plant.

[21] HoltraChem's 1996 TRI Report (EPA Form R).

HoltraChem's Environmental Impacts

While it is clear that the facility's historical operations have caused serious environmental damage, the process of evaluating the environmental effects of its ongoing operations continues. Among the difficulties in this assessment are the following:

- it is difficult to distinguish historical effects from current impacts;
- because air releases are fugitive, rather than from a stack, it is not possible to have measured air emission data, only estimates based on models. However, the company reports that over 7000 air samples are taken annually, and over 1000 temperature measurements are used to determine the quantities of mercury reported annually in the federal Toxic Release Inventory.
- the science of mercury transport is in its infancy; it is only possible to estimate the relationship between local emissions releases and emissions deposition.
- the river near the site is at the transition point between saline and freshwater concentrations which makes biological monitoring more difficult.

Air Emissions -- The largest mercury emissions from this facility are from the cell room where the chemicals are manufactured. These air emissions do not go out of a stack where they could be easily measured. Rather, these are "fugitive" emissions, released through a large roof vent in the cell room when the company periodically removes the covers from the individual cells for maintenance. Mercury released from the HoltraChem facility is in gaseous form. An estimated 30%[22] is in a divalent form which deposits rapidly in the immediate vicinity of the plant. The rest is elemental mercury which goes into the atmosphere and circulates the globe until it is eventually deposited.

In 1992 HoltraChem's predecessor LCP Chemicals reported that its air emissions contained 756 pounds of mercury per year, which is below federal limits allowing 1850 pounds per year. The company reported 329 pounds in 1996 and now claims that its 1997 emissions will show a reduction to 176 pounds per year. DEP has required HoltraChem to perform tests at the facility that will help verify these estimates. The company has pledged that by the year 2000 it will reduce air emissions of mercury to below 100 pounds per year. (**See Appendix 7:** *Commitment of HoltraChem Manufacturing to Reduce Mercury Releases*)

While the precise effect of the mercury emissions is not known, DEP sampling of lakes downwind of HoltraChem in the Orrington area shows that concentrations of mercury in fish (perch) and sediments are higher than the average of other lakes in the state. Other known sources of mercury emissions in the Orrington area are much smaller than HoltraChem (e.g. PERC at 10 pounds a year and Champion at 50 pounds). This suggests that the elevated levels of mercury in the sampled lakes may be attributable in part to historical and ongoing HoltraChem releases. For a further discussion of these impacts, please see **Appendix 5,** *Mercury Contamination in Lakes Downwind of HoltraChem Manufacturing Co.*

---

[22]EPA, Mercury Study Report to Congress, December 1997, and NESCAUM Draft Northeast States/Eastern Canadian Provinces Mercury Study, November 1997, pg. VI-10, Table VI-1. Both of these studies contain peer-reviewed estimates of the mercury speciation typical of different source categories.

Water Discharges -- HoltraChem is the only permitted discharge in the state pursuant to a grandfather clause in state statute passed in 1971. While it is permitted to discharge 16 pounds per year of mercury to the Penobscot River, HoltraChem currently discharges an estimated 6 pounds per year from its outfall licensed under the National Pollution Discharge Elimination System (NPDES). The company is working on a pilot project for a wastewater process which is intended to reduce its water discharge to less than a pound per year.

An unpermitted stormwater discharge, a small stream and contaminated groundwater carry mercury from the HoltraChem property into the Penobscot River. The mercury content from the unpermitted water sources of the facility is estimated to be about 9 pounds per year. The company has pledged to reduce its permitted discharge to less than a pound in the year 2000.

Spills -- Spills of mercury have occurred often at the facility, carrying unrecoverable mercury onto the plant property and into the Penobscot River. According to HoltraChem, the minimum amount of mercury-contaminated spills at the site totals 39,000 gallons for the years 1985 to 1997. The actual amount is likely much larger since this figure does not include spills prior to 1985. It is also possible that more recent spills may have been substantially under-estimated. The most common mercury contaminated item to be spilled was brine with an estimated mercury concentration of 25 ppm.

As an example, on February 19, 1997, a drop in the brine tank (contaminated with 25 mg/l of mercury) was observed. HoltraChem estimated that 30,000 gallons of hazardous waste brine leaked out of the tank over a 13 day period. A contractor hired by DEP estimated that the leak had been ongoing for a minimum of two months, during which time it leaked approximately 270,000 gallons of hazardous waste into the ground. This spill resulted in the direct or indirect discharge of pollutants, including mercury, to the waters of the state.

Landfills, Lagoons and Leachfields -- The facility has five landfills that are no longer in use, but hold over 15,000 tons of mercury-containing sludge, in addition to other mercury-contaminated wastes. The landfills are currently capped with impermeable material, but they are not lined.

In addition to the landfills, the facility has an outdoor lined lagoon and five leachfields. The lagoon is located over a landfill and it is actively used for holding brine solution. It has leaked in the past and is considered a possible source of mercury discharges. Some of the leachfields have received mercury-bearing water in the past, including human waste.

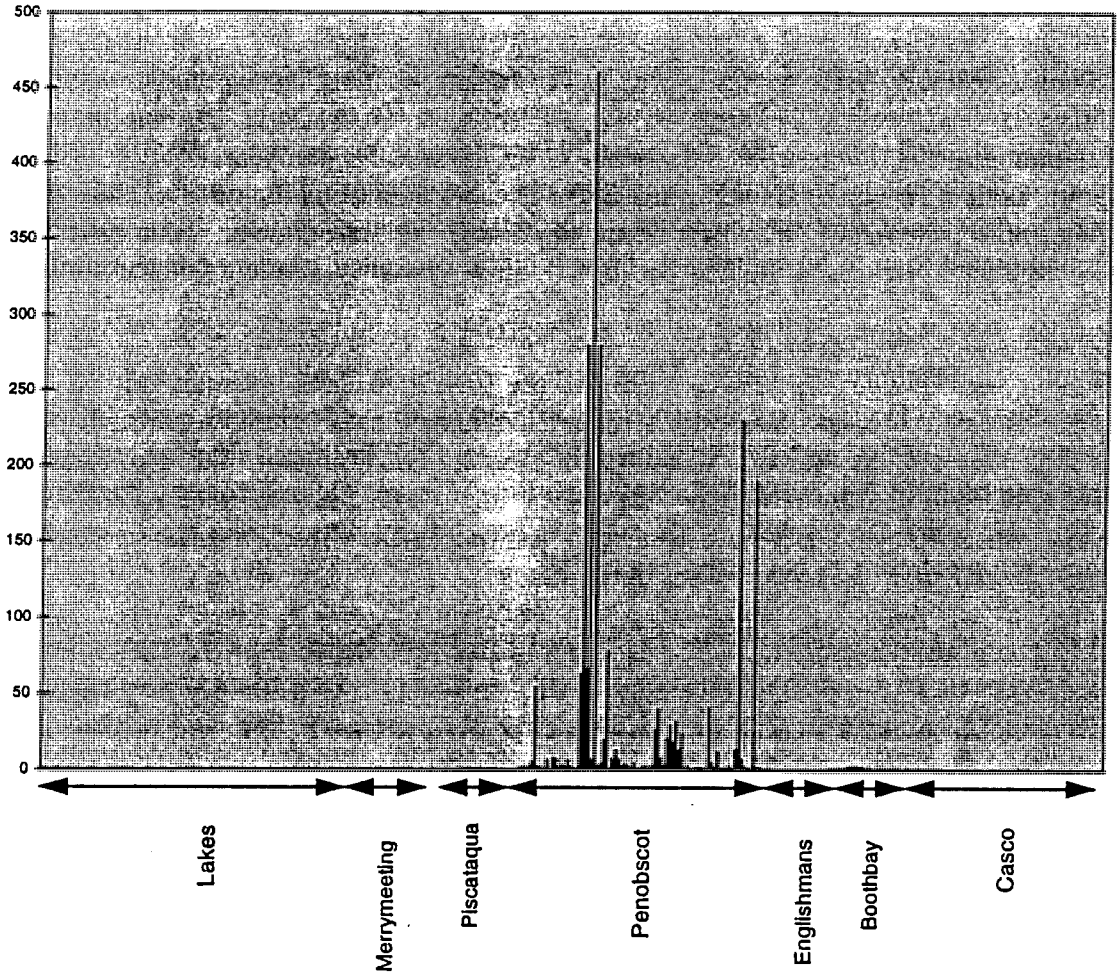
Contaminated Sediments -- Sediments below HoltraChem's wastewater discharge and in numerous locations adjacent to the facility are the highest known in the state and possibly in the country. These deposits are most likely attributable to a combination of historical practices (including direct dumping into the river by HoltraChem's predecessors) as well as spills at the site, on-going discharges to the river from waste water, stormwater and unlined landfills, and contaminated soil which moves with surface water run-off.

At levels ranging up to 460 ppm, the concentrations of mercury in the sediments around HoltraChem are well in excess of background (0.1 ppm) and of the 0.71 part per million standard

where aquatic impacts are expected. The magnitude of the contamination is so great that, when Penobscot results are plotted together with the other sediment data charted in Figure II-6 (page 18) earlier in the report, sites of concern such as Boothbay Harbor, Portland and the Piscataqua River are barely noticeable on the graph. Please see ***Figure III- 10:*** *Mercury Concentrations in Aquatic Sediments including Penobscot River Sediment at HoltraChem Manufacturing.*

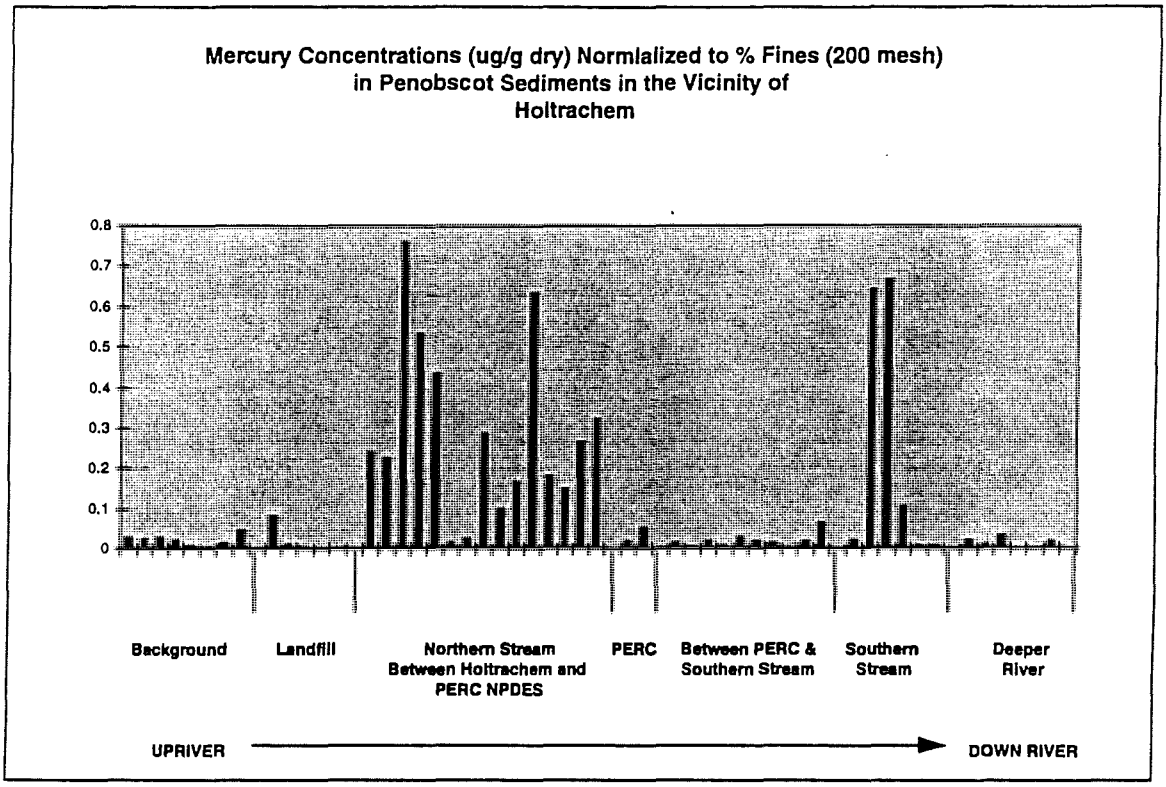
Figure III-10

Mercury Concentrations (ppm dry wt.) in Aquatic Sediments including Penobscot River Sediment at HoltraChem Manufacturing



When sample results are arranged in an upstream to downstream order and normalized to the type of sediment, the pattern of contamination becomes obvious – please see ***Figure III- 11:*** *Mercury Concentrations in Penobscot Sediments in the Vicinity of HoltraChem.* (Note that because these are normalized, units are not directly comparable to the previous graphs). Upstream background sediments are low (note a slight increase in the vicinity of the landfill) and the largest areas of contamination are directly in front of the facility off Northern Stream and the Southern Stream areas.

Figure III-11

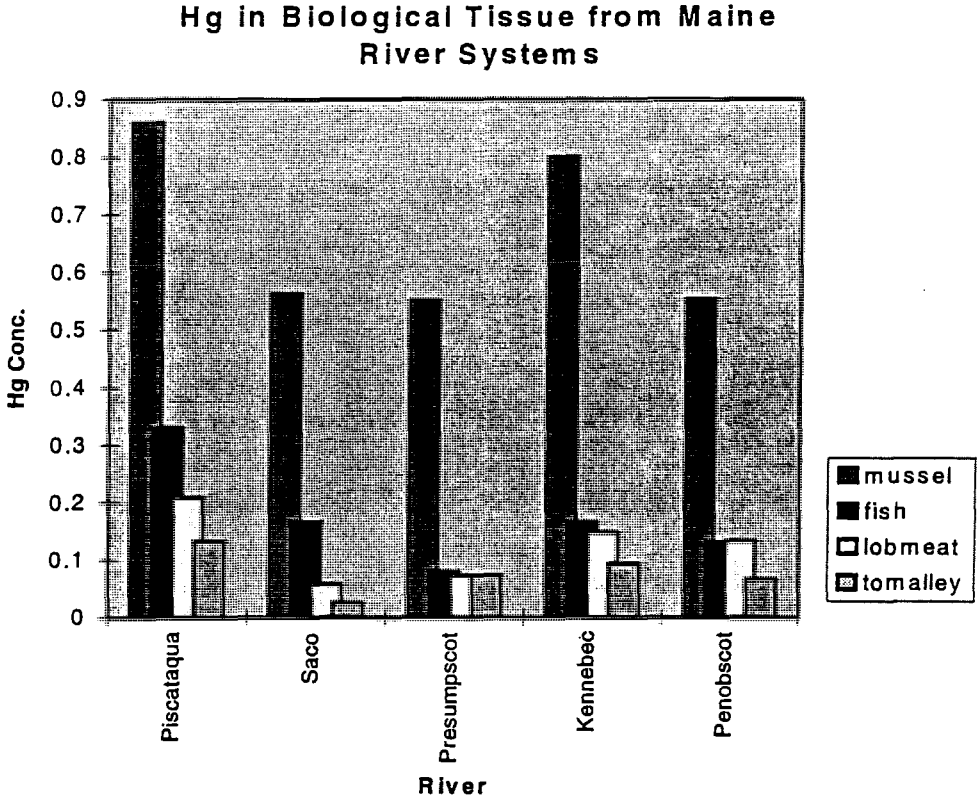


A federal investigation of contamination at the property, which has been on-going for 9 years at a cost of over $3 million, will eventually lead to clean-up efforts. Both HoltraChem and its predecessors will be involved in paying for the clean-up work.

Aquatic Life Impacts -- Levels of mercury in eels below the facility exceed the thresholds for Maine's fish consumption advisories. However, because of the unique setting of the HoltraChem facility, separating the contribution of mercury from HoltraChem to tissue concentrations from that of other upstream sources is difficult. Nonetheless, there is some indication that mercury levels in aquatic tissues below HoltraChem are indeed elevated. This is suggested by comparing relative order of mercury in fish upriver, above the site, with the mercury seen in lobsters down river, below the site.

In all the major river systems except the Penobscot, fin fish immediately above tidewater contain higher levels of mercury in their tissues than lobsters. In the Penobscot, fin fish and lobster meat contain roughly similar concentrations (see ***Figure III-12: Mercury in Biological Tissue from Maine River Systems***). While this is not in itself statistically significant, when viewed together with other information, DEP staff analysis concludes that an input of mercury exists between sample stations. In addition, fish samples collected from lakes downwind of the HoltraChem facility have significantly greater levels of mercury as compared to the statewide average for fish in lakes elsewhere in Maine. The report in **Appendix 5** describes this data in more detail.

Figure III-12



Human Health Impacts -- There are no documented human health effects linked to the facility. Workers at the plant are exposed to mercury in their daily work activities, but they are monitored to ensure concentrations in their blood do not exceed OSHA standards. OSHA recently conducted an inspection at the facility and reportedly found no violations. The company recently had an accidental release of chlorine gas which sent several area residents as well as on-site contractors to the hospital for observation, but no injuries were sustained.

Residential wells down-gradient from the facility have not tested positive for mercury; however, elevated levels of saline were found in the wells of two residents. This may indicate an effect from the plant, where quantities of sodium are stored on a concrete pad without containment and utilized continuously. However, at this time no definitive link has been made.

DEP has recently required HoltraChem to conduct ambient air testing near the facility to determine whether reference concentrations are being exceeded.

Compliance Record -- Historical operations at the facility have caused contamination of the property and the Penobscot River, and HoltraChem continues a pattern of serious chemical spills. As a result, DEP recently negotiated a consent order with the company that includes $700,000 in penalties and $1.5 million in measures aimed at preventing further spills. The chlorine gas release noted above occurred after a year long enforcement campaign.

As a result of the accidental release of approximately 1700 pounds of chlorine that occurred at HoltraChem's Orrington facility on November 17, 1997, HoltraChem agreed to conduct an operations "stand down" at the facility in order to review the company's operating, safety, and emergency response procedures with plant workers on all shifts. The stand down was conducted to ensure that proper procedures for preventing and handling emergencies were reviewed with all workers.

The stand down was conducted on November 20, 1997. The plant was idled for approximately 12 hours while personnel on all shifts attended a comprehensive six-hour long training review on safety and environmental practices relating to all phases of plant operations of the Orrington facility.

Conversion of Facility to Mercury Free Process

Roughly 15 per cent of chlorine manufactured in the United States utilizes the mercury cell process[23]. New facilities utilize either of two new alternative technologies which do not employ mercury. Reportedly 14 of 41 facilities nationally utilize the mercury-cell processes used by HoltraChem in Maine.

A HoltraChem facility in North Carolina will be converting to an alternative mercury-free technology process. According to the company, this is economically justified in North Carolina only because of a constellation of factors unique to that location, including such things as the greater age of the North Carolina facility and the savings associated with the new process through improved energy efficiency and substantial personnel reduction.

In a draft document produced by HoltraChem as part of its air license renewal application, HoltraChem has estimated it would cost roughly $40 million dollars to convert to a mercury-free process. These figures are based on industry averages. A detailed site-specific cost estimate performed by a consultant hired by HoltraChem now projects $47 million. The company president has assured DEP that this conversion is economically prohibitive for a $50 million per year business, despite the significant savings in energy costs that would result from the conversion. HoltraChem has consistently said it will shut down the Orrington plant if it is required to make such a conversion.

The operational history of the Orrington facility, including the period of ownership by HoltraChem Manufacturing Corporation, has been characterized by significant mercury releases to Maine's environment through air emissions, permitted and unpermitted discharges to groundwater and to the Penobscot River. While HoltraChem has also discharged other toxics, such as chlorine gas, to the environment, the most significant adverse effects from HoltraChem are directly traceable to its continued use of significant quantities of mercury as a major constituent of its industrial process. This is true even though 85% of the chlorine manufactured in the US comes from facilities which do not utilize mercury at all in the manufacturing process.

[23] The 2 primary mercury free technologies are known as membrane cell technology or diaphragm cell technology.

HoltraChem has made improvements in its pollution control systems during the last year, and has indicated it is pursuing additional control programs which will reduce its release of mercury to air and water. These commitments have been reiterated to DEP and to the Land and Water Resources Council during the process of developing this initial evaluation and report, and are attached as **Appendix 7** of this report. Nonetheless, because of the tangible human and environmental risks associated with mercury contamination, coupled with the availability of viable mercury-free manufacturing alternatives, the reduction or elimination of the use of mercury in the manufacturing process deserves serious consideration.

Findings and Recommendations

Findings

1. HoltraChem is a significant source of mercury emissions to the air in the state. Federal rules and current state and federal permits allow up to 1850 pounds of emissions of mercury per year. Due to the nature of HoltraChem's emissions, reliable estimates of the level of emissions are not known, though the company has dropped its reported estimate from 756 to 176 pounds per year.[24] DEP has not been able to verify these reductions.

2. HoltraChem is the only permitted source of mercury in wastewater in the state.

3. Historical and current operations of the HoltraChem facility have resulted in chronic unpermitted releases of mercury to the environment.

4. HoltraChem has made some efforts to achieve reductions in air and water discharge compliance, and has committed to doing more.

5. HoltraChem may be subject to a mercury federal rule change by the year 2000.

6. The HoltraChem site is highly contaminated. Sediments below the facility in the Penobscot have the highest levels of mercury reported in the state and possibly in the country.

7. White perch in lakes downwind of HoltraChem have levels of mercury higher than average statewide levels to a degree considered statistically significant.

8. DEP has the authority to impose controls on HoltraChem's wastewater and air emissions via permits. Controls will be based on best practical technology currently available. Alternatively, controls could be established via legislation.

9. Nonpoint source runoff from the HoltraChem site, and discharges from contaminated groundwater cause additional mercury discharges to the Penobscot River.

[24] Neither the new emissions estimate of 176 lb./yr. or the earlier estimate of 350 lb/yr. have been verified by DEP.

Recommendations

1. A mass balance analysis should be required of HoltraChem to determine how much mercury is coming into and leaving the plant via all routes as a result of current operation of the facility.[25]

2. Statutory changes or new permit limits should be established to achieve significant reductions in discharges to air and water. The statutory grandfathering of the facility's wastewater discharge of mercury should end.

3. Remedial actions involving on-site soils, contaminated sediments and landfills should proceed as quickly as possible.

4. EPA should be encouraged to develop a National Emissions Standard for Hazardous Air Pollutant (NESHAP) and/or a Maximum Available Control Technology (MACT) standard for chlor-alkali facilities to require significant reductions nationwide.

5. Actions should be taken to reduce mercury use at the HoltraChem facility.

[25]Department of Economic and Community Development Commissioner, Thomas McBrierty supported the goal of this recommendation, but preferred the use of permit or regulatory mechanisms rather than legislation, to achieve it.

IV. PRELIMINARY STRATEGIC PLAN

A. NATIONAL CONTEXT

As part of the research to develop recommendations, the State Planning Office conducted a brief survey of other states that have adopted plans or strategies to address mercury contamination. This research found that there are a number of other states that have adopted goals and strategies to reduce mercury contamination. A summary follows.

The Great Lakes region seems to have moved the farthest in developing controls for mercury. "A Bi-National Program to Restore and Protect the Lake Superior Basin" agreement was signed in 1991 by the governors of the Great Lake States and adjacent Canadian Provinces to reduce mercury emissions to zero. The bi-national agreement has set a goal to reduce the use and release of mercury by 60 % by 2000, by 80% by 2010, and virtual elimination of inputs by 2020 from 1990 levels. The agreement contains 45 action items aimed at reducing toxic pollution. Minnesota and Michigan have adopted strategies to achieve the goals in the agreement. Some of the key state strategies being pursued are as follows:

Minnesota published a 1994 report entitled "Strategies for Reducing Mercury in Minnesota" that contains the following strategies: pollution control; energy conservation; reducing or eliminating mercury use; and recycling products that contain mercury. The Plan includes specific actions to: prohibit mercury in batteries sold in Minnesota; ban disposal of fluorescent lamps; limit mercury emissions from incinerators; prohibit mercury-containing substances in packaging material; and encourage product stewardship by manufacturers.

Michigan has a Mercury Pollution Prevention Task Force that issued a 1996 report, listing six strategies: education and outreach; improve the mercury inventory and database; evaluate the collection and recycling systems; provide incentives for utilities to reduce mercury emissions; adopt new mercury legislation; and improve mercury pollution prevention efforts.

Michigan's report also offers 45 recommendations, including: a comprehensive state-wide education campaign to divert mercury from the waste stream; a phase-out of mercury-containing products in the health care industry; encourage the voluntary use of dental amalgam alternatives; ensuring compliance with Michigan's battery law; encouraging the voluntary use of pollution prevention methods by the chemical industry; providing additional state resources for mercury pollution prevention; and creating an Energy Bank to finance energy audits.

Wisconsin is focused on research in the following areas: lake trout; air monitoring; biogeochemical fate of mercury in north central Wisconsin lakes; sampling of 39 river sites; lake sediments in northern lakes; bio-accumulation of mercury in fish, and wildlife; and human health studies.

In the Northeast, Massachusetts and New Jersey have adopted strategies to reduce mercury and New Hampshire is developing a similar strategy. Other states have taken some actions to address mercury as well, but not as part of a coordinated strategy. Key initiatives in other states:

Massachusetts' strategy focuses on reducing mercury from the municipal waste stream and health care facilities. The following actions are included: legislation to ban mercury containing batteries; pilot programs to recycle mercury containing lamps, batteries, switches, thermometers; pollution prevention outreach to hospitals and health care facilities; solid waste reduction and recycling; best available control technology for air emissions from municipal waste combustors; workshops and technical assistance for municipalities; and adoption of EPA's Universal Waste Rule.

New Jersey's mercury reduction strategy also focuses on mercury-containing products flowing into municipal solid waste incinerators. Specific actions: remove mercury- containing products from municipal solid waste; dry cell battery management law; toxic packaging reduction law; reduction of mercury products discarded from hospitals and health care facilities; air pollution controls on sewage sludge incinerators; reduce mercury products from hazardous waste incinerators, and increase the use of air pollution control technologies.

New York is taking the following actions to reduce mercury: a ban on burning of mercury or Ni-Cd containing batteries; ban on the sale of alkaline and zinc carbon batteries; limits on mercury in packaging; technical assistance to municipalities; continue carbon injection flue gas controls at the Onondaga Resource Recovery Facility, and adopt EPA's Universal Waste Rule.

Other states

Florida The Florida DEP's Strategic Plan has set a goal to reduce mercury in solid waste by 50% by 2000 from 1995 levels. This initiative also proposes the following laws to control and reduce mercury: environmentally-sound management of mercury-containing devices and lamps; elimination of toxics including mercury from packaging; and collection and recycling of mercury -containing batteries.

B. MAINE'S POLICY FRAMEWORK: OVERALL GOAL AND PROPOSED OBJECTIVES

The Land and Water Resources Council has begun to develop a policy framework for addressing mercury in the state.

The policy framework will ultimately consist of three parts:

- an overall goal, which sets forth the direction in which the State wishes to move;
- a set of measurable objectives, which set interim milestones and measurable targets for the achievement of that goal; and
- identification of preferred strategies to realize those objectives.

1. GOAL

All inhabitants of the State of Maine will enjoy an environment free of restrictions in activity or food source due to unhealthful levels of bioaccumulating, persistent toxic chemicals, including mercury. Mercury levels in sediments, soils, fish and wildlife will not exceed thresholds where adverse health effects are expected for terrestrial, aquatic or marine life.

2. PROPOSED OBJECTIVES

The two objectives proposed reflect both a recognition of the major way mercury enters Maine's environment, and the most tangible and immediate impact that mercury has on Maine's population, both human and wildlife.

Less mercury will be discharged – By 2002, the levels of mercury discharged to Maine's environment by all major sources – municipal, industrial, and commercial – will be substantially reduced, compared to levels in a baseline year set in 1998.

Discussion:

As discussed in Chapter III, the principle contribution of mercury to Maine's environment is through air emissions from a variety of sources. State and federal control strategies on municipal waste combustors and industrial sources will be aimed at reducing those emissions in the near-term. Progress against this objective will be measurable via actual emissions reported in DEP's biennial air emissions inventory. DEP will establish specific measurable objectives in 1998 which will be included in the next report to the legislature.

Reductions will also be sought in Maine's one permitted water discharge (HoltraChem) and in any unpermitted discharges which are identified through monitoring. The ultimate target of these reductions should be zero discharge of mercury to state waters. A timeframe for achieving this target will be set in 1998 and included in the next report to the legislature.

Fish consumption advisories will be lifted -- [specific target and baseline will be identified in 1998.]

Discussion:

Since the primary pathway for human exposure is through the consumption of mercury contaminated fish, reducing levels of mercury in fish below advisory thresholds is a key measurable objective. Due to a complete absence of data regarding the time involved in reducing mercury levels in fish based on source control strategies, no timeframes have been set at this time.

Since mercury-related advisories have been issued statewide based on limited data, additional water-body specific sampling may enable the state to identify areas where less restrictive or no advisories are needed. Targets and timetables for achieving additional sampling and potential modification of advisories will be established in 1998.

C. STRATEGIES AND PRELIMINARY ACTION PLAN[1]

Strategy 1:
Reduce air emissions discharges from Maine's largest mercury sources.

Discussion:

As Chapter III explains, the largest source of mercury air emissions in Maine come from HoltraChem and municipal waste combustors. State rulemaking will be utilized to achieve reductions at the two in-state waste to energy facilities which emit significant levels of mercury.

No federal or state rules currently require air emission reductions at HoltraChem.

Industrial and/or utility boilers utilizing coal or oil can achieve reductions through fuel switching, particularly as natural gas becomes available.

Proposed Actions:

- **Rule-making for large municipal waste combustors (MWCs)** -- DEP will complete the rulemaking for these Maine sources, imposing the most stringent standard acceptable to the Board of Environmental Protection based on public comment. DEP has proposed a standard more stringent than the Federal rule; this proposal was posted for public comment on 12/17/97. Three of Maine's MWCs will be subject to this new standard. Maine Energy and PERC already have the capability to meet it; RWS will have to employ new controls. Compliance with the new standard would be expected in the year 2000.

- **State standard for small MWCs.** Currently, Mid-Maine Waste Action Corporation (MMWAC) is not required to comply with either federal or state standards for mercury emissions; federal standards are anticipated, albeit not for several years. DEP will initiate a rule-making process to develop a state standard for this facility. DEP will consult with other New England states and with EPA to try to avoid subjecting the facility to a second round of controls when federal requirements kick in.

- **Funding assistance.** DEP will explore with the legislature whether funding assistance for RWS and MMWAC are warranted.

- **HoltraChem.** DEP will pursue reductions in allowable emissions through permit modification or legislation. DEP will participate in federal rule development for this sector, pushing for a national standard which will achieve the greatest reductions. Efforts will be made to identify strategies, including federal action, which would move the industry toward mercury-free processes, including financial assistance to achieve such a transition.

---

[1]By formal action, January 26, 1998, the Land and Water Resources Council approved this report, and its recommendations, for submission to the legislature. Department of Economic and Community Development Commissioner Thomas McBrierty supported the policy recommendations in this report, but voiced opposition to the pursuit of legislative action to achieve it.

- **Medical Waste Incinerators.** DEP and SPO will work with any medical waste incinerators which intend to continue operation to employ strategies to reduce use and incineration of mercury containing products.

- **Industrial and Utility Boilers.** DEP will investigate whether any incentives could be provided to coal-fired industrial and utility boiler operators to switch to alternative fuels.

Strategy 2:
Reduce and eliminate mercury discharges to state waters.

Discussion

HoltraChem is the only remaining licensed wastewater discharger of mercury in the state. Other unpermitted discharges may be occurring.

Proposed Actions:

- **HoltraChem.** Through permit modification or change of law, HoltraChem's authority to discharge mercury to Maine waters will end.

- **Unpermitted discharges.** DEP will give priority to identifying unpermitted mercury in wastewater effluent for testing and elimination through the effluent toxics wet testing program.

Strategy 3:
Divert mercury from the solid waste stream.

Discussion:

While national and regional data indicate that mercury is a declining component of the waste stream, it continues to be concentrated in landfills and air emissions from municipal waste combustion. In order to reduce this concentration, products containing mercury must be removed from the waste stream. As removing these products at the landfill or combustion plant is very difficult and inefficient, actions must be taken to reduce and divert these products before they enter the waste stream.

Achieving this will require the development of programs to reduce the use of mercury in products and other commercial/ industrial processes, in partnership with the largest manufacturers and users of products that contain mercury. Finally, while this pollution prevention strategy will require a host of sector-specific steps, it is the strategy that received the broadest support from all stakeholder groups and, as of January 1998, has the highest probability of immediate EPA support.

Proposed Actions:

- **Mercury-containing lamps.** DEP will give high priority to ensuring compliance with rules regarding disposal of mercury containing lamps. DEP will utilize education and assistance first, to ensure that there is knowledge of existing regulations and disposal options. Enforcement will be utilized as needed.

- **Other mercury-containing products.** To the extent practicable, DEP will utilize the existing mercury-containing lamp policy as a framework for the development of similar policies governing the recycling and/or disposal of other mercury-containing wastes: e.g. thermostats, switches, ballasts, mercury-containing laboratory preparations.

- **Sector-specific Mercury Pollution Prevention Partnerships.** DEP will seek funding for outreach efforts with appropriate trade associations for specific mercury-using audiences, targeting those which are determined to be the highest contributors of mercury to Maine's waste stream. Those which will be considered include: medical waste generators, including hospitals/labs, dentists and veterinarians; lighting and electrical contractors; heating/ventilation/AC contractors; and other mercury-using businesses.

  As part of these industry partnerships, DEP and SPO will seek funding for the publication of educational materials that will: a) provide alternatives to the use of mercury; b) educate on proper disposal, recycling of mercury; c) create industry-specific inventories of current mercury use and disposal practices; d) develop mercury disposal agreements with trade associations; and e) develop use-specific mercury collection programs.

- **Mercury-containing battery disposal.** DEP and SPO will collaborate to determine the level of compliance with the existing law requiring the collection of mercuric oxide and rechargeable batteries in the state.
  - ⇒ DEP and SPO will work with battery manufacturers to determine the extent to which other battery types sold in the state contain mercury and to determine if other types of batteries should be diverted from the solid waste stream.
  - ⇒ DEP and SPO will seek the cooperation of the Maine Municipal Association to develop a "user-friendly" battery collection system that builds on existing municipal recycling programs, while taking into account the special hazards posed by these wastes. Funding will be sought to conduct a pilot program for a collection system to recycle batteries in at least one community for broader application in the state.
  - ⇒ As appropriate following the state inventory completed under Strategy 1, action will be taken to ensure that government agencies are disposing of batteries in compliance with the law.

- **Mercury in products.** DEP and SPO will explore with the legislature the legal viability and overall effectiveness of a state ban on non-essential mercury-containing products.

- **Mercury in packaging.** DEP will continue to implement federal and state laws which set limits on the mercury content in packaging.

Strategy 4:
Complete a Maine inventory and risk ranking

Discussion:

As discussed in Chapter III, the inventory of mercury sources in Maine is not complete and does not rank the risk posed by the various sources. By completing a full Maine inventory and risk assessment, DEP will build a solid basis for prioritizing future actions. DEP and SPO will

undertake the following actions as funding and staff resources allow. DEP has requested funding for these efforts from EPA and will pursue other sources.

Proposed Actions

- **Local emissions monitoring.** Emissions sampling to verify national emissions factors against Maine sources will be conducted at sources likely to be significant based on emission factors.

- **Waste characterization.** DEP and SPO will use models from other New England states to identify sectors of Maine commerce where mercury use is highest. As resources allow, DEP and SPO will undertake a study of the mercury levels in Maine solid waste.

- **"Clean State" mercury inventory.** As resources allow, DEP will work with other state agencies under the "Clean State" Initiative, to complete a comprehensive inventory of mercury use, including recycling and disposal practices. Depending upon the findings from this effort, DEP may recommend additional pollution prevention activities aimed at state agencies.

- **Residential wood combustion.** Research into mercury from residential wood combustion of Maine tree species is beginning at the University of Maine in Orono. DEP will pursue both possibilities for regional and national collaboration and additional funding to supplement UMO's research efforts.

- **Risk ranking.** DEP and SPO will develop a risk ranking of significant mercury sources, based upon both levels released to the environment and the human/wildlife implications of exposure pathways.

- **Economic effects.** As resources allow, DEP and SPO will undertake an analysis of the economic effects associated with mercury in Maine's environment. This study will examine such issues as the economic impacts of the fish consumption advisories, and the implications of continued ecological effects due to mercury contamination.

Strategy 5: Expand fish sampling.

Discussion:

As discussed in Chapter II, currently available data on mercury levels in fish in state waters suggests that fish consumption advisories could be lifted or relaxed on certain water bodies if additional water body specific sampling were undertaken. Sampling should be conducted to identify the lakes where fishing without restrictions could be safely conducted. Some funding (approximately $100,000) and staff support for the initial years of this effort will come from the Surface Water Ambient Toxics Program (SWAT). A cost-sharing program in conjunction with lake associations or municipalities may be utilized to extend state dollars and to conduct sampling in areas where local interest is greatest.

Proposed Actions:

- **Expanded sampling plan.** Under the guidance of the SWAT monitoring program, DEP will design an expanded sampling plan to yield a) indicator species and b) priority lakes/areas for lake-specific fish consumption advisories.

- **Use of volunteers** to assist in sampling and extend state resources will be explored.

Strategy 6:
Continue remediation activities at mercury contaminated sites.

Discussion:

As discussed in Chapter III, DEP has significant authority for the clean-up of sites contaminated with mercury due to either historical or present-day activities. Under this strategy, DEP will evaluate any sites known or suspected to be contaminated with mercury for priority remedial action.

Proposed Actions:

- **Contaminated sites.** DEP will push for prompt remedial action at HoltraChem and any other site in the state where soil or sediment contamination warrants.

- **Contaminated sediments.** DEP will work with the EPA, other states, the University of Maine, responsible parties and others to identify successful methods for remediation of contaminated sediments in lakes, rivers and marine settings.

Strategy 7:
Develop regional and national strategies to further reduce mercury emissions and mercury-containing products.

Discussion:

As discussed in Chapter II, mercury deposition in Maine comes from regional, national, and global air emission sources. For this reason, Maine's must pursue reductions in upwind states and in Canada. Ultimately, to address the global circulation of elemental mercury, an international effort is required.

To reduce and eliminate mercury as a component of commercial products and Maine's waste stream, national legislation or regulatory controls will be needed.

Proposed Actions:

- **Regional/national collaboration.** Governor King will host a workshop of environmental officials from New England and Canada in February 1998 to develop a regional strategy for mercury controls. The Governor is expected to charge the participants to examine several possible components of that strategy, possibly to include:

⇒ Development of a plan leading to mercury emission standards and/or a national cap on mercury emissions from key sectors (e.g., utilities and other industrial sectors).

⇒ Collective endorsement of prompt EPA action to develop emission control requirements for the utility sector on a parallel track with reductions of ozone precursors.

⇒ Implementation of trading in emission reduction credits, with an eye toward balancing the savings in cost of control with environmental justice issues.

DEP will press other states and Canada to go beyond Federal standards in controlling mercury emissions from waste to energy facilities and will lead efforts to gain consensus on a regional strategy to control emissions from small MWCs not currently subject to federal rules.

Regional and national collaboration in several key research areas will also be pursued by DEP. Topics include: mercury deposition and transport b) predictive models for mercury in lake sediments and fish; and c) mercury contributions from residential wood combustion.

- **Federal legislation.** The Land and Water Resources Council is evaluating MERCURI, the federal bill cosponsored by Maine Congressman Tom Allen, with an eye toward identifying elements which will support Maine's efforts. The Council will work with Maine's Congressional delegation to refine the bill and gain passage of legislation which will benefit Maine and national interests.

- **Sale of mercury stockpiles.** The U. S. Department of Defense is considering the sale of significant stockpiles of mercury. State officials have expressed Maine's position, that this volume of mercury should not be reintroduced to the market, to be used in products that will ultimately enter the waste stream. DEP and other state agencies, in collaboration with other states as possible, should continue to communicate this position to federal officials.

- **Mercury-free products.** DEP should push for national legislation or rules to limit the unnecessary use of mercury in products such as sneakers, toys, and other consumer goods.

Strategy 8:
Urge federal agencies to adopt a single health-based dose response standard for mercury contamination in fish.

Discussion:

Maine officials had hoped that publication of the EPA's Mercury Study Report to Congress would clarify the present discrepancy in health-based standards for mercury contamination in fish. As discussed in Chapter III, the setting of different action levels and the consequent can significantly affect the fish consumption advisories in Maine and the actions required to address them.

Proposed Actions:

- **Federal consensus.** State officials should call on the Vice President to convene all relevant federal agencies to adopt a single dose response threshold.

Strategy 9:
Focus biological research on the effects of mercury on the health of loons, fish, and other wildlife with elevated mercury levels.

Discussion:

As noted in Chapter II, research to date has focused primarily on documenting the presence of mercury in fish and wildlife. Far less research has been done on the immediate and long-term effects of mercury contamination, for example in terms of species vulnerability to predation and lower reproduction rates.

Proposed Actions:

Research funded by the Surface Water Ambient Toxics program and other collaborative efforts will include projects aimed at documenting any reproductive or other effects which may be associated with elevated mercury levels. In addition, the state will begin to seek ways to document improvements in fish and wildlife effects following reduction of mercury loading.

Strategy 10:
Assess and implement strategies to communicate fish consumption advisories to key population segments.

Discussion:

As noted in Chapter II, additional study is needed to effectively communicate Maine's fish consumption advisories. Research is needed on the effectiveness of various communication strategies, including posting by lakes, literature in doctors' offices, and publication in the biennial fishing rule book.

Proposed Actions:

The Bureau of Health will continue to work with the federal government, other states and interested parties on this issue. Efforts will be made to develop a risk communication strategy which informs people of both the health benefits of fish consumption and the risks associated with concentrations of toxics in fish. Specific strategies will be developed to reach the populations most at risk for mercury-related health effects, women of child-bearing age, children and other sensitive individuals.

Appendix 1

Legislative Mercury Resolve

APPROVED

MAY 30'97

BY GOVERNOR

CHAPTER

41

RESOLVES

STATE OF MAINE

IN THE YEAR OF OUR LORD
NINETEEN HUNDRED AND NINETY-SEVEN

S.P. 580 - L.D. 1745

Resolve, to Direct the Land and Water Resources Council to Develop a Report and Proposed Actions to Control Mercury Emissions and Discharges

Emergency preamble. Whereas, Acts and resolves of the Legislature do not become effective until 90 days after adjournment unless enacted as emergencies; and

Whereas, the 116th Legislature established the Land and Water Resources Council, in part to study specific water resource management issues and problems of statewide significance and formulate policies that achieve the goal of protecting the quality of Maine's water resources; and

Whereas, mercury is a persistent, bioaccumulative and highly toxic metal that is found in air emissions and water discharges from various facilities both within Maine and beyond its borders; and

Whereas, mercury contamination from discharge and deposition has caused fish consumption advisories in Maine water; and

Whereas, in the judgment of the Legislature, these facts create an emergency within the meaning of the Constitution of Maine and require the following legislation as immediately necessary for the preservation of the public peace, health and safety; now, therefore, be it

Sec. 1. Report and recommendations. Resolved: That the Land and Water Resources Council shall develop a long-range strategy to evaluate and reduce the levels and sources of mercury contamination affecting Maine's environment. The council shall seek the advice and support of the Maine Environmental Priorities

Project, Legislators, the Federal Environmental Protection Agency and other groups in completing this task. The strategy includes, but is not limited to, the following:

1. A description of the levels and locations of mercury contamination that are known or suspected to exist in Maine's environment;

2. A survey of sources and quantities of mercury discharged to or deposited into Maine's natural resources. This survey should include both in-state and out-of-state sources and estimates of relative contribution;

3. Recommendations for further data acquisition, if necessary; and

4. Recommendations for regulatory, legislative, pollution prevention or technical assistance actions to reduce mercury contamination; and be it further

Sec. 2. Report. Resolved: That the evaluation and recommendations of the Land and Water Resources Council on mercury be part of its annual report to the joint standing committee of the Legislature having jurisdiction over natural resource matters. The council shall report its initial evaluation and recommendations as part of its January, 1998 annual report; and be it further

Sec. 3. Legislation. Resolved: That the Joint Standing Committee on Natural Resources may report out legislation regarding the reduction of mercury emissions and discharges to the Second Regular Session of the 118th Legislature.

Emergency clause. In view of the emergency cited in the preamble, this resolve takes effect when approved.

Appendix 2

Activities Undertaken Under Mercury Resolve

Activities Undertaken Under Mercury Resolve

The following tasks have been undertaken or continued in the seven months since the Resolve was approved:

1. DEP, the Bureau of Health and the State Planning Office (SPO) have compiled information on ongoing research efforts and their findings regarding the levels and sources of mercury contamination in the state and risks posed to the health of Maine's people, its fish and its wildlife.

2. DEP has participated in development of an inventory of mercury sources and deposition within the Northeast region. This regional inventory, discussed further in Chapter III, is expected to be finally released in February, 1998.

3. SPO has conducted a survey of selected states that are developing mercury strategies. A summary of the findings from this effort is included in Chapter IV.

4. DEP, SPO and the Bureau of Health briefed and consulted with the Land and Water Resources Council on this information. Specific briefings were conducted as part of the LWRC's monthly meetings from August through January 1998.

5. DEP, SPO and the Health Bureau briefed and consulted with the Maine Environmental Priorities Council and members of the Joint Standing Committee on Natural Resources on this information and on the progress of this initiative on November 7, 1997.

6. DEP staff participated in a seminar on mercury at the Maine Audubon Society on December 2, 1997. At that session, DEP Commissioner Sullivan presented draft findings relating to the Mercury Resolve.

7. DEP conducted a study of mercury concentrations in fish from the region downwind of HoltraChem. That study is discussed in Chapter IV and II and is attached as Appendix 5.

8. DEP invited comment and specific feedback on the priorities to be accorded different mercury control strategies at a half-day meeting December 5, 1997. Participants included members of the Land and Water Resources Council, the Maine Environmental Priorities Council, the Joint Standing Committee on Natural Resources and other interested parties.

9. DEP has included mercury as an emerging issue in its Performance Partnership agreement with the EPA and has consulted with the federal agency on a variety of related issues. During the year, DEP urged EPA to release its report to Congress on mercury through formal and informal communications.

10. DEP, SPO, and the Bureau of Health have jointly assembled this report to summarize the information, findings and preliminary recommendations of this initiative.

11. Since no funding was provided to implement this effort under the Mercury Resolve, DEP has relied on existing resources in state government to prepare this initial report. DEP has begun pursuing funding for the implementation of proposed action items, has submitted one proposal to EPA and is investigating other sources.

Appendix 3

List of Contributors

List Of Contributors

A host of people have contributed to the preparation of this report, and to the continuing technical and policy discussions that have preceded and shaped it. Thanks are due to all of the following individuals, without whose contributions this initiative would not have been able to move forward:

Principal Writing Team

Dave Courtemanch, DEP
Ellen Doering, DEP
Bill Ferdinand, SPO
Deb Garrett, DEP
Mark Margerum, DEP
Erika Morgan, DEP
Barry Mower, DEP
Andy Smith, Bureau of Health
Ned Sullivan, DEP
Barbara Welch, DEP
Karl Wilkins, DEP

Project Coordinator

Erika Morgan

Technical Contributors

Al Ball, DEP
Jim Brooks, DEP
Dave Courtemanch, DEP
Ellen Doering, DEP
Bill Ferdinand, SPO
Martha Kirkpatrick, DEP
Stacy Ladner, DEP
Mark Margerum, DEP
Erika Morgan, DEP
Barry Mower, DEP
Doug Saball, DEP
Andy Smith, Bureau of Health
John Sowles, DEP
Ned Sullivan, DEP
Hank Tyler, SPO
Barb Welch, DEP
Karl Wilkins, DEP

In addition to those listed above, a significantly larger number offered comment to the development of the findings, recommendations, objectives, strategies and actions described in this report. In addition to monthly meetings of the Land and Water Resources Council, two separate meetings were held November 7 and December 5, 1997. Invitees to these meetings included the Maine Environmental Priorities Council, Land and Water Resources Council and the Joint Standing Committee on Natural Resources.

Land and Water Resources Council:

Evan Richert, State Planning (Council Chair)
Lee Perry, IF&W
Ron Lovaglio, DOC
Ed McLaughlin, AGR
John Melrose, DOT
Kevin Concannon, DHS
Ned Sullivan, DEP
Robin Alden, DMR
Thomas McBrierty, DECD

Project contributors

Bill Ferdinand, State Planning
Clough Toppan, Dept. Health
Fran Rudoff, State Planning
Hal Winters, Dept. Marine Resources
John DelVecchio, State Planning
Kathleen Leyden, State Planning
Mark DesMeules, State Planning
Martha Kirkpatrick, Dept. of Environmental Protection
Paula Valente, Me. Municipal Assoc.
Warren Foster, Dept. of Transportation
Chris Hall, Maine Chamber & Business Alliance
Henry Nichols, State Planning
William Nichols

Attendees at the November 11, 1997, Mercury Technical Briefing:

Albert Curran, Woodard & Curran
Andrew Hamilton, Eaton, Peabody
Barry Mower, DEP
Carol Blasi, Conservation Law Foundation
David Bois, Dragon Products Co.
Deb Garrett, DEP
Ed Logue, DEP
Erika Morgan, DEP
Hank Tyler, State Planning
Mark Margerum, DEP
Mic Lebel, Maine Pulp & Paper Assoc.
Ned Sullivan, DEP
Phil Haines, Dept. of Human Services
Senator John Nutting
Sharon S. Tisher, MEPC
Thomas Fusco, MEPC
Amy Holland, Policy & Legal Analysis
Andy Smith, Bureau of Health
Brian Stetson, Great Northern Paper
Chris Hall, Me Chamber & Business Alliance
David Keeley, State Planning
Doug Saball, DEP
Ellen Doering, DEP
Fred Hurley, Dept. Inland Fisheries & Wildlife
Karl Wilkins, DEP
Marquita Hill, University of Maine
Peter Mosher, Dept. Agriculture
Pamela Person, Coalition for Sensible Energy
Representative June Meres
Senator Sharon Treat
Ted Koffman, College of the Atlantic
Thomas Urquhardt, Maine Audubon Society

List Of Contributors

A host of people have contributed to the preparation of this report, and to the continuing technical and policy discussions that have preceded and shaped it. Thanks are due to all of the following individuals, without whose contributions this initiative would not have been able to move forward:

Principal Writing Team

Dave Courtemanch, DEP
Ellen Doering, DEP
Bill Ferdinand, SPO
Deb Garrett, DEP
Mark Margerum, DEP
Erika Morgan, DEP
Barry Mower, DEP
Andy Smith, Bureau of Health
Ned Sullivan, DEP
Barbara Welch, DEP
Karl Wilkins, DEP

Project Coordinator

Erika Morgan

Technical Contributors

Al Ball, DEP
Jim Brooks, DEP
Dave Courtemanch, DEP
Ellen Doering, DEP
Bill Ferdinand, SPO
Martha Kirkpatrick, DEP
Stacy Ladner, DEP
Mark Margerum, DEP
Erika Morgan, DEP
Barry Mower, DEP
Doug Saball, DEP
Andy Smith, Bureau of Health
John Sowles, DEP
Ned Sullivan, DEP
Hank Tyler, SPO
Barb Welch, DEP
Karl Wilkins, DEP

Appendix 4

Mercury Contaminated Sites

Mercury Contaminated Sites

HOLTRACHEM CHEMICAL COMPANY: A chlor-alkali manufacturing facility in Orrington. Substantial contamination as identified in this report in great detail.

VAN BUREN MADAWASKA CORP.: Board dipping operation at a former saw mill, North of Van Buren on the St. John River. The fungicide mixture contained mercury and the site had a remediation effort in 1991 by the Irving Corporation.

THE PHILIPS ELMET SITE: A long time electric light manufacturing facility in Lewiston. The site assessment was conducted by a consultant and according to the report residual mercury had been removed by a contractor. Any remaining residual mercury is probably contained in the clay underlayment and building foundation.

PORTSMOUTH NAVAL SHIPYARD: The naval shipyard is under going remediation activities in their landfill area and one of the two mercury vaults have been removed. The second vault will be addressed next year upon completion of the overall site investigations.

MERCURY SPILLS: A large amount of elemental mercury was found along the Royal River in Yarmouth in the late '70's or early '80's. Memory of a responder indicated that the majority was cleaned up but the written record is missing.

MILLER INDUSTRIES - Juliette Mill: Approximately 100 pounds of mercury contaminated soil and 50 pounds of elemental mercury was cleaned up as the result of children breaking mercury manometers in the basement of the mill.

BOISE CASCADE: Now the Mead facility in Rumford. Between 1910 and 1970, a chlor-alkali plant operated and unknown concentrations of mercury contaminated debris was put into the Farrington Mountain landfill upon closure. Soil and groundwater in the area is contaminated. Other work on the site in 1983 and 1985 caused contaminated materials to be put into the Norridgewock and Farrington landfills. Additional investigation on the site in 1989 and 1990 indicates that contamination may have consolidated in free product at specified depths. EPA has issued a letter indicating no further action is needed at the site. DEP is assessing the need for a corrective action work plan in the near future.

WOLMAN STEEL, WATERVILLE: Reported in the "Sources of Mercury to Land and the Waste Stream" section of this report.

The vessel, EMPIRE KNIGHT, off the coast of York, Maine at Boon Ledge, reported in the " Sources of Mercury Discharged to Water" section of this report.

Appendix 5

Mercury Contamination in Lakes

MERCURY CONTAMINATION IN LAKES DOWNWIND OF HOLTRACHEM MANUFACTURING CO.

David L. Courtemanch, Ph.D.
John Hopeck, Ph.D.
Bureau of Land and Water Quality
and
Kevin Ostrowski
Bureau of Air Quality

Maine Department of Environmental Protection

1997

Introduction

The report on *Fish Tissue Contamination in Maine Lakes* (Mower et al., 1997, referred to as the REMAP study) found widespread mercury contamination in fish tissue throughout the state. This contamination is attributed to mercury deposition from air emission sources within and outside the state. Initial review of that data suggested that there may be higher contamination in lakes east of Penobscot Bay (fig. 1). Since three significant air contamination sources of mercury are situated next to the Penobscot estuary, interest was focused on the contribution of small local emission sources. Further examination of that data, however, did not provide convincing evidence that these sources were discernible because the data included lakes that were widespread and variously affected by the local emissions and included different species and size classes of fish that significantly determines mercury concentrations in the tissue. Therefore, a second study was conducted that focused on determining if lakes are measurably affected by small local sources of mercury. This study used a targeted sampling strategy, rather than the randomized approach used in REMAP, and employed a more standardized sampling design.

Study Methods and Lake Selection

The primary subject of the study was the effect of the HoltaChem facility on downwind lakes. This is one of the largest mercury emission sources in the state (reported at 760 lbs/year in 1992), however, other local sources (PERC 10 lbs/year, Champion International, 50 lbs / year) may also contribute mercury to lakes in the area.

Lakes were selected using a modeling analysis (*Results from an ISCST3 Mercury Dry Deposition Modeling Analysis in the Eastern Maine Area*, DEP 1996). The model uses air emission data and characteristics, meteorological data and particle behavior to predict areas of high relative deposition[1]. Lakes within a 25 km radius of the facility with the highest modeled deposition rates were selected for the study (Table 1, Fig. 2). Lakes were also selected based on the availability of a common species. In this study, white perch were selected since they were available in many of the lakes, were known from the REMAP study to typically have greater concentrations of mercury than other species and are an important sport fishing species. Eight lakes were finally selected in the towns of Orrington, Bucksport and Dedham that represent higher expected deposition and that could provide comparable fish data (Table 1, Fig. 3). Two lakes, Fields Pond and Jacob Buck Pond had been part of the REMAP study, however, white perch data was only collected for Jacob Buck in that study. The REMAP sediment data was used for these ponds and the white perch data for Jacob Buck was included along with the white perch caught in 1996 for this study. White perch, sediment and water quality data were collected on the other lakes following the field methods described in *Fish Tissue Contamination in Maine Lakes, Data Report* (DiFranco et al., 1995)

---

[1]HoltraChem's emissions are primarily in gaseous form; however, a percentage of those are divalent and subject to local deposition. Though gaseous deposition will not necessarily be identical to particle deposition, this model was used as an indicator of where deposition might be expected.

Fish were collected by gillnet in 1996 and individual skinless filets were analyzed for mercury at the University of Maine environmental chemistry laboratory. Sediment mercury data and other water quality information were also collected for the study lakes and analyzed by the university laboratory. Analytical methods are described in *Fish Tissue Contamination in Maine Lakes, Data Report* (DiFranco et al., 1995)

For comparison, two data sets were used. First, the REMAP data were used to provide comparative sediment mercury information, and comparison of fish filet composites for those lakes in that study where white perch were sampled. Additionally, white perch were collected in another 18 lakes outside of the modeled area and were analyzed as individual filets (Fig. 4).

Results

Sediment: Distributions of the sediment data are presented in figures 5 and 6. Figure 5 presents all the lake data arranged in increasing concentrations. The Orrington-Bucksport lakes (in red) are above the 42nd percentile of sediment mercury concentrations from a random population of lake sediments. Figure 6 presents the data as interval data, again indicating that the Orrington-Bucksport lakes occur on the high concentration tail of the distribution. This distribution infers that these lakes may be exposed to a greater source of mercury, different from the rest of the Maine lake population. A T-test performed on the means of the two populations was significant ($\rho = 0.07$).

While the data suggests that HoltaChem contributes an additional load to the sediments of these lakes, this cannot be concluded. Other sources, such as geologic, also need to be considered. Preliminary review of available geologic data suggests that bedrock in the South Orrington - North Bucksport area is not likely to be a significant source of mercury for aquatic life and lake sediments. The majority of this area is underlain by the Passagassawakeag Gneiss, an amphibolite-facies quartz - plagioclase gneiss locally containing sillimanite and garnet; most other lithologies in this general area have been metamorphosed to a similar grade; these rocks underwent a high-grade metamorphism in the Silurian, and a lower -grade/retrograde metamorphism in the Devonian. Any lower-grade rocks are outside of the area of immediate concern. It is unlikely that a mercury-bearing ore body, or mercury-bearing metasediments, could have retained a significant amount of the metal at the metamorphic grades found in this area. Minerals which contain significant amounts of mercury, principally mercury sulfides or minerals with similar compositions, are stable only at temperatures well below the metamorphic temperatures of these rocks. Any mercury present in such minerals would most likely have been driven off. Post-metamorphic mineralization is not impossible, but data found thus far do not indicate metallic mineral occurrences in these rocks.

Although metallic minerals have been found in units to the south of this area, and it may be assumed that the rocks in the area of concern were relatively well explored for similarly mineralized zones. No reports describing metallic mineralization of this area, associated with either fluid motion on the Norumbega Fault Zone (last motion in the Carboniferous or later), Sunnyside Fault (Devonian and younger), or intrusion of the Lucerne Pluton (Devonian) or Mount Waldo Granite (Devonian) have been found thus far.

Fish tissue: Initially this study was planned to look at composite samples of white perch from the Orrington-Bucksport group of lakes and to compare these to white perch composites from the REMAP study. The Orrington-Bucksport fish were processed individually, then the results were composited for this analysis. Regression analysis combining these two data sets was performed and found that fish tissue levels were highly correlated with fish length and with lake location ($\rho<0.05$, $r = 0.7$). While this inferred that the Orrington-Bucksport populations may be different in their mercury concentrations, there were not many lakes for comparison in the analysis (only 9 lakes outside the Orrington area) and the composites used in the REMAP study sometimes mixed fish of considerably different size. Size (and age) are important factors in determining mercury concentration.

A second data set was collected from 18 lakes around the state that provided individual fish data, (i.e. specific size and mercury concentration values for each fish, $n = 242$). This removes the error associated with using an average size and an average mercury concentrations for each composite sample. The box plots in figure 7 provide a comparison of the mercury concentrations found between the two fish populations. The median value is noticeably higher for the Orrington-Bucksport lakes population. T-test performed on the means was significant ($\rho<0.001$). The difference between the means (0.31 mg/kg) is greater than the concentration recommended as a threshold for a fish consumption advisory for the most sensitive human consumer group (0.2 mg/kg for fetus and developing children).

Since size is a very important factor determining mercury concentration, distribution of mercury and length data presented in figure 8 provides a better representation of the mercury data between the two populations (Orrington-Bucksport lakes are represented by the pink squares). This plot indicates that the Orrington-Bucksport fish tend to contain higher amounts of mercury relative to their size than the other white perch in the state. Multivariate analysis was performed on this data. A number of variables known to be correlated with mercury concentrations in fish were included in the analysis. These included individual fish length, lake location (whether it was selected by the deposition model or not), water color (as a surrogate measure for dissolved organic carbon), pH, mean depth, drainage area, flushing rate, distance from HoltaChem, and direction from HoltaChem (ranked as percent frequency of wind direction). Simple regressions were performed on each variable to the log of the mercury concentration in the fish.

The highest correlation coefficients (r-values) were found for log of the fish length (0.59), lake location (0.43), and direction (0.41). Since the model uses prevailing wind data as an important factor in lake selection, lake location and direction from the source are intercorrelated. Direction was not used in later multiple regressions. Stepwise multiple regression was used to conduct the multivariate analysis. This analysis selected (in order of their contribution to the regression model) log of fish length, lake location, drainage area, pH, color and mean depth and yielded an r-value of 0.80.

Size (and age) of a fish is well known to be positively correlated to mercury concentration in fish tissue. Drainage area, pH, water color (dissolved organic carbon) and mean depth (which may also be a surrogate for temperature) are also known to be involved with delivery of mercury to a lake or in the methylation process that makes the mercury biologically available. For this study, lake location (those lakes selected by the deposition model to be most affected by the HoltaChem facility) appears to also be a very important variable to describe the mercury concentration in the fish samples.

Conclusions

Sediment mercury concentrations, collected in an area where mercury deposition is estimated to be greater (Orrington-Bucksport) than other areas of the state, show statistically greater mercury concentrations compared with lakes outside of the area.

Tissue mercury concentrations, in fish collected in an area where mercury deposition is estimated to be greater (Orrington-Bucksport) than other areas of the state, show greater mercury concentrations in the sampled population and greater mercury concentrations relative to size compared with fish outside of the area.

There are no known or anticipated natural sources of mercury that might account for the differentials observed between the Orrington-Bucksport group of lakes and other lakes located throughout the state.

Along with fish length, association with a known source (using distance and direction from the source along with characteristics of the emission) can be an important factor in determining the mercury contamination in sediment and tissue.

The HoltaChem facility may account for this differential between the lake populations since there are no other known sources of a similar magnitude and dispersion characteristics that would affect the lakes selected in this study. Effects from this source are detected downwind for a distance of at least 25 km.

Lakes associated with small local atmospheric mercury sources can have higher amounts of mercury in sediment and fish tissue. This increased amount does not require a more restrictive advisory (for white perch) but indicates that recovery time in the presence of the source is unlikely, and with removal may lag behind the recovery rate of other lakes.

Additional work

Continue to explore the relationship between lake factors and the concentrations of mercury in the fish. Assess waters in the state that may be affected by other small local mercury emitters.

Assess historical mercury loadings to the Orrington-Bucksport lakes in relation to other lakes in the state using dated cores from the lake sediments or local ombrotrophic peat deposits. (Proposal in development with the University of Maine Water Research Institute).

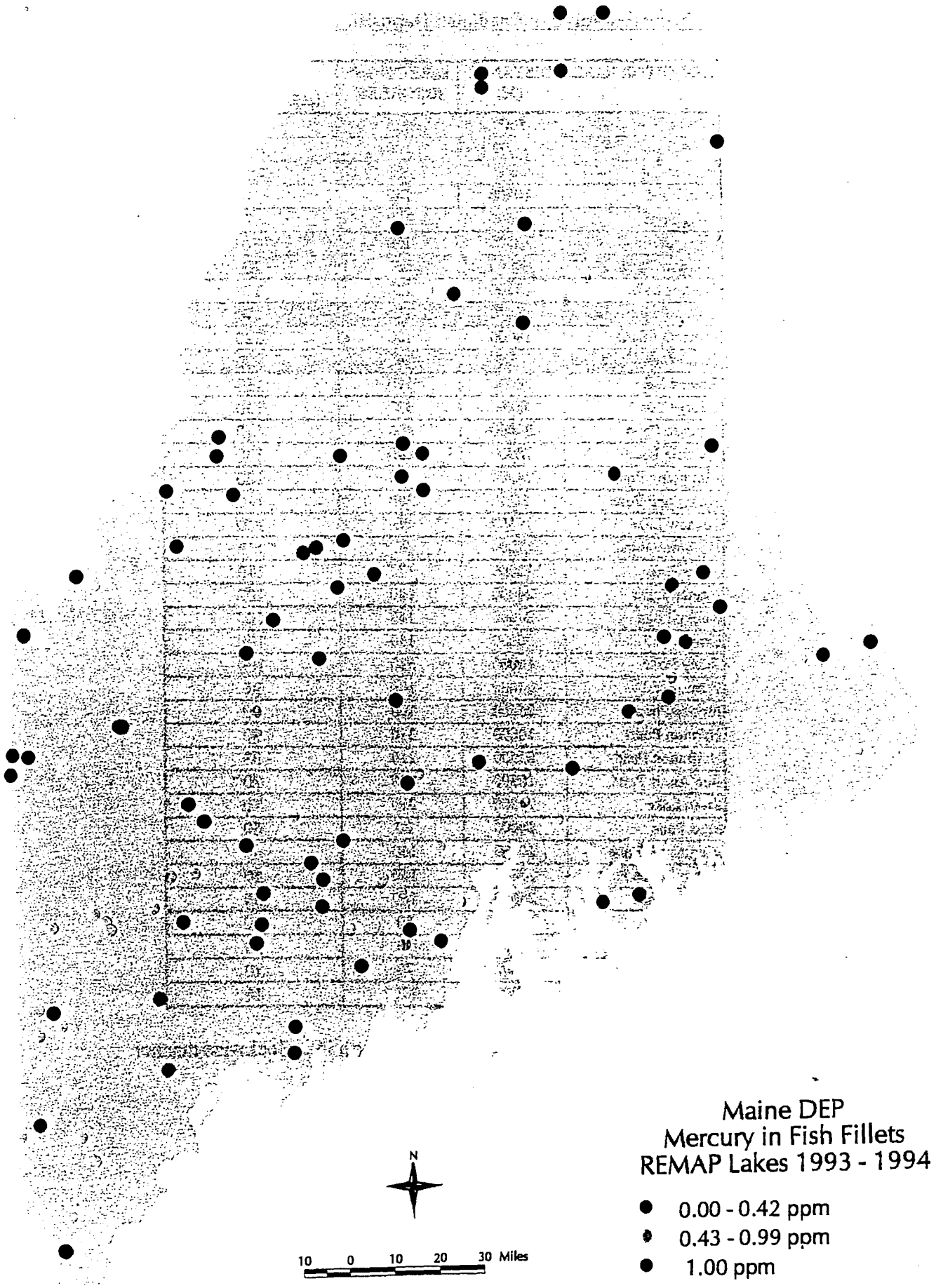
Citations

DEP, 1996. *Results from an ISCST3 Mercury Dry Deposition Modeling Analysis in the Eastern Maine Area*, Maine Department of Environmental Protection, Bureau of Air Quality, Augusta, ME 12p.

DiFranco, J., L. Bacon, B. Mower, and D. Courtemanch 1995. *Fish Tissue Contamination in Maine Lakes, Data Report.* Maine Department of Environmental Protection, Augusta, 120p.+app.

Mower, B., J. DiFranco, L. Bacon, D. Courtemanch, V. Schmidt and J. Hopeck 1997. *Fish Tissue Contamination in Maine Lakes*, Maine Department of Environmental Protection, Augusta, ME DEPLW97-6, 63p.

Figure 1

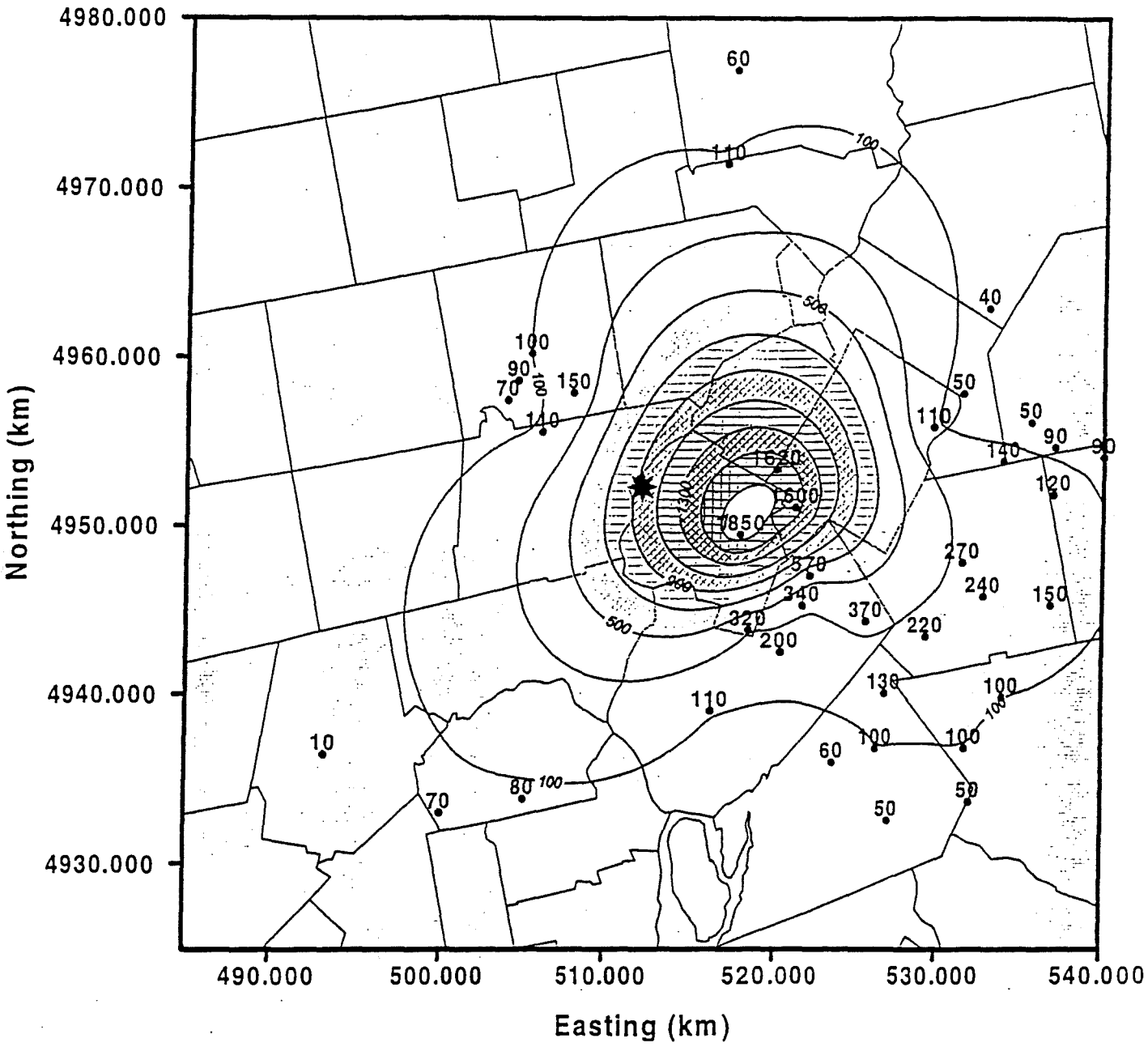


vls 97

5-Year Cumulative Predicted Depositions at All Discrete Receptors

RECEPTOR NAME	DISTANCE (M)	DIRECTION* (DEGREES)	DEPOSITION ($\mu g/m^2$/5-years)
Swetts Pond	5000	150	1850
Fields Pond	6000	100	1620
Brewer Lake	8000	120	1600
Mud Pond	10500	140	570
Long Pond	14500	130	370
Thurston Pond	11000	150	340
Williams Pond	10000	160	320
Phillips Lake	18500	120	270
Goose Pond	19500	120	240
Harriman Pond	18000	130	220
Jacob Buck Pond	12000	160	200
Greene Lake	24000	120	150
George Pond	8000	320	150
Hatcase Pond	20000	100	140
Hothole Pond	18000	150	130
Mountany Pond	24000	110	120
Hammond Pond	8000	290	110
Pushaw Lake	19000	20	110
Holbrook Pond	17000	90	110
Silver Lake	15000	170	110
Branch Lake	24000	140	100
Rocky Pond	24000	140	100
Craig Pond	20000	150	100
Tracy Pond	10000	320	100
Burnt Pond	24000	100	90
Floods Pond	25500	100	90
Hermon Pond	10000	310	90
Halfmoon Pond	22500	210	80
Ben Annis Pond	10500	290	70
Swan Lake	24000	210	70
Mud Pond	24000	20	60
Alamasook Lake	20000	160	60
Upper Patten Pond	27000	150	50
Toddy Pond	25000	160	50
Davis Pond	19000	80	50
Fitts Pond	22000	90	50
Chemo Pond	21500	70	40
Toddy Pond	27000	230	10

* Direction units are in degrees from true north in a clockwise manner



Dry Deposition Isopleths (ug/m²/5-years)

Figure 3

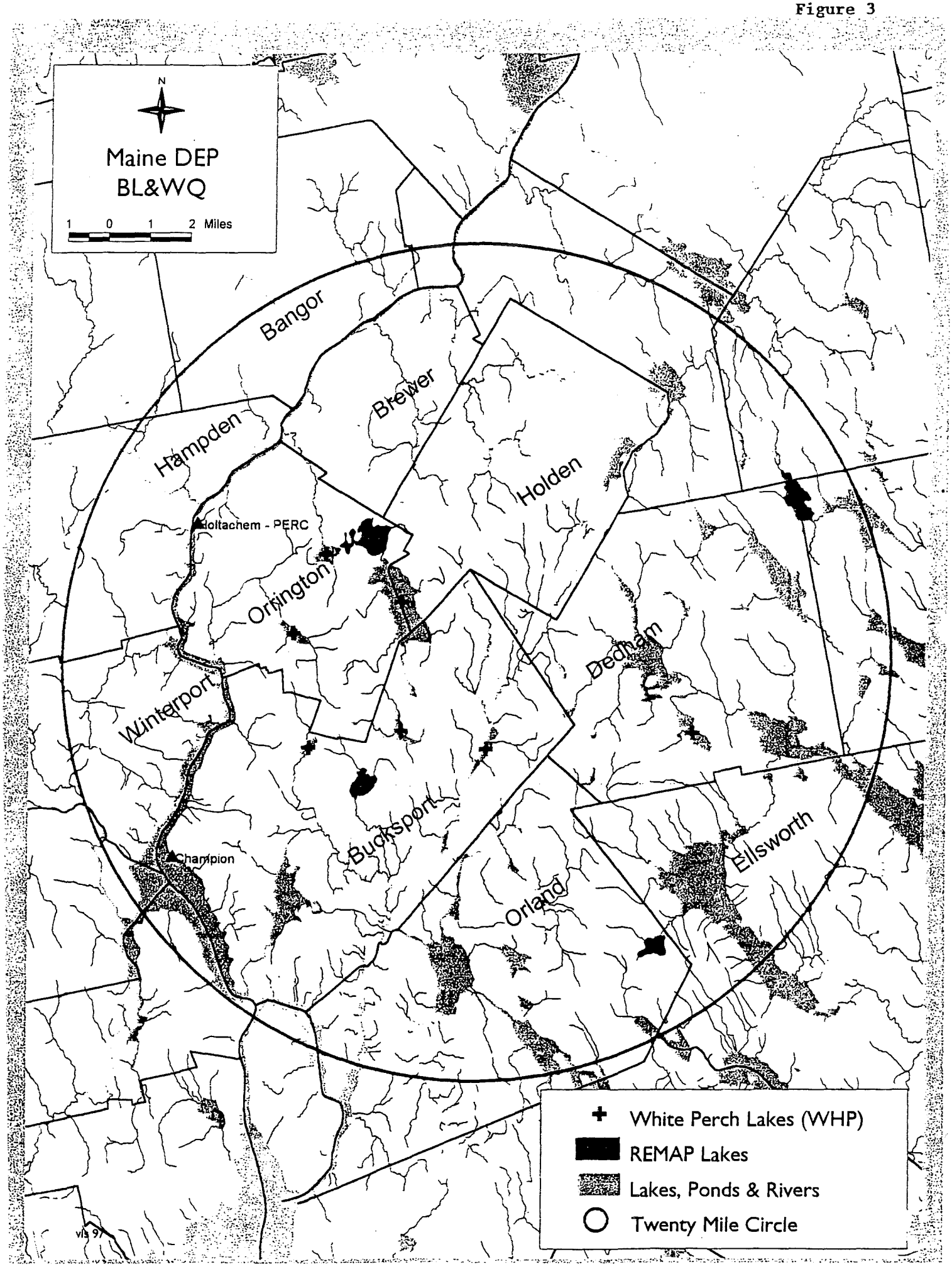
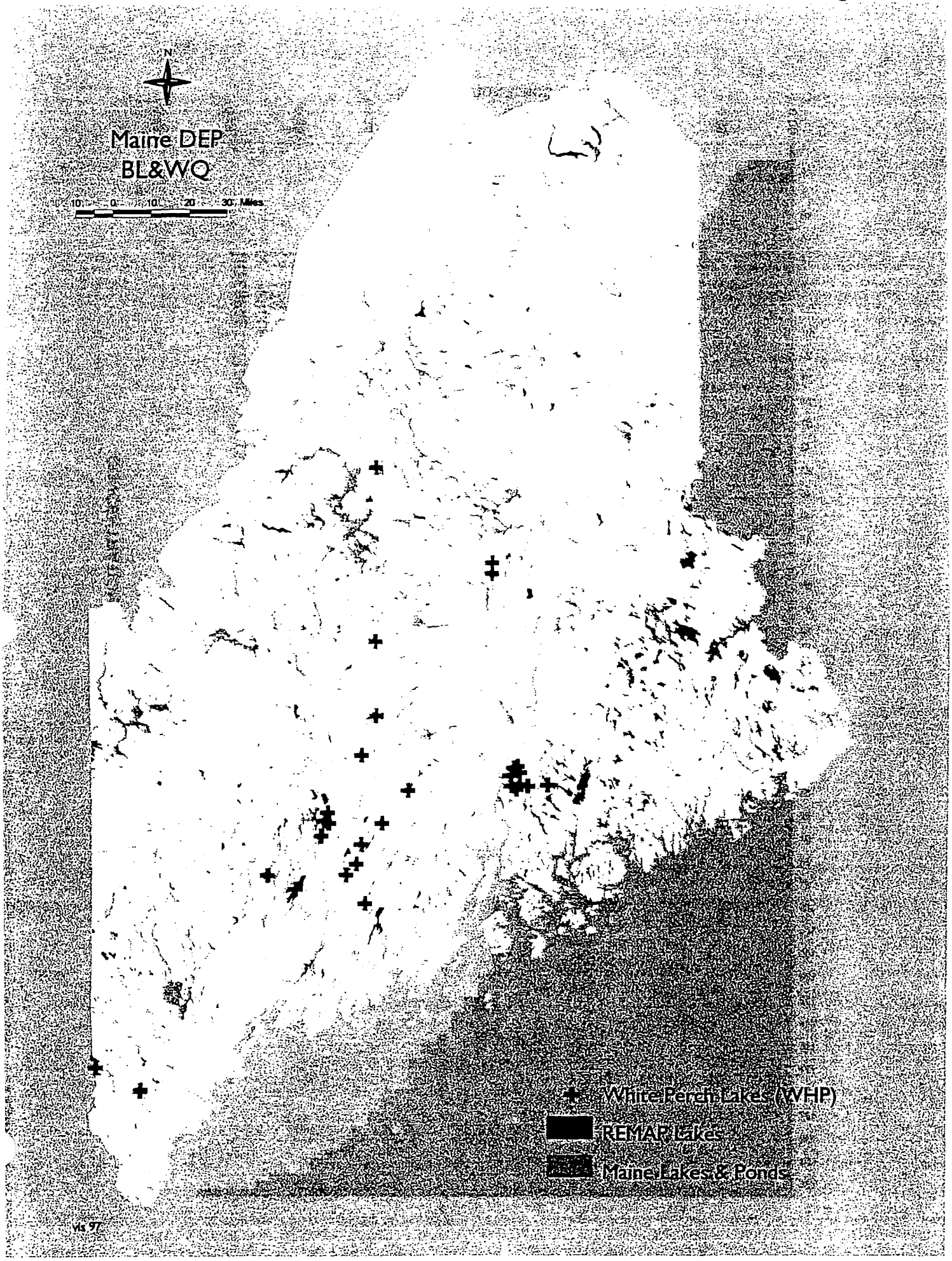
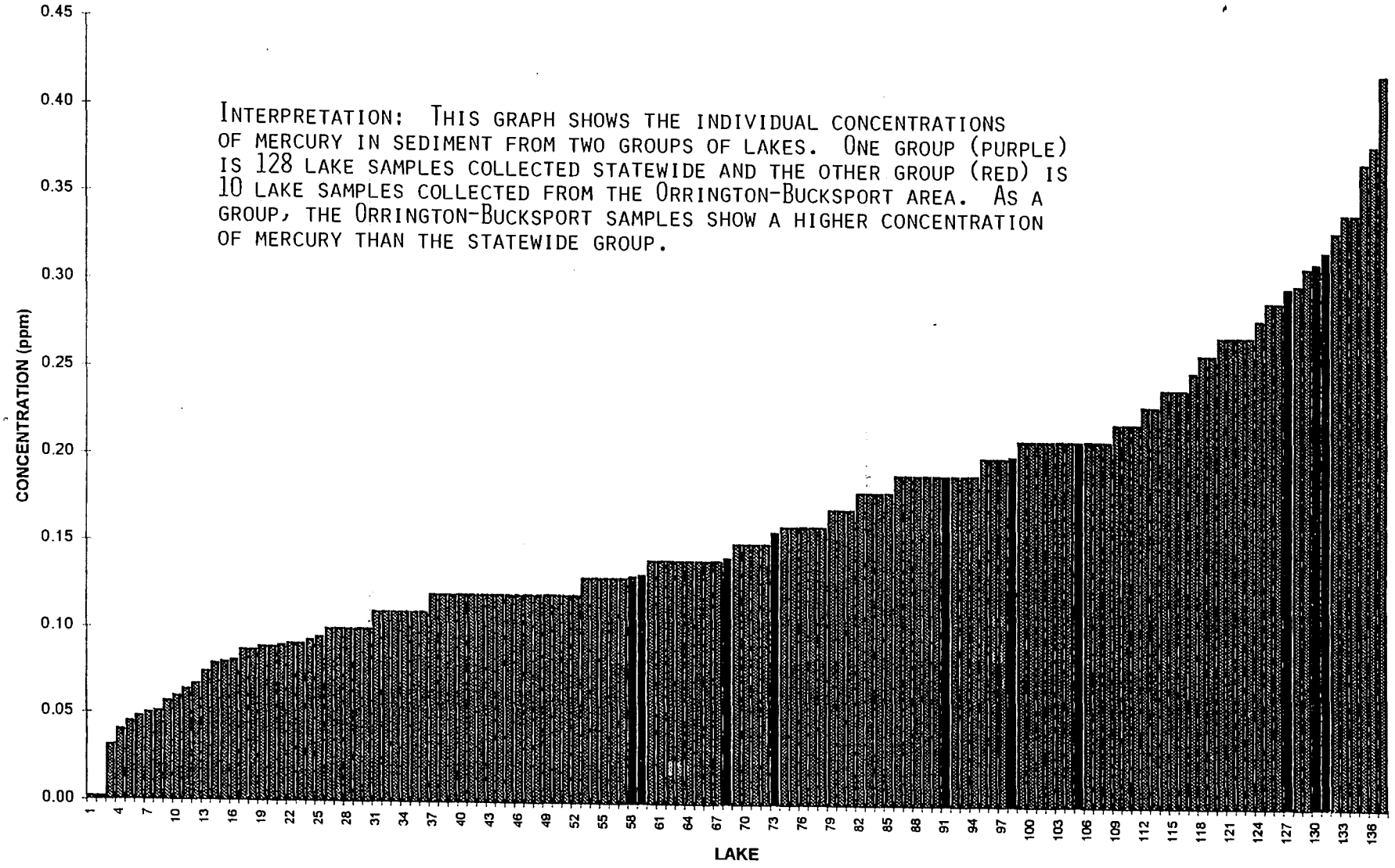
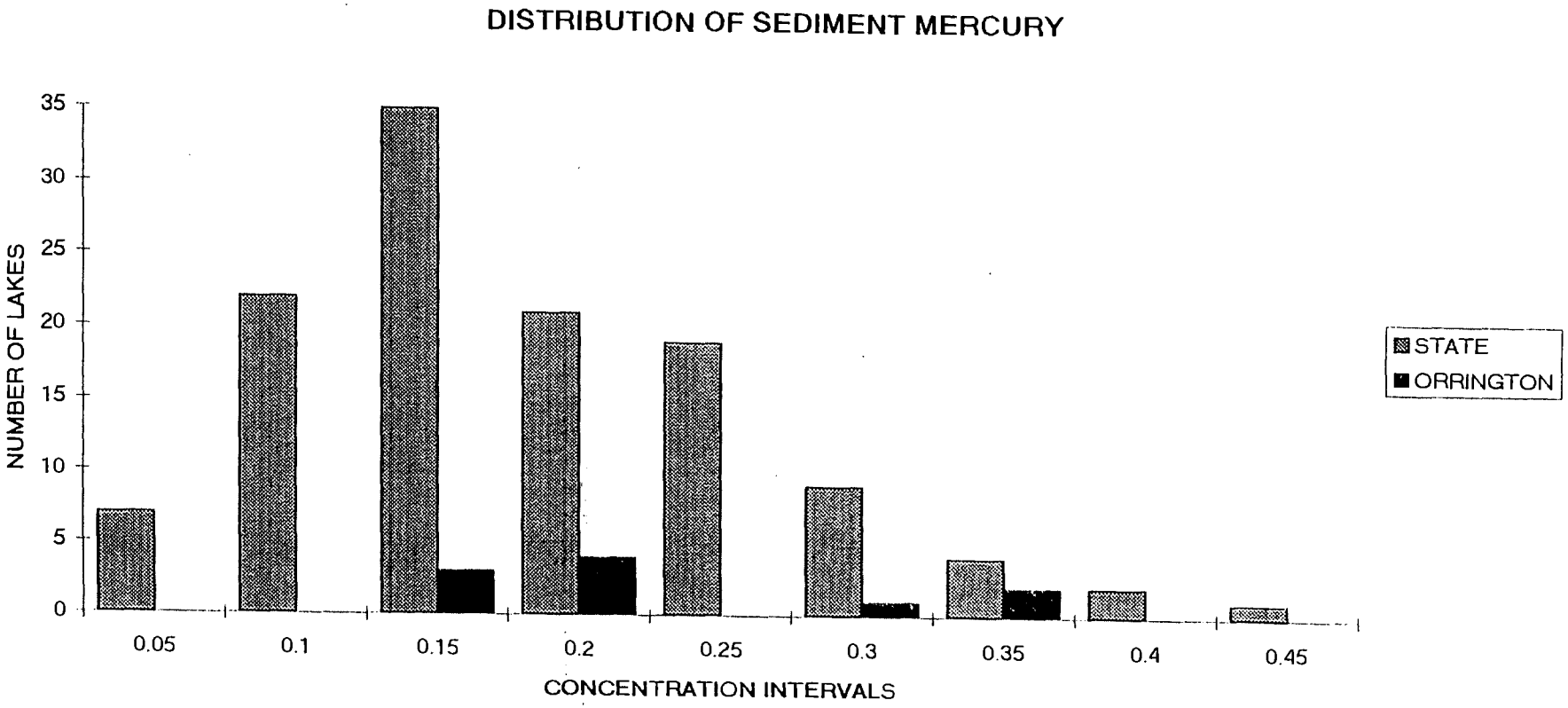

N
Maine DEP
BL&WQ
1 0 1 2 Miles
Bangor
Brewer
Hampden
Holden
Doltachem - PERC
Orrington
Dedham
Winterport
Bucksport
Champion
Orland
Ellsworth
White Perch Lakes (WHP)
REMAP Lakes
Lakes, Ponds & Rivers
Twenty Mile Circle
vls 97

Figure 4


N
Maine DEP
BL&WQ
30 0 10 20 30 Miles
White Perch Lakes (WHP)
REMAP Lakes
Maine Lakes & Ponds
vis 97

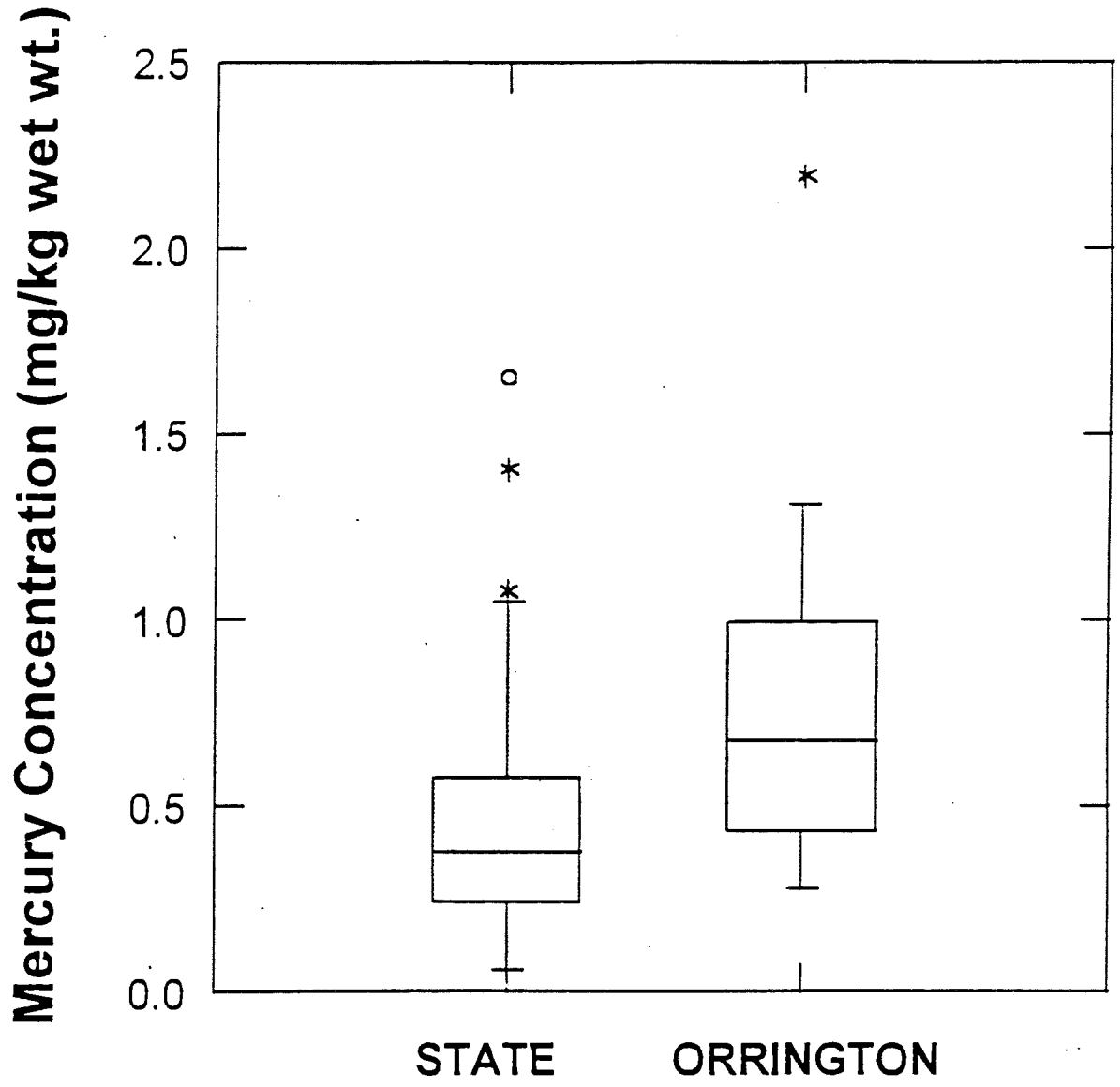
CONCENTRATION OF SEDIMENT MERCURY



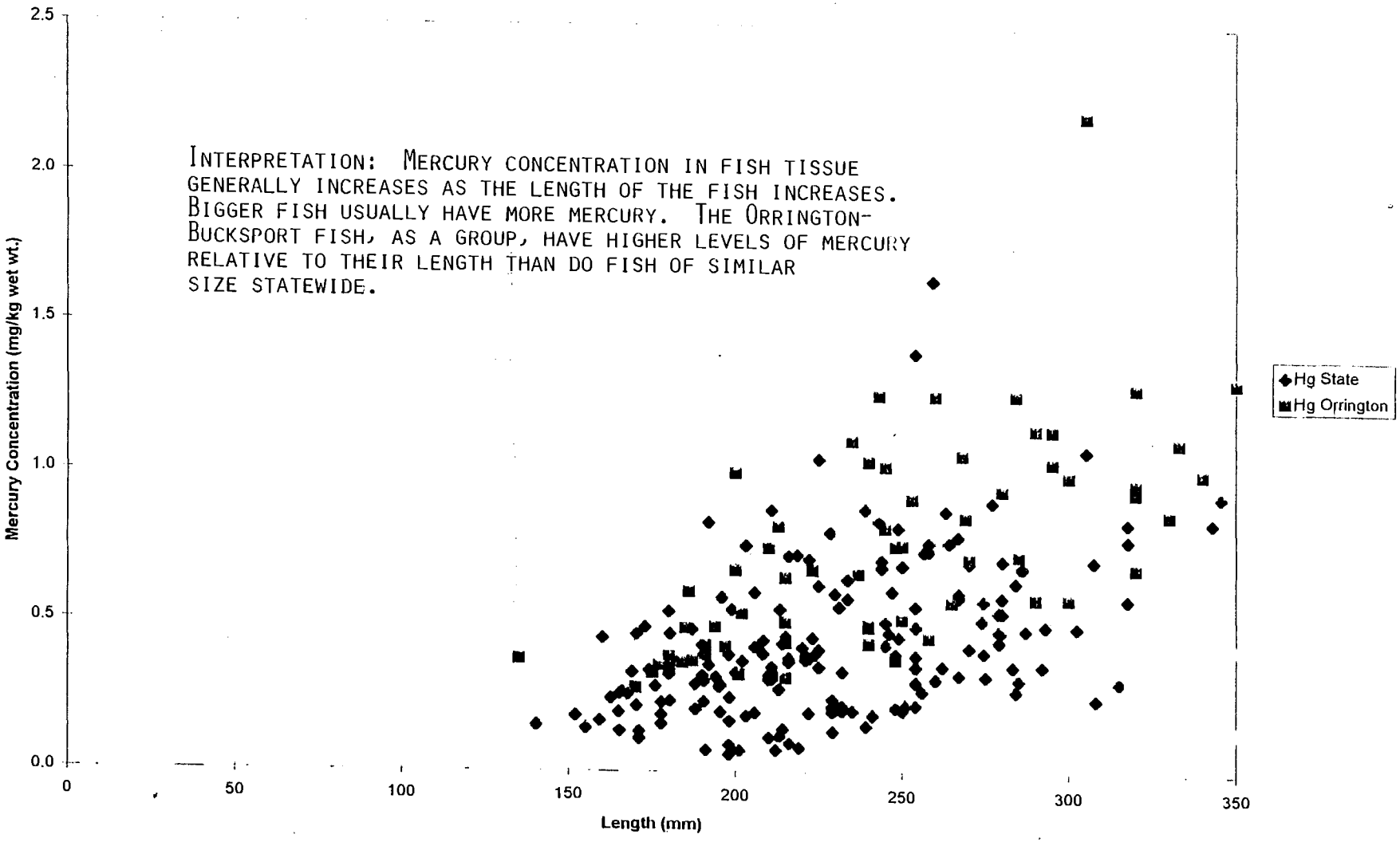


INTERPRETATION: ANALYSIS OF THE MERCURY CONCENTRATIONS OF SEDIMENT IN LAKES THROUGHOUT THE STATE SHOWS A NORMAL DISTRIBUTION FROM LOW TO HIGH VALUES. WITHIN THIS DISTRIBUTION, THE ORRINGTON-BUCKSPORT LAKES ONLY OCCUR AMONG THE HIGHER CONCENTRATIONS.

Tissue Mercury Concentration in Statewide and Orrington Fish Populations



Mercury-Length Relationship



Appendix 6

Fish Research and Consumption Advisories in Selected States

Fish Research & Consumption Advisories in Selected States

MICHIGAN

Funding -- The Department of Environmental Quality's (DEQ) Surface Water Division has a state funded annual budget of $320,000 for chemical analysis of fish tissues. Analytical costs for mercury are $100/sample, and an organic scan for 23 chemical species costs about $500/sample. Thus it costs about $2,000 per water body for a mercury test of 20 fish, and about $10,000 per water body for organic tests labs of 20 fish. Chemical tests for mercury are performed by the Department of Community Health (DCH), and test results are evaluated by the department for specific health advisories. The DCH contributes about $15,000 per year to the Department of Natural Resources (DNR) for the cost of including the health advisories in the Michigan Fishing Guide.

Monitoring -- DEQ's Surface Water Division conducts Michigan's fish monitoring program in cooperation with the DNR fisheries division. The DNR fisheries staff annually collects samples 600 to 700 fish per year from 50 to 60 lakes and rivers. DEQ contracts with the DCH for chemical tests. 70% of the monitoring is edible portions of individual fish, and 30% is whole fish composites of salmon for trend analysis. Generally for each water body sampled, ten individual top predators (pike, bass, walleye) are collected, and ten bottom species (carp) are collected.

Advisory Committee -- Preliminary recommendations are reviewed by the Fish and Wildlife Contaminant Committee (Department of Agriculture, Department of Natural Resources, Department of Environmental Quality, and Community Health). The Department of Community Health issues health advisories. Between five and ten changes are made annually to specific advisories.

Health Advisories -- In 1988, a generic statewide health advisory for eating predatory fish was issued based upon elevated levels of mercury. Pregnant women, nursing women or children under 15 are advised to eat only one fish meal per month. The general public is advised to eat only one fish meal per week. Specific advisories are issued for fish species or individual water bodies. The consumption advisories are published annually in the DNRs' Michigan Fishing Guide. Advisories are issued by water body, by species, and by length. There are four categories of advisories: (1) no restrictions, (2) general population, 1 meal per week, women and children, 1 meal per month; (3) general population, 1 meal per week, women and children, do not eat; (4) do not eat. These four advisory groups are color coded by species and fish length for each water body.

The Governor has recently asked the Michigan Environmental Science Board to review the advisory process with respect to PCBs.

Contacts: Bob Day, Department of Environmental Quality, fish monitoring: 517-335-3314,
Jim Bedford, Department of Health, health advisories: 517-335-9215

MINNESOTA

Funding -- The State of Minnesota has spent between $160,000 and $200,000 per year since 1990 collecting and testing fish tissue for a variety of contaminants including mercury. The 1997 State budget from the general fund was $160,000. About $110,000 is allocated for sample analysis. About $55,000 is allocated for testing fish tissue samples for mercury. The current cost is $56/sample for mercury.

Monitoring -- Fish samples are collected by the Department of Natural Resources (DNR), and chemical tests are done by private contractors. Around 100 lakes are sampled each year for mercury. About 1,000 fish tissue samples are evaluated each year for mercury. The traditional analysis has been composting 10 to 15 pan fish into one sample, and compositing 5 to 8 walleye into one sample. As a result of their extensive annual testing, Minnesota has a good understanding of the patterns of mercury contamination in the state, and now is concentrating its efforts on individual fish from key waters and is now directing more of their analysis to individual fish (walleye) for better trend data. Individual fish samples provides more reliable data for trend analysis.

Advisory Committee -- Minnesota has a formal Fish Contaminant Group composed of staff from the DNR, Pollution Control Agency and Department of Health. The staff at the Department of Health are responsible for issuing the annual health advisories for fish consumption.

Health Advisories -- Initial advisories were issued in the early 1970s. The Department of Health uses "risk management" analysis in establishing health advisories for fish consumption, and issues health advisories annually in the booklet Minnesota Fish Consumption Advisory. Minnesota issues fish consumption health advisories on a lake by lake basis. In 1996 there were fish advisories for 687 lakes covering the whole state. About 75 lakes will be added in 1997 to the 1998 advisory. For each lake, there are recommendations for fish species and sizes. The guidelines recommend eating smaller fish, less contaminated fish, and to clean the fish properly. Special recommendations are given for pregnant women, nursing mothers, women who may become pregnant, and children under six.

The Minnesota Department of Health spends about $60,000 of state funds annually on staffing and $28,000 on publications for fish consumption health advisories. The Minnesota Fish Consumption Advisory gives specific advisories for PCBs and mercury. For specific lakes, a warning and recommended consumption level are issued for PCBs as well as mercury.

Minnesota is in the process of evaluating their approach to sampling, analysis and issuing health advisories. There are 5,000 lakes that are managed for fish. Minnesota would like to collect more data on fewer lakes in order to obtain a better understanding of the chemistry and biology of sampled lakes. Minnesota is exploring the concept of identifying and sampling "indicator lakes."

Contacts: Pat McCann, Department of Health, health advisories: 612-215-0923,
Mark Briggs, Department of Natural Resources, fish monitoring: 612-215-0316

NEW HAMPSHIRE

Funding -- The Bureau of Health Risk Assessment in the Department of Health and Human Services spends about $15,000 annually from a federal Preventative Health and Health Services grant from the Center for Disease Control for testing fish tissue for mercury.

Monitoring -- Fish are collected by citizen volunteers for the Department of Environmental Services and Department of Fish and Wildlife.

Advisory Committee -- New Hampshire does not have an advisory committee.

Health Advisories -- The Department of Health and Human Services' Bureau of Health Risk Assessment evaluates the data and issues New Hampshire's fish consumption health advisory. New Hampshire's advisory is statewide for all inland waters and all inland fish species and sizes.

Contacts: Dr. John Dreisig, Dept. of Health & Human Services, health advisories: 603-271-4610,
Bob Esterbrook, Department of Environmental Services: 603-271-2963,
Steve Perry, fisheries biologist chief: 603-271-2501

NEW YORK

Funding -- The Department of Environmental Conservation (DEC) spends about $750,000 annually on testing for contaminants in fish tissue. The state appropriates about $500,000 per year, EPA provides a grant of about $125,000 and General Electric provides about $125,000. The Department spends about $100,000 per year for mercury testing in fish.

Monitoring -- DEC's fisheries bureau collects fish samples and DEC labs run the chemical tests. About 1200 standard fish filets are tested each year for mercury at a cost of $45-$50/sample. The number of fish samples per site varies greatly from 6 to 200. Composite testing is rarely done.

Advisory Committee -- DEC and Department of Health (DH) have a Memorandum of Understanding fish consumption health advisories. DEC provides information to DH which reviews the data with consultation with DEC, and then DEC issues the health advisories.

Health Advisories -- DH issues an annual general advisory for fish consumption - Chemicals in Sportfish and Game. It is estimated that DH spends about three person-months per year on fish consumption advisories. There are 60 waters with specific advisories, and the chemical contaminant for each water is listed. New York's general health advisories for fish and game consumption are: (1) Eat no more than one meal (one-half pound) per week of fish from the state's freshwaters, (2) Women of childbearing age, infants and children under the age of 15 should not eat any fish species listed in the specific advisories, and (3) Follow the trimming and cooking advice. The DH and DEC share equally the educational outreach workload. DH issues a special booklet, and the DEC prints four pages of advisories in the New York Regulation Guide.

Contacts: Larry Skinner, Environmental Conservation/environmental monitoring: 518-457-0751
Tony Forti, Department of Health, health advisories: 518-458-6409

VERMONT

Funding - The Vermont Department of Natural Resources (DNR) spent about $40,000 from their state general operating budget in 1996 to test for mercury in fish. In 1997 DNR spent only $1,000 of state funds. There is no annual budget for fish monitoring in Vermont.

Advisory Committee -- Vermont has an informal committee structure to review data from chemical tests. The Fish Contaminant Monitoring Committee (chemical analyst, risk assessment analyst, fisheries biologist, and toxicologist) meet and review the data from chemical tests. The Commissioner of the Department of Health, the State toxicologist, and risk management analyst meet to formulate the recommended fish consumption advisory. The Commissioners of the Departments of Health and Fish and Wildlife meet to review the recommended fish consumption advisory. The Commissioner of the Department of Health issues the health advisory.

Health Advisories -- Vermont has a general health advisory for fish consumption on a statewide basis issued by the Department of Health. Vermont also has specific advisories for certain fish species and waters for children and women.

Contacts: Bill Bress, fish advisories: 802-863-7220,
Rich Landgon, analysis: 802-244-5420,
Razell Hoffman, health risk analyst: 802-863-7558

WISCONSIN

Funding -- The Wisconsin Department of Natural Resources (DNR) spends $140,000 of state funds annually sampling, testing fish tissue for chemical contaminants including mercury from fish, loons, eagles and mink. In 1997, $95,000 was spent on analysis, $15,000 on collection, $15,000 on processing, and $15,000 on printing the advisory and educational materials. Between $15,000 and $20,000 per year is spend on mercury testing. The current cost is $31/year for each mercury test. The Great Lakes Indian Fish & Wildlife Commission also spent about $20,000 monitoring fish from tribal waters and waters used by tribal members.

Monitoring -- Between 500 and 600 samples per year are tested for mercury. Filets and individual fish of different lengths are sampled and tested. More fish in the 15" to 18" range are sampled than other size classes. About twenty-five new lakes are monitored each year, and fish consumption advisories are issued for about ten new lakes annually.

Advisory Committee -- Fish consumption advisories are established at the staff level between DNR and the Department of Health (DH).

Health Advisories -- Health advisories for fish consumption were first established in 1985 by DH on a lake by lake basis. There are now over 800 lakes with fish consumption advisories. The booklet, Important Health Information for People Eating Fish from Wisconsin Waters is published annually by DH and DNR. The advisory booklet has a section on PCB advisories for specific waters and recommends annual, monthly or no consumption levels. The advisory booklet has a section on mercury for specific waters (mostly lakes), for fish species and size. Four consumption levels are recommended:

(1) Pregnant women should eat no more than one meal a month (fillets average 0.5 ppm mercury or less);
(2) Pregnant or breast feeding women, women who plan to have children, and children under 15 should not eat fish in the group (fillets average 0.5 to 0.75 ppm mercury);
(3) Pregnant or breast feeding women, women who plan to have children, and children under 15 should not each fish in this group (fillets average 0.75 to 1.0 ppm mercury); and
(4) No one should eat fish in this group (average above 1.0 ppm mercury).

DH has a occupational health physician and three toxicologists who work on the fish consumption advisory. The amount of staff time devoted to analysis of the data and issuing health advisories varies from year to year from an estimated three months to six months of staff time. An estimated average is three months per year. Two health educators spend about 15% of their time on fish consumption advisories. The amount of time devoted to educational outreach is expected to increase in the future.

Contacts: Jim Amrhein, Department of Natural Resources, monitoring: 608-266-5325,
Dr. Henry Anderson, Department of Health, health advisories: 608-266-1253,

Appendix 7

Commitment of HoltraChem Manufacturing to Reduce Mercury Releases

HoltraChem Manufacturing Company, L.L.C.

5 Strathmore Road
Natick, MA 01760-2446
Tel (508) 655-2510 800-343-6470
Fax (508) 650-1164

January 14, 1998

Mr. Evan Richert
Land and Water Resources Council
State Planning Office
State House Station 30
Augusta, ME. 04333

Dear Mr. Richert:

At the presentation made to certain members of the Land and Water Resources Council on Monday, January 12, 1998, HoltraChem Manufacturing Co. L.L.C. indicated it was prepared to commit to attaining certain levels of mercury discharge to water, and mercury emissions to air, by the end of the year 2000. This letter confirms in writing the commitments made at that presentation.

Mercury Discharge to Water

HoltraChem Manufacturing Co. will reduce mercury discharge from its licensed outfall 001 from a current level of about four pounds per year to a level below one pound per year by the end of the year 2000. If the Solmetix resin, to be pilot tested shortly, proves successful, that amount could be reduced to less than one/ one-hundredths of a pound per year. Analysis will be performed using an extremely sensitive atomic florescence spectroscopy instrument, recently purchased by HoltraChem to permit measurements at these levels.

Mercury Emission to the Atmosphere

HoltraChem Manufacturing Co. will reduce mercury emissions to the atmosphere from an amount preliminarily determined at 176 pounds for the year 1997, to a level below 100 pounds per year by the end of the year 2000, as reported by HoltraChem annually in its filing for the USEPA mandated Toxic Release Inventory. The amount emitted will be determined by taking over seven thousand air samples during the year at 20 different points in the cell room, air temperatures at three

different points in the cell room, and ambient outside air temperatures. These measurements are then used to calculate the total mercury emitted based on a recognized engineering formula for determining convection air flow volumes. This method has been reviewed by Earth Tech, Inc., a national company recognized for expertise in environmental air modelling and emission measurement methodologies, and found to be a credible method. The instrument used to measure mercury content in the cell room air is a Jerome portable mercury analyzer using a gold-film detector capable of measuring mercury levels at 0.002 milligrams per cubic meter.

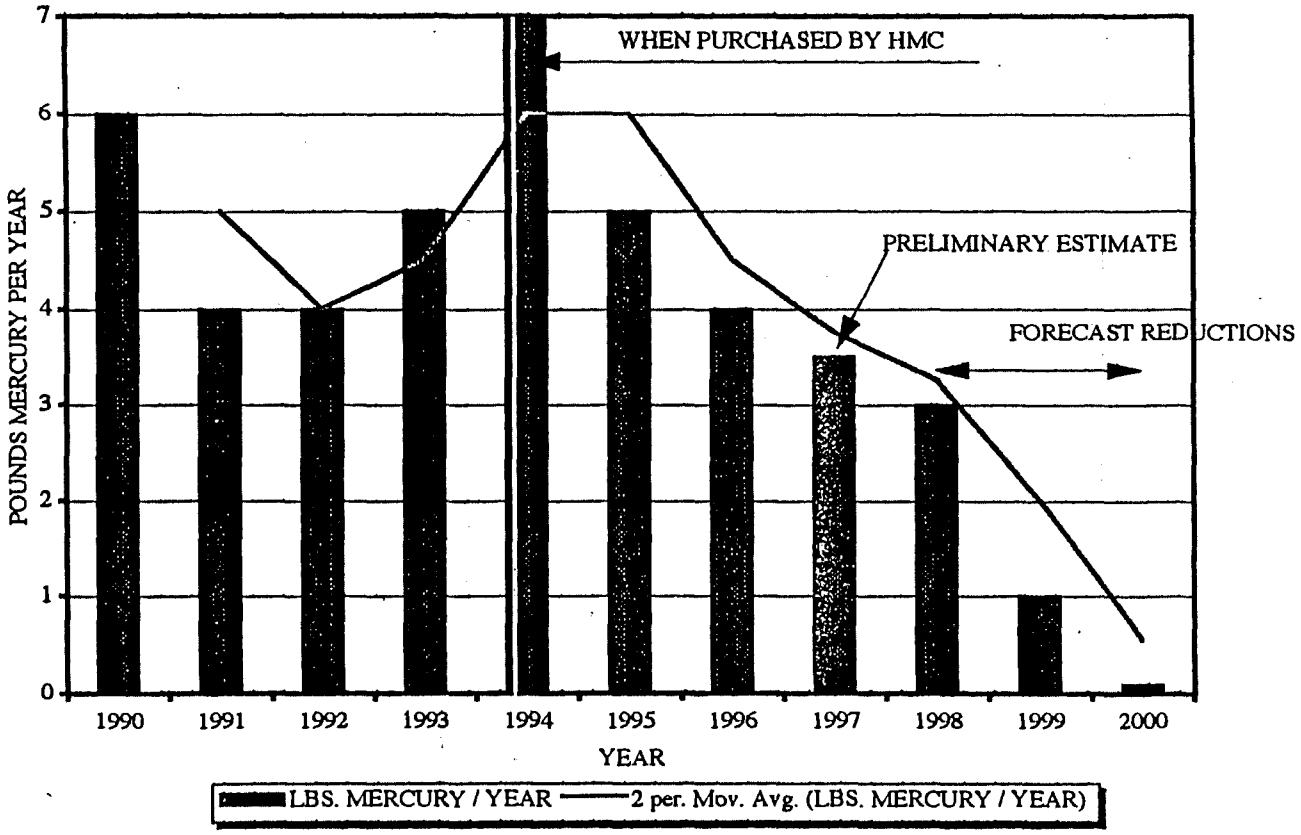
Attached are copies of two graphs presented at that meeting which depict the significant progress made to date in improving both these areas, and showing the commitment level for the year 2000. HoltraChem Manufacturing Co. is committed to continuing to improve its environmental performance, and is prepared to make both the capital, as well as the human, investment in order to attain these commitments.

Very truly yours,

Bruce D. Davis
President
HoltraChem Manufacturing Co. L.L.C.

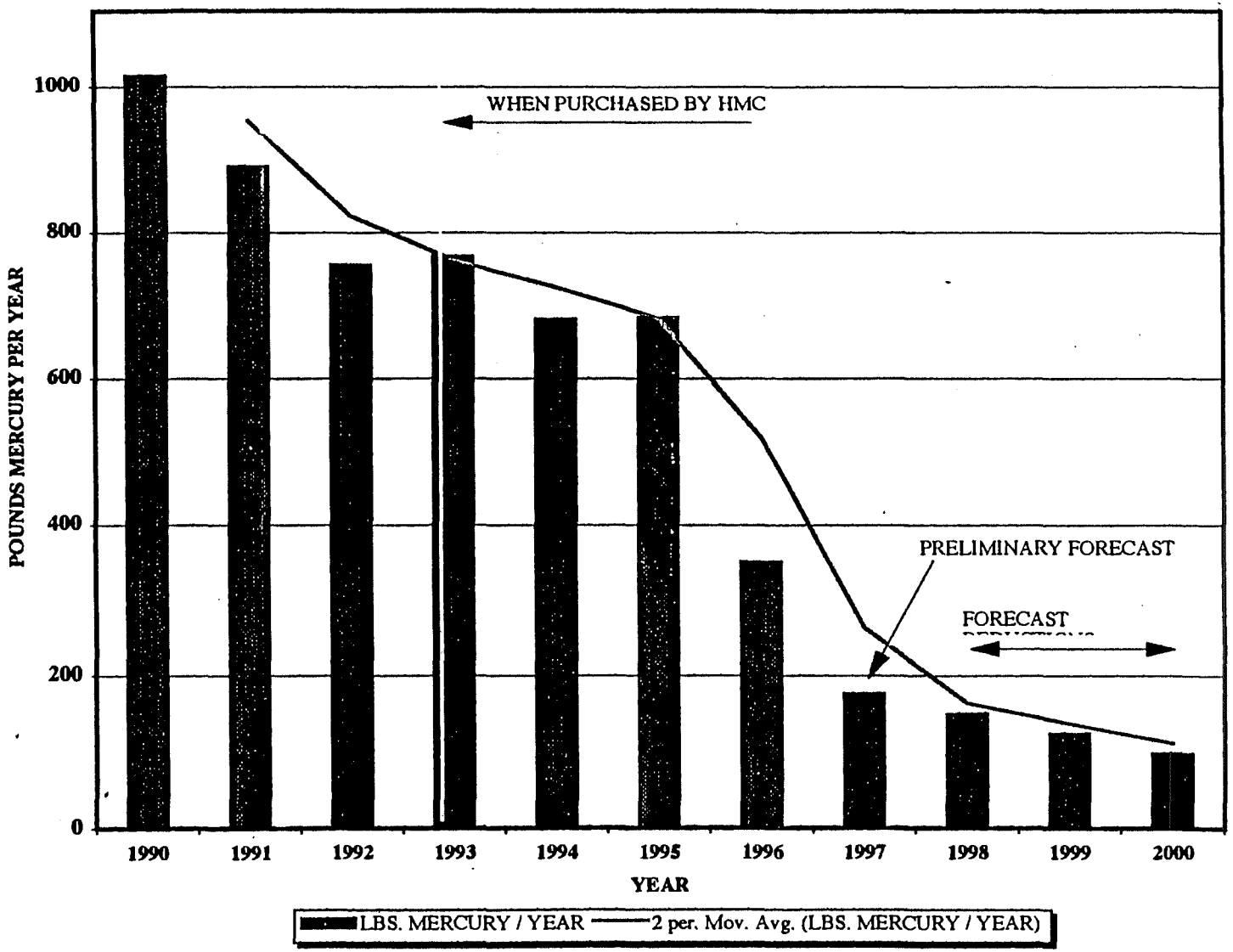
HOLTRACHEM MANUFACTURING CO. L.L.C.

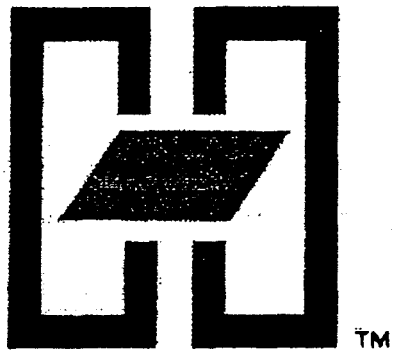
MERCURY DISCHARGE TO PENOBSCOT RIVER - OO1 LICENSED OUTFALL



HOLTRACHEM MANUFACTURING CO. L.L.C.

MERCURY AIR EMISSIONS





HOLTRACHEM MANUFACTURING CO. L.L.C.

ORRINGTON, ME. PLANT

HOLTRACHEM MANUFACTURING CO. IN THE STATE OF MAINE

ITS CONTRIBUTION TO THE ECONOMY AND ITS IMPACT ON THE ENVIRONMENT

HoltraChem Manufacturing Co. L.L.C. indicated it would be willing to agree to reductions in its NPDES water discharge limits, and its air emissions limits as listed below. At no time has HoltraChem ever been in violation of its air emission limits, and for 11 days during the last 3.5 years it exceeded its water discharge limits. The cause for those exceedences were promptly eliminated and have not recurred. The company has just completed the installation of a new $850,000 waste water treatment system, which should eliminate the recurrence of such incidents, and will result in further reductions in the low levels of contaminants in the licensed discharge.

HoltraChem Proposal for Reductions in Mercury Emissions

Water Discharges

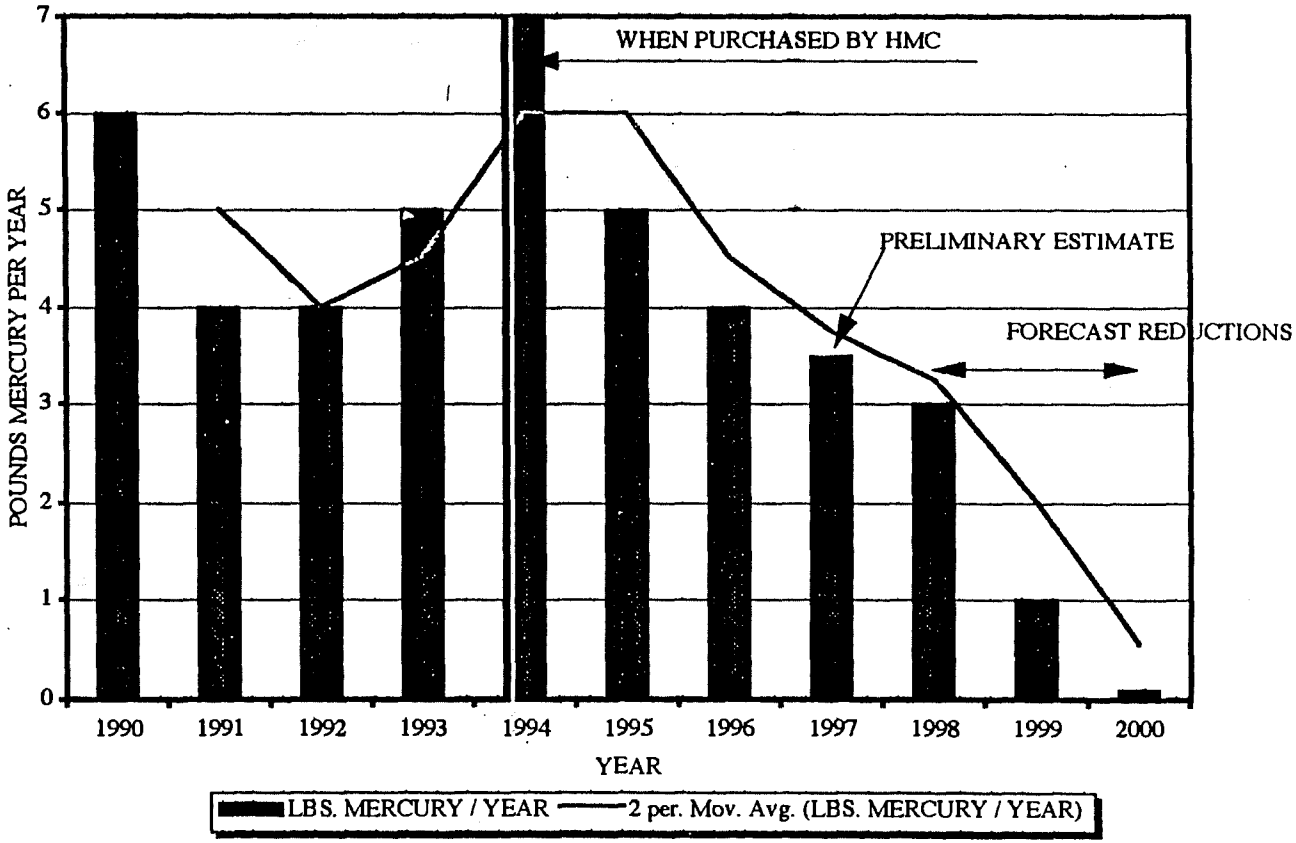
Reduce the daily permitted discharge limit by 50% from present limits, and the monthly limit by 60 % from the present limit. The discharge limits could be re-visited in three years to incorporate any further reductions HMC was able to accomplish in even tighter permit limits.

Air Emissions

Reduce the daily permitted air emission standard by 60%, and the annual standard limit by 80% from current NESHAP emission standards The discharge standard could be re-visited in three years to incorporate any further reductions HMC was able to accomplish in even tighter standards.

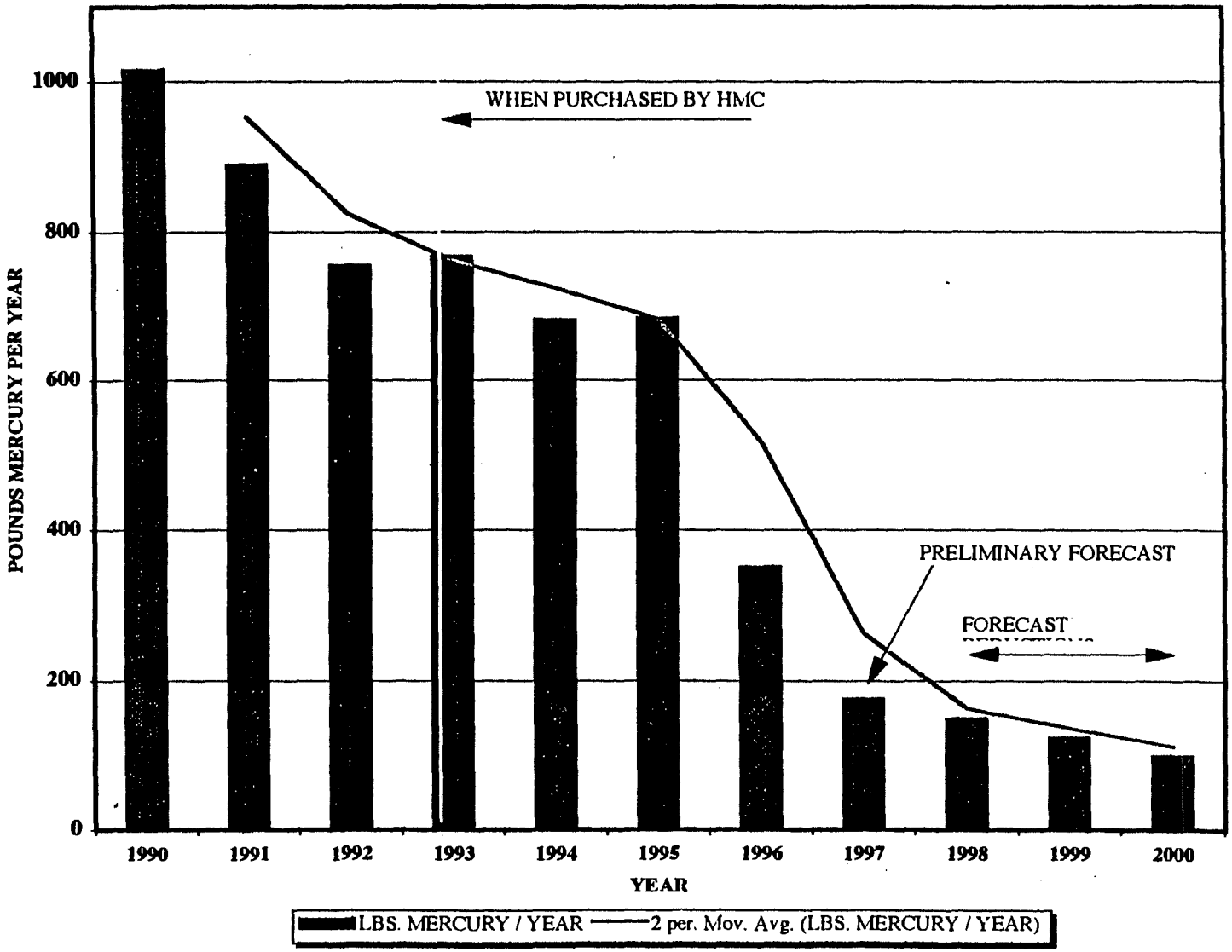
HOLTRACHEM MANUFACTURING CO. L.L.C.

MERCURY DISCHARGE TO PENOBSCOT RIVER - OO1 LICENSED OUTFALL



HOLTRACHEM MANUFACTURING CO. L.L.C.

MERCURY AIR EMISSIONS



HOLTRACHEM MANUFACTURING CO. L.L.C.
ORRINGTON, ME. PLANT

ANNUAL CONTRIBUTION TO THE ECONOMY OF MAINE

1.	**Payroll (68 Associates)**	**$3,000,000**
2.	**Orrington Property Taxes**	**$140,000**
3.	**Maine Sales Tax**	**$160,000**
4.	**Power Purchases (Bangor Hydro Electric** (Profit Contribution to BHE in 1996 - $5,750,000)	**$13,000,000**
5.	**Purchases From Local Suppliers/Contractors**	**$1,500,000**
6.	**Local Trucking Firms**	**$900,000**
7.	**Springfield Terminal Railway**	**$3,750,000**
	TOTAL ANNUAL CONTRIBUTION TO THE ECONOMY OF MAINE	$22,450,000

HOLTRACHEM MANUFACTURING CO. L.L.C.
ORRINGTON, ME. PLANT

MAINE CUSTOMERS OF ORRINGTON PLANT

	Company	Product Purchased
Paper Mills		
1.	Chinet	Bleach (Sodium Hypochlorite)
2.	Eastern Fine Paper	Bleach (Sodium Hypochlorite)
3.	Fraser Paper	Bleach (Sodium Hypochlorite
3.	International Paper	Caustic Soda
4.	James River	Chlorine, Caustic Soda
		Bleach (Sodium Hypochlorite)
5.	Kimberly Clark	Caustic Soda
		Bleach (Sodium Hypochlorite)
6.	Lincoln Pulp & Paper	Chlorine, Caustic Soda
7.	Mead Paper	Caustic Soda
8.	S.D. Warren	Hydrochloric Acid
9.	Tree Free	Caustic Soda
		Bleach (Sodium Hypochlorite)
Distributors		
1.	All Waste	Hydrochloric Acid
2.	Harcross	Caustic Soda
		Bleach (Sodium Hypochlorite)
3.	Monson/W.H.Shurtleff	Caustic Soda
		Bleach (Sodium Hypochlorite)
		Hydrochloric Acid
Other		
1.	Osran	Hydrochloric Acid

HOLTRACHEM MANUFACTURING CO. L.L.C.
FINANCIAL ANALYSIS - CONSTRUCTION OF A MEMBRANE CELL PLANT
ORRINGTON, MAINE

EXECUTIVE SUMMARY

Purpose

It has been suggested that the Orrington, ME plant of HoltraChem Manufacturing Co. ("HMC"), which currently employs a mercury - based process in the manufacture of chlorine and caustic, replace that process with a more modern process employing a so-called membrane process which does not employ mercury. The purpose of this document is to provide a careful and thorough financial analysis of all the savings and additional expenses involved in conversion of the Orrington ME. plant from mercury to membrane cell technology, and determine the Internal Rate of Return that such savings would generate for the investment cost required for the conversion. This analysis is based on an engineering cost estimate provided by one of the leading engineering firms in the world involved in building membrane cell plants - Kvaerner Chemetics.

General Information

Membrane cell technology is the latest development in the industrial processes for manufacturing chlorine and caustic. All new capacity built in the U.S.in recent years employs the membrane technology. At present there are 41 plants in the U.S. producing chlorine and caustic, of which 8 are membrane cell plants (4 in

plants operating diaphragm cells as well), 23 diaphragm cell plants, and 14 mercury cell plants. Mercury cell operations comprise 12% of the total U.S. chlor/alkali capacity.

Advantages and Disadvantages of Membrane Cell Technology

Membrane cell technology offers certain advantages and disadvantages when compared to mercury and diaphragm technology. Membrane cells are the most efficient in electric power (kwh) consumed per ECU (electrical chemical unit - 1 ton chlorine plus 1.1 tons caustic). However, membrane cell technology requires that the caustic produced must be concentrated from the 32% produced to the 50% the market demands, offsetting some of the power savings. Diaphragm cell technology also requires caustic evaporation; mercury cell technology produces caustic at 50%. Mercury cells produce the highest quality caustic, which demands a higher price in the market. Membrane cells are next in caustic quality but cannot command the same premium price, and diaphragm cells produce the lowest quality caustic, saturated with salt. Membrane cells require periodic replacement of membranes (as do diaphragm cells) - mercury cells do not.

Economic Analysis of Replacing Mercury Cells with Membrane Cells

A rigorous economic analysis was undertaken to evaluate the feasibility of replacing the mercury cell operation at Orrington with membrane cells. The economic justification for such a substitution can be based only on the improvement in operating cash flow generated by the substitution.

The investment required to substitute membrane cells for mercury cells, plus the interest cost on borrowing during the construction period, is estimated at $47,700,000. The estimated annual savings based on current power costs, as well as that which can be expected when retail power wheeling comes to Maine in March 2000, and the resulting Internal Rates of Return (IRR) are summarized in the table below.

HOLTRACHEM MANUFACTURING CO. L.L.C.
SUMMARY OF FINANCIAL ANALYSIS
FEASIBILITY OF REPLACING MERCURY CELL TECHNOLOGY WITH MEMBRANE CELL

FINANCIAL ITEM	SAVINGS YEAR 1	SAVINGS YEAR 10	SAVINGS AVERAGE
AT CURRENT POWER COSTS			
NET TOTAL ANNUAL CASH SAVINGS - OPERATIONS (before interest and taxes)	$4,150,726	$4,125,648	$4,131,173
NET TOTAL ANNUAL CASH SAVINGS - OPERATIONS (after taxes)	$3,368,479	$2,875,928	$3,144,774
INTERNAL RATE OF RETURN (IRR)			
BEFORE INTEREST AND TAXES		5.38%	
AFTER INTEREST AND TAXES		NEGATIVE	
AFTER RETAIL WHEELING POWER COSTS			
NET TOTAL ANNUAL CASH SAVINGS - OPERATIONS (before interest and taxes)	$3,322,030	$3,135,280	$3,223,774
NET TOTAL ANNUAL CASH SAVINGS - OPERATIONS (after taxes)	$2,821,540	$2,222,285	$2,545,891
INTERNAL RATE OF RETURN (IRR)			
BEFORE INTEREST AND TAXES		3.30%	
AFTER INTEREST AND TAXES		NEGATIVE	

Conclusions of Financial Analysis

- Financial analysis does not justify substituting membrane cell technology for mercury cell technology, even if it were possible (although extremely unlikely) that HMC could obtain the financing for such a conversion.
- If HMC were required to convert to membrane cell technology, the Orrington plant would be shutdown. At that point, the site would be converted to a Superfund site, to clean up the hazardous materials that have accumulated at the site during the 30 years the plant has been in operation.*
- Given the programs underway at HMC to make further reductions in mercury emissions in the future, conversion to membrane cell technology does not withstand the test of cost effectiveness for the small benefit to be obtained.

*This statement has led DEP to insert an editorial footnote for clarification. In 1991, EPA secured a RCRA corrective action plan with the then-owner of the facility, L.C.P.. Various environmental studies have been undertaken and others are being developed by the responsible parties with the oversight of EPA and assistance of DEP. The Consent Agreement recently entered into by HoltraChem and DEP put additional corrective actions into place to expand the work directed in EPA corrective action plan. Should HoltraChem close its doors due to financial conditions, this site would not automatically become a Superfund site. HoltraChem's predecessor company is also a responsible party and would be next in line to finish the work. If both parties became bankrupt, then Maine's uncontrolled sites statute may become the next procedural vehicle. Then, if the site scored high enough to be classified on the National Priorities List (NPL), then it may become a Superfund site.

Appendix 8

Summary of Minnesota Mercury Bill

Summary of Minnesota Mercury Products Laws

1. MN Stat. §115A.932 Mercury prohibition

   This law prohibits disposal of mercury and certain mercury-containing products (thermostats, electric switches, fluorescent lamps, appliances) in solid waste.

2. MN stat. §115A.9561 Major appliances.

   This law requires major appliances to be recycled or reused. Each county must provide the opportunity to recycle used major appliances. "Recycling" is defined to include the recycling or reuse of the metals, including mercury.

3. MN stat. §166.92 Mercury emissions reduction.

   Subdivision 1 of this law prohibits the sale of mercury unless the purchaser is given a material safety data sheet and signs a statement that the purchaser:

   - will use the mercury only for a medical, dental, instructional, research or manufacturing process; and

   - understands the toxicity of mercury, will appropriately store it, and will not place it in the solid waste stream or in a wastewater disposal system.

   Subdivision 2 prohibits anyone who uses mercury from placing it, or giving it to another person who places it in the solid waste stream or in a wastewater disposal system. There is an exception for traces of mercury that inadvertently pass through a filtration system during a dental procedure.

   Subdivision 3 requires mercury products to be labeled to clearly inform the purchaser or consumer that mercury is present and that the item many not be placed in the garbage unless the mercury is removed and properly managed.

   Subdivision 4 requires a person in the business of replacing or repairing mercury-containing items in households to deliver the item to a facility that will ensure the mercury is reused or recycled. It also prohibits crushing of motor vehicles unless a good faith effort has been made to remove all mercury switches.

   Subdivision 5 requires manufacturers of thermostats to provide incentives and information to purchasers or consumers to ensure that the mercury in thermostats is reused or recycled or otherwise managed so that it does not end up in solid waste.

Subdivision 5a requires manufacturers of displacement relays to collect and manage them so that they do not become part of the solid waste stream. The manufacturer must provide incentives and information to purchasers or consumer to ensure that relays do not become part of the waste stream. A displacement relay is an electric flow control device having one or more poles that contain metallic mercry and a plunger which, when energized, moves into a pool of mercury, displacing the mercury sufficiently to create a closed electrical circuit.

Subdivision 6 prohibits medical facilities from routinely distributing mercury-containing thermometers.

Subdivision 7 requires persons who sell fluorescent lamps to large volume users to inform the purchaser that the lamps contain mercury and may not be placed in solid waste. Contractors who service high volume users must inform the user of the contractor's arrangements for management of mercury in the removed lamps.

Subdivision 8 bans the sale of toys, games and apparel having an electric switch that contains mercury.

Subdivision 8a bans sale of mercury manometers on dairy farms.

Subdivision 9 sets reduced penalties for homeowners who violate the prohibitions on disposal of mercury containing items in the solid waste stream or in wastewater.

4. MN stat. §116.93

This law requires a permit for operation of a "lamp recycling facility," i.e., a facility operated to remove mercury from fluorescent or high intensity discharge lamps.

5. MN stat. §216B.241

Subdivision 5 of this law requires public utilities to encourage use of fluorescent and high intensity discharge lamps, and requires public utilities that serve 200,000 or more customers to provide for collection of the lamps for reclamation or recycling. The collection system must include reasonably convenient locations for collecting spent lamps and financial incentives to encourage generators to take the lamps to collection centers.