Appendix 4. Great Lakes Human Health Effects Research Program

Overview

The Great Lakes—Superior, Michigan, Huron, Erie, and Ontario—occupy a special place in North America's physical and cultural heritage.

Consider first their sheer size. The Great Lakes comprise 5,500 cubic miles of surface water. This is the earth's largest fresh water system—only the polar ice caps contain more. And the lakes cover an area of some 94,000 square miles, with a shoreline of over 10,000 miles. Eight states have borders that include Great Lakes shoreline.

Next, for almost two centuries the Great Lakes have been among the largest contributors to the national economy. After the 1825 completion of the Erie Canal, settlers from the eastern United States poured into the lakes region, where they became farmers, loggers, fishers, and miners. Eventually, however, heavy industry became the region's dominant commercial activity. By the middle and late 1800s, manufacturers began to locate around the lakes to take advantage of easy access to iron ore, copper, coal, salt, and limestone—availability of water transport meant the mine operators in, for example, northern Michigan or Minnesota could easily ship raw materials to the foundries, mills, and factories that had sprung up along the lakes' more southern shores.

The Great Lakes region especially benefitted from the United States' age of invention: roughly from 1870 to 1910. By the 1880s, chemists had learned how to extract chlorine from salt brine to make commercially viable bleach. More importantly, however, that and other discoveries gave rise to the chemical industry in Michigan and elsewhere in the region. The invention of the refrigerated rail car in 1881 meant that meat processors could ship market-ready products directly from the Chicago slaughterhouses to the eastern United States. In 1903, Henry Ford made his third and ultimately successful effort at founding an automobile company in Detroit, thus paving the way for that city to become the nation's automotive center.

But all of this industrial activity, accelerated and intensified by defense production during two world wars and by an expanding national economy, took its toll on the lakes. By the early 1960s, overfishing, pollution, and eutrophication—wherein water becomes enriched with dissolved nutrients (e.g., fertilizer runoff, animal waste, sewage) and thus becomes oxygen-depleted—caused the lakes' aquatic life to decline seriously. The physical nature of the basin and the accumulation of persistent pollutants made this huge freshwater resource a storehouse for toxic chemicals. The lakes are—despite their size—especially sensitive to pollution; each year less than 1% of their total volume flows out of the St. Lawrence River. This means toxic substances accumulate in the lake sediment where they then contaminate fish and other aquatic life.

Yet as alarming as these developments were, even more important was the fact that approximately 10% of the U.S. population and 25% of the Canadian population lived in the region. The persistence and widespread occurrence of Great Lakes pollutants had evident toxic effects in wildlife. Now, however, epidemiologic investigations suggested that exposure to Great Lakes pollutants could result in adverse human health effects, (e.g., reproductive, developmental, behavioral, neurologic, and immunologic disorders).

Given the implications of the association between persistent toxic substances in the Great Lakes and the potential for adverse human health outcomes, Congress passed the Great Lakes Critical Programs Act of 1990, which, among other things, created the ATSDR Great Lakes Human Health Research Program (GLHHERP). In establishing GLHHERP, Congress mandated ATSDR "To assess the adverse effects of water pollutants in the Great Lakes on the health of persons in the Great Lakes states." This mandate has resulted in a program designed to characterize exposure to toxic chemicals and investigate the potential for short- and long-term health outcomes from that exposure in vulnerable populations.

More specifically, GLHHERP's six objectives are to

1. Build upon and extend the results from past and ongoing research.
2. Develop information databases or research methodology that will provide long-term benefits to the human health effects research efforts in the Great Lakes region.
3. Provide direction for future health effects research.
4. Provide health information to state and local health officials, the concerned public, and their medical health care professionals.
5. In concert with state and local health officials, increase public awareness regarding the potential health implications of toxic pollution in Great Lakes region.
6. Coordinate as necessary with relevant U.S. Department of Health and Human Services research programs and activities, including those of FDA, CDC, NIH, and IHS, as well as the U.S. EPA and state and local health departments to ameliorate adverse public health effects of persistent toxic substances in the Great Lakes region.

If so indicated by additional research or by new information, ATSDR might update or revise these GLHHERP objectives.

GLHHERP Strategy

In support of the research program's goals, GLHHERP implemented the following strategy, built on the five traditional elements of disease prevention:

1. Identification of patterns of morbidity and mortality (through use of surveillance systems, exposure registries, and reports from state/local health agencies)
2. Evaluation of causal factors accountable for the observed pattern of morbidity or mortality (through epidemiologic investigations and experimental research)
3. Control of the factors found or thought to be accountable for the observed morbidity or mortality (through health advisories, regulatory actions, and medical interventions)
4. Dissemination of information about the identification, evaluation, and control of the observed patterns of morbidity/mortality (through local advisories, publications, state programs, and local, state, and national media)

5. Development of infrastructure to support the elements of disease prevention - identification, evaluation, control, and dissemination (through institutional mechanisms that involve staffing, budgets, and organizational arrangements)

To identify human populations who may be at special risk of adverse health effects, particularly from consumption of Great Lakes sport fish, ATSDR is funding research to better characterize exposure, pathways, associated body burdens, and potential human health effects from exposure to persistent toxic substances in the Great Lakes region, with special emphasis on at-risk populations. ATSDR is working with state and local health agencies in the Great Lakes region to obtain any surveillance data, reports of morbidity, and other information that might help identify populations at health risk.

Organizations at Work in the Great Lakes

- ATSDR,
- Centers for Disease Control (CDC),
- Food and Drug Administration (FDA),
- Great Lakes National Program Office (GLNPO),
- Great Lakes States,
- Health Canada,
- Health Effects Research Laboratory (HERL) EPA,
- Indian Health Service (IHS),
- International Joint Commission (IJC),
- Local authorities,
- National Institutes of Health (NIH),
- Other federal agencies,
- Tribal Governments, and
- United States Environmental Protection Agency (USEPA) Regions II, III, V.

Lakewide Management Plans (LaMPs)

The Great Lakes Water Quality Agreement of 1978, as amended (GLWQA), is a binational agreement between the United States and Canada that calls for the restoration and maintenance of the chemical, physical, and biological integrity of the waters of the Great Lakes region Ecosystem. GLWQA also calls for the development of lakewide management plans (LaMPs) for open waters in the Great Lakes. The plans are designed to reduce loadings of Critical Pollutants (e.g., PCBs, mercury) that interfere with the lakes' beneficial uses (i.e., drinking water, fishing, and swimming) and to define threats Critical Pollutants pose to human health.

In 2000, ATSDR participated in the development and the writing of the human health sections for the Lake Erie, Lake Michigan, and Lake Superior LaMPs and participated in human health activities for the LaMP Workgroups. More recently, ATSDR has been involved in the creation and development of the U.S.EPA-led Human Health Network composed of members from Canada and the United States. This group acts as a resource for current, peer-reviewed documents that the LaMP Workgroups may use in their reports. The ATSDR GLHHERP Web site (http://www.atsdr.cdc.gov/grtlakes/) helps the Network members keep abreast of recent research findings from the Program's investigators. Through contribution to LaMP activities, ATSDR has participated

indirectly in the Remedial Action Plan (RAP) Workgroups. The RAPs describe remedial actions for Areas of Concern in which beneficial uses have been impaired.

Fish Advisories

ATSDR's GLHHERP has also been involved in fish advisory activities for the Great Lakes region. ATSDR and U.S. EPA have developed brochures alerting the public about safe fish consumption guidelines and have developed a display informing the public about fish advisories. The display and the educational brochures have been shown at conferences and meetings where fish advisories are the topic of interest. Because many minorities consume Great Lakes sport fish, the brochures have been translated into English and into other languages such as Chinese and Spanish.

The ATSDR-funded consortium of Great Lakes state health departments developed uniform fish advisory materials that the Great Lakes states disseminate at women and infant clinics, physician's offices, fairs, and other public gatherings. They also distribute the materials at meetings of health professionals, including physicians, and at public health agencies. Initially, the consortium organized fish advisory workshops to develop the materials and then refine them at subsequent workshop sessions. The materials alert the public about safe fish consumption and include brochures in appropriate languages. Also distributed are refrigerator magnets, note pads, recipe cards, drinking cups, T-shirts, and other items designed to catch the interest of the public and of risk groups (e.g., women of child-bearing age). These items also contain a toll free telephone number where more information may be obtained.

Sensitive Subpopulations

GLHHERP has identified several human populations who may be at particular risk because of greatest exposure to Great Lakes pollutants via fish consumption. Such predisposition to toxic injury in these populations can be due to behavior (e.g., degree of contaminated fish consumption), nutritional status, physiology (e.g., developing fetuses), or other factors.

The vulnerable populations include

- African-Americans,
- American Indians,
- Asian Americans,
- elderly,
- fetuses, nursing infants, and children;
- persons with compromised immune function,
- pregnant and nursing females,
- sport anglers, and
- urban poor.

Ongoing work

Over time, the GLHHERP has contributed to an understanding of human exposures to environmental pollutants in the Great Lakes region and to the health effects that may be attributed to those exposures. The references below illustrate the contributions. But as noted elsewhere in this report, much more work is needed. In FY 2008, ATSDR funded four research grant applications in the Great Lakes:

1. P.I. Bonner, State University of New York at Buffalo is investigating the association between long-term fish consumption and chronic disease risk in an established large cohort of anglers and their spouses. Funding for 2008: $199,879.
2. P.I. Schantz, University of Illinois at Urbana-Champaign is investigating neuropsychological outcomes in adolescents from Southeast Asian (Hmong) and from the general population of sport anglers in Wisconsin who have been exposed to polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), methyl mercury and other contaminants via fish consumption. Funding for 2008: $198,737.
3. P.I. Osuch, Michigan State University at East Lansing is studying a multigenerational cohort of fisheaters to determine 1) in the F0 generation the association between organochlorine exposure from fish meals and the expression of key genes involved in sex steroid metabolism and 2) in the F1 generation, to examine key gene expression and to determine whether altered gene expression is due to transgenerational inheritance of epigenetic phenomena, inherited polymorphisms, or both. Funding for 2008: $199,016.
4. P.I. Stewart, State University of New York at Oswego is working with children from the Oswego area to determine the impact of PCBs, mercury, and lead on neurodevelopment. Earlier work predicted that prenatal PCB exposure predicts impulsive behavior and impaired inhibitory control from ages 4 years through 13 years of age. As these investigators continue to work in this area other chemicals such as MeHg and Pb have begun to emerge as endpoints in their work. The researchers will focus on all three chemicals to determine the mixture of these toxic chemicals on behavior in children. Funding for 2008: $200,000.

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