

Chapter 5

Human Health Information



Children at the beach.
Photo Credit: Elizabeth LaPlante, US EPA.

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Chapter 5

Human Health Information

5.0 INTRODUCTION

The Lake Superior Lakewide Management Plan (LaMP) seeks to restore and protect the beneficial uses of Lake Superior, including safe beaches, clean drinking water, and healthy fish and wildlife populations. Awareness of the underlying causes of these beneficial use restrictions from chemical and microbial contaminants and the associated health consequences will allow public health agencies to develop societal responses protective of public health.

These beneficial uses include “Swimmability,” “Fishability,” and “Drinkability.” Swimmability means that all beaches are open and available for public swimming. Fishability means that all fish are safe for human consumption. Drinkability means that treated drinking water is safe for human consumption.

Chemical and microbial pollutants enter the human body through three major routes: ingestion (water, food, soil), inhalation (airborne), and dermal contact (skin exposure). Within the scope of the LaMP update, exposure to pollutants through water contact will be highlighted. The major areas of health concern directly related to Great Lakes water quality are pollutant exposure from ingestion of contaminated fish, incidental ingestion of water while swimming along beaches, and ingestion of contaminated water.



Figure 5-1. The LaMP seeks to restore and protect the beneficial uses of the Great Lakes, such as safe beaches. Photo credit: Frank Koshere, Wisconsin Department of Natural Resources.

5.1 LAMP 2006-2008 ACCOMPLISHMENTS AND ACTIVITIES

5.1.1 Great Lakes Public Health Network

In May 2002, the Great Lakes Binational Executive Committee (BEC) endorsed a recommendation to establish a Great Lakes Human Health Network as a forum or mechanism to discuss human health issues directly related to Great Lakes water quality. The U.S. and Canada then proceeded to develop their own domestic networks, to be joined together once established,

to form the binational forum endorsed by BEC. Both countries have proceeded with different approaches based on their different institutional structures and capacities.

In Canada, Health Canada has led the development of the Canadian network. Under the *Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem* (COA), Health Canada committed to undertake this work. The 2002 COA commitment 3.4.2 stated “Establish and facilitate the work for a Public Health Network in the Great Lakes Basin.” The current 2007 COA commitment 3.2.a states “Support and facilitate the activities of environmental public health networks in the Great Lakes Basin.”

The Canadian network, called the Great Lakes Public Health Network (GLPHN), was formally established on November 16, 2005. It took three years to establish the network, which involved working closely with the Ontario Ministry of Health and Long Term Care (not signatories of COA) to build trust and a grassroots development process for the GLPHN through the 37 Ontario Public Health Units and their respective Medical Officers of Health.

Today, the GLPHN consists of 183 voluntary representatives of governments and their agencies, including Ontario Public Health Units. The network assists in the provision of members’ respective environmental health programs and facilitates participation in other related networks by:

- Exchanging high-quality, peer-reviewed human health information related to drinking water and recreational water quality, fish consumption, air quality, sediment, soil, and other ecosystem issues in the Great Lakes basin, in support of the Great Lakes Water Quality Agreement and in turn, COA;
- Identifying and documenting health issues related to chemical and biological contaminants in the ecosystem and establishing priorities of concern, and to bring these priorities back to their respective organizations and to the attention of the COA management committees;
- Communicating human health information and advice (technical, policy, or other) related to the ecosystem of the Great Lakes basin among federal and provincial governments and their agencies, and local health units, that are mandated to protect public health in the Ontario Great Lakes basin to stakeholders (including the public) through member organizations, as required; and
- Creating a forum for discussion to support the coordination of public health and environmental management decisions regarding health matters related to water, air, and soil quality in the basin ecosystem.

The GLPHN is primarily designed to facilitate information sharing of environmental health issues between federal and provincial governments and Ontario Public Health Units. Members are able to use the information in their respective organizations and relay it to the communities they serve. The network facilitates better coordination and communication among governments, researchers, health officers, and the Great Lakes community on health issues related to the ecosystem of the basin.

A Steering Committee was formed on September 22, 2005, consisting of representatives from Environment Canada, Ontario Ministry of Environment, and seven representatives from the Public Health Units around the Great Lakes. The committee is co-chaired by Health Canada and Ontario Ministry of Health and Long Term Care. Secretariat support is provided by Health Canada Safe Environments Programme B Ontario Region (SEP-ONR.). The Steering Committee approved the GLPHN Terms of Reference, which are currently under its biennial review; review considerations include such topics as broadening membership, binational restructuring, and expanding information-sharing mechanisms. The Steering Committee meets four times a year to provide direction and set priorities for the GLPHN, the committee meets as needed to establish working groups to address specific issues or projects.

Eleven teleconferences have been held to date on topics that have included transboundary air pollution, health effects of PBDEs (flame retardants), children's health and environment, health-based air quality index, environmental and occupational causes of cancer, health risks of pesticides and best practices to reduce exposure, bluegreen algae and microtoxins, climate change, wood smoke, radon, pharmaceuticals, and mercury in fish.

Currently the GLPHN Steering Committee is considering alternative methods of information-sharing such as web site portals, listservs, and workshops. The success of the GLPHN over the last two years has been the caliber of its speakers and material packages that members receive on each teleconference topic. Medical doctors that join the call are able to earn Continuing Medical Education credits.

The approach taken by Canada in establishing the GLPHN has been to create a network that meets the environmental health information needs of the public health users. Care was taken to ensure that users of the network had a hand in creating and maintaining it, thereby valuing it. Years of establishing trust and developing a system that meets the needs of the user have resulted in a highly valued network that public health units depend on for credible and reliable environmental health information in a format that is not overbearing or inaccessible.

Health Canada is working together with US EPA to establish ways to join each country's respective networks to establish a binational network. The GLPHN has expressed strong interest in this collaboration and wants to work toward developing the Binational Network in 2008.

5.1.2 Children's Health Activities

Children are different from adults and may be more vulnerable to environmental exposures. Consider that:

- Children's neurological, immunological, digestive, and other bodily systems are still developing and are more easily harmed;
- Children eat more food, drink more fluids, and breathe more air than adults in proportion to their body mass—their food, fluids, and air therefore must be safe; and
- Children's behavior patterns—such as crawling and placing objects in their mouths—often result in greater exposure to environmental contaminants.

US EPA has forged partnerships and taken increasingly more steps to protect children's health from the variety of contaminants and pollutants that may affect them in the air they breathe, the water they drink, and the food that they eat. US EPA directs its efforts toward ensuring that children's homes and schools are healthy and safe places where they can live and learn. The goal is to ensure that state, local, and tribal governments; communities; school districts; and caregivers in the Great Lakes region understand the relationship between the environment and the health of children and will take action to improve the health of children by reducing risks and exposures to environmental hazards where they live and learn.

More information on children's environmental health can be found at www.epa.gov/children.

Toxicity and Exposure Assessment for Children's Health (TEACH)¹ contains information pertaining to scientific literature in the field of children's environmental health for 18 chemicals or chemical groups of concern to children, which may potentially impact children's health. The goal of the TEACH project is to complement existing children's health information resources by providing a listing and summary of scientific literature applicable to children's health risks due to chemical exposure.

Green Cleaning in Schools Act. Many schools and states are recognizing the vulnerabilities of children to toxic substance exposures, including those in cleaning agents, and have taken innovative steps to reduce this exposure. One such innovative program is the "Green Cleaning in Schools." Illinois and New York became the first two states in the country to require that all elementary and secondary schools purchase only environmentally-sensitive cleaning supplies. More information can be found at www.ilga.gov/legislation/publicacts/fulltext.asp?Name=095-0084 and www.healthyschoolscampaign.org/campaign/green_clean_act_2007.

Environmental Health Issues during Pregnancy Awards. US EPA recently awarded more than \$500,000 in federal grant funds to educate healthcare providers and women of child-bearing age on environmental health risks. The EPA grants focus on environmental health issues that include exposure to mercury, lead, environmental tobacco smoke, chemicals, pesticides, drinking water contaminants, and indoor and outdoor air contaminants. Much peer-reviewed research has documented the relationship between a mother's environment and the health of her developing fetus. Various behaviors and experiences are associated with adverse health outcomes for both the mother and infant. These experiences can occur before, during, and after pregnancy.

An award was given to the Michigan Inter-Tribal Council, Sault St. Marie, Michigan, to deliver the message of the environmental risks of tobacco smoke, mercury, lead, and drinking water contaminants directly to Native American women of child-bearing age. The project includes two phases:

- Provide outreach and education on environmental health issues to pregnant women and healthcare providers; and
- Evaluate the effectiveness of the outreach and education to both audiences.

¹ US EPA Toxicity and Exposure Assessment for Children's Health (TEACH) web site: www.epa.gov/teach.

More information can be found at

<http://yosemite.epa.gov/ochp/ochpweb.nsf/content/prenatalgrants.htm>.

Natural Lawn Care Workshop

Many peer-reviewed research studies have linked pesticide exposures to a variety of adverse human, aquatic, and ecosystem effects. To reduce pesticide use, exposure, and run off, the US EPA Great Lakes National Program Office (GLNPO) awarded a grant to a non-profit organization, Safer Pest Control Project, to hold a Natural Lawn Care workshop. The sold-out workshop was held in Chicago on February 20-21, 2008, and educated lawn care professionals, schools, cities, park districts, nurseries, and businesses on how to reduce reliance on lawn pesticides and chemicals. The workshop taught the fundamentals of organic and natural lawn care in addition to providing information on the possible human and ecosystem health risks of pesticides. The workshop was consistent with both the Lake Superior LaMP pollution prevention goals and the pesticides/non-point source reduction goals of the Great Lakes Regional Collaboration. A similar workshop will be held in the Lake Superior basin and will provide valuable information to cities and towns, including cities and towns in Ontario where they have banned the cosmetic use of pesticides. Information on the workshop, including access to summary materials, can be found at www.spcpweb.org/yards/.



Safer Pest Control Project Executive Director Rachel Rosenberg speaks at the Natural Lawn Care Workshop held in Chicago, February 2008. Photo credit: Mark DeMeulenaere.

5.1.3 Beaches Safe to Swim

Background. The Great Lakes Water Quality Agreement calls for recreational waters to be substantially free from bacteria, fungi, and viruses.² These microbial organisms of fecal origin have the potential to cause relatively mild illnesses (e.g., gastroenteritis) to more serious illnesses (e.g., hepatitis, typhoid fever) from a single exposure.

Lake Superior's myriad recreational activities do present risks for contamination to occur (i.e., swimming, water-skiing, sail-boarding, and wading). Apart from the risks of accidental injuries,

² International Joint Commission. 1994. Revised Great Lakes Water Quality Agreement of 1978 as Amended by Protocol Signed November 18, 1987. Reprint February 1994.

the major human health concern for Lake Superior recreational waters is microbial contamination by bacteria, viruses, and protozoa.^{3,4}

To improve water quality testing at the beach and to help beach managers better inform the public when there are water quality problems, Congress passed the *Beaches Environmental Assessment and Coastal Health* (BEACH) Act in October 2000. One of the provisions of the BEACH Act authorizes US EPA to award grants to eligible states, tribes, and territories to develop and implement beach monitoring and public notification programs at coastal beaches, including the Great Lakes.

Progress on Developing and Implementing Beach Monitoring and Notification Plans. Since passage of the BEACH Act, approximately \$11.7 million in BEACH grants have been issued to Great Lakes states to implement beach programs, which has resulted in a significant increase in the number of monitoring and notification programs at Great Lakes beaches. All of the Lake Superior states have beach monitoring and public notification programs in place at most of their coastal beaches and at all of their high-priority coastal beaches.

During the years 2004 to 2006, the States of Michigan, Wisconsin, and Minnesota significantly expanded the number of beaches reported within each state (Table 5-1) and the number of bacterial samples analyzed.⁵ As a consequence, the number of Lake Superior beaches monitored increased from 11 in 2000 to 305 in 2006. The additional resources available from the Beach Act resulted in more frequent monitoring at beaches where problems were detected. Sampling frequency was increased from once a month to a sampling frequency of one to two times per week. However, many Lake Superior beaches are not monitored unless the public reports a problem. Monitoring resources expended at beaches where no bacterial pollution sources exist and pristine conditions are found would not be a wise use of these resources.

However, beach managers have directed their monitoring resources to priority beaches to protect the public. The beaches selected for more frequent monitoring are the beaches where contamination problems have been detected and risk to human health requires more information. Thus, the increase in postings during the years 2004 to 2006 at some Lake Superior beaches resulted when samples were directed to areas where known problems existed.

Table 5-1. Number of Great Lakes beaches reported per state

State	Number of Beaches 2000-2002		Number of Beaches 2004-2006	
	Average	Minimum - Maximum	Average	Minimum - Maximum
Michigan	137	125-157	577	337-971
Minnesota	3	1-5	79	79-79
Wisconsin	45	39-54	192	192-192

³ Health Canada. 1998. Summary: State of Knowledge Report on Environmental Contaminants and Human Health in the Great Lakes Basin. Great Lakes Health Effects Program, Ottawa, Canada.

⁴ World Health Organization. 1998. Guidelines for safe recreational water environments: Coastal and fresh-water.

⁵ Rockwell, Wirick, and Kovatch, 2006. Bacteria, beaches and swimmable waters: has bacterial contamination increased? MWWWD-IEMES Antalya, November 6-10.

During 2006, 97 percent of Lake Superior beaches were open more than 95 percent of the time in the U.S. This meets the key objective of the 2002 U.S. Great Lakes Strategy goal: “By 2010, 90% of monitored, high priority Great Lakes beaches will meet bacteria standards more than 95% of the swimming season.” Figure 5-2 shows the percentage of Lake Superior beaches with postings from 1998 to 2006. The red and yellow segments, representing greater than 5 percent of beaches with postings, range from 3 to 10 percent of each year’s total number of beaches.

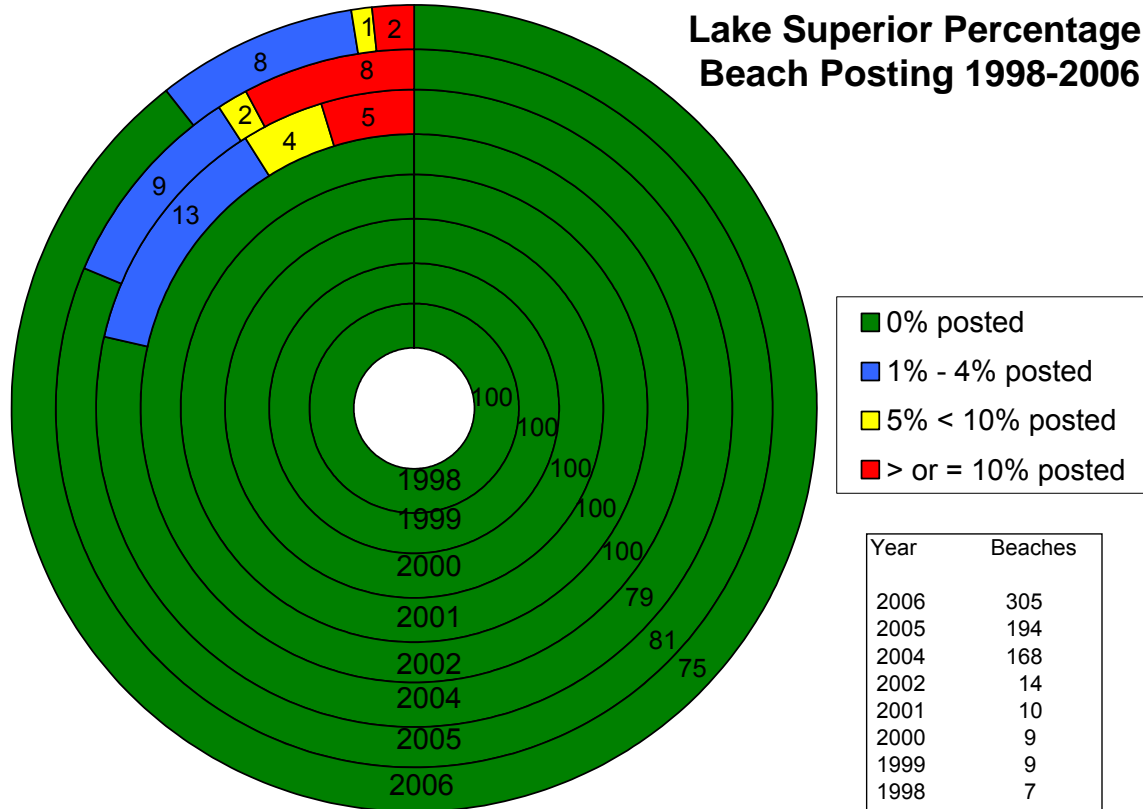


Figure 5-2. Lake Superior Percentage Beach Posting 1998-2006.

Beach program summaries for Michigan, Minnesota, and Wisconsin are presented below.

Michigan’s Beach Program. The Michigan Department of Environmental Quality (MDEQ) has received a total of \$1,708,572 in BEACH Act funding since 2002 to support beach monitoring and notification programs. Along Lake Superior:

- There are 115 public Michigan beaches in 9 counties, 21 of which are monitored; and
- An estimated \$33,414 (an estimated 12 percent of BEACH Act funds for 2007) was distributed to monitor 21 beaches in 7 counties on Lake Superior in 2007.

The monitoring of beaches in Michigan is voluntary and is conducted by local health departments, which are required to notify various entities of the test results within 36 hours, and

may petition the Circuit Court for an injunction ordering the owners of a beach to close the beach. The MDEQ provides Clean Michigan Initiative-Clean Water Fund (CMI-CWF) and BEACH Act grants to local health departments to aid in the implementation or enhancement of their beach monitoring programs. The CMI-CWF and BEACH Act grants are designed to fund proposals that determine and report levels of *E. coli* in the swimming areas of public beaches. The objectives of MDEQ's beach program are to:

- Assist local health departments to implement and strengthen beach monitoring programs;
- Determine whether waters of the state are safe for total body contact recreation;
- Create and maintain a statewide database;
- Compile data to determine overall water quality; and
- Evaluate the effectiveness of MDEQ programs in attaining water quality standards for pathogen indicators.

Local health departments request an average of \$380,000 of BEACH Act funds per year from the MDEQ for local beach monitoring programs for approximately 200 high-priority beaches. The BEACH Act allocation for Michigan provides funding to support monitoring once per week at 80 beaches for part of the summer and 100 beaches for most of the summer. In 1998, only 20 counties monitored their beaches. Since the MDEQ has been providing grants for beach monitoring, the number of counties with a beach monitoring program has risen steadily: 24 counties monitored at least one of their beaches in 2000, 36 counties monitored in 2001, 26 counties monitored in 2002, and 38 counties monitored in 2003, 53 in 2004, and 52 in 2005.

In 2006, monitoring was conducted at 207 Great Lakes public beaches in 37 counties in Michigan. Out of 2,422 daily samples collected, 85 (3.5 percent) exceeded Michigan's water quality standards for *E. coli*. The exceedances were reported from 50 beaches (24 percent of monitored Great Lakes beaches), 41 of which reported beach closures or advisories (52 incidents lasting a total of 333 days).

All beach monitoring data are reported to and evaluated by the MDEQ. The MDEQ incorporates beach monitoring data into other water pollution prevention programs to encourage strategic improvements in water quality. Michigan's Beach Monitoring web site immediately provides current and historical test results for *E. coli* and beach closings/advisories as they are reported from health departments for all public beaches in Michigan.⁶ All public beaches are required to post a sign indicating whether the beach is monitored and where the results can be found.⁷

Minnesota's Beach Program. The Minnesota Pollution Control Agency (MPCA) administers Minnesota's Beach Monitoring Program. The purpose of the program is to implement a consistent coastal beach water monitoring program to reduce the risk of beach users' exposure to disease-causing microorganisms in water. Approximately 58 miles of public beaches and a total of 79 coastal beaches were identified along Lake Superior. Selected beaches along Lake Superior are monitored in accordance with BEACH Act requirements with prompt notification to the public whenever bacteria levels exceed US EPA-established standards.

⁶ Michigan's Beach Monitoring web site: www.michigan.gov/deq/1,1607,7-135-3313_3686_3730--CI.00.html.

⁷ Michigan House Bill 4719 (Act 507). 2001. Available at: www.deq.state.mi.us/beach/public/default.aspx.

The state has received \$1,488,365 in BEACH Act grants since 2001 to develop and implement beach monitoring and notification programs. A Beach Team comprised of state and local-level environmental and public health officials, and other interested parties, was formed to design MPCA's Beach Program. A standard sampling protocol was developed, and standard advisory signs were designed based on feedback from Beach Team members and public meetings held in coastal communities. The 2007 beach season was the fifth full season that a consistently implemented beach-monitoring program was conducted in the coastal area of Minnesota. Other facts about the 2007 beach season include:

- There were 913 monitoring visits during the 2007 beach season;
- 39 sites were monitored once a week from May to October for both *E. coli* and fecal coliform;
- 66 of the samples collected exceeded the water quality limit of 235 cfu/100 mL for *E. coli*;
- 33 advisories were posted during the monitoring season;
- Two of the monitored beaches were under advisory for most of July and August; and
- 93 percent of Minnesota's Lake Superior beaches met bacteria standards more than 95 percent of the time.

MPCA has improved many aspects of its public notification process. The state has developed an exceptional interactive and informative web site that summarizes key information about beach advisories and closings.⁸ This site also provides information on beach logistics, amenities, and local weather. E-mail notices are automatically sent to interested parties. A local phone message is continually updated with the latest advisories (218-725-7724).



Figure 5-3. Minnesota's Beach Monitoring Program provides prompt notification to the public whenever bacteria levels exceed US EPA-established standards. Photo credit: Frank Koshere, Wisconsin Department of Natural Resources.

Minnesota Success Stories and Current Research Projects. The principal success of MPCA's Beach Monitoring Program is the continued public awareness the advisories bring to ongoing

⁸ Minnesota Lake Superior Beach Monitoring Program web site: www.MNBeaches.org.

water pollution issues. Since the MPCA started monitoring 35 beaches in 2002 (39 since 2005), the level of awareness of bacterial pollution of recreational waters in the region, as well as in the state, has risen dramatically. The understanding that wastewater overflows and by-passes can have an effect on beach water quality, even a short-lived one, has led to the demand for solutions to the inflow and infiltration problems in the region. Residents and tourists are starting to realize that bacteria problems can occur in any part of the Lake Superior basin, but that they occur with more frequency in the most urban areas and during storm events. Residents and visitors are picking up after their dogs on a more regular basis. They continue to be vocal about sewage overflows and demand that they be corrected. The coastal cities are installing large holding tanks, backup generators, and home sump pumps to slow and/or stop storm-related sewage overflows.

At all 39 monitored Lake Superior beaches, potential sources of pollution either on the beach or nearby have been identified. These sources include stormwater discharges or streams with stormwater discharges into them. The City of Duluth and the Western Lake Superior Sanitary District (WLSSD) have conducted dye testing in the sewer lines and stormwater pipe tanks to eliminate them as potential sources of bacteria at the New Duluth Boat Club (DBC) site on Park Point. They have also conducted a limited amount of spatial testing to determine if there is one specific point of discharge.

The University of Minnesota – Duluth, in collaboration with WLSSD and the MPCA’s Lake Superior Beach Program, received a grant from Sea Grant to research DNA fingerprinting at two of the more polluted beaches, including the New DBC Beach. The project, entitled “Beach sand and sediments are temporal sinks and sources of *Escherichia coli* in Lake Superior,” will investigate sources of *E. coli* bacteria contributing to beach closures in the Duluth-Superior Harbor. This study investigated potential sources of *E. coli* contaminating DBC Beach by using DNA fingerprinting. Over 3,600 *E. coli* strains were obtained from 55 lake water, 25 sediment, and 135 sand samples taken from five transects at the DBC Beach at 11 different times during the summer through fall months of 2004 and 2005. Potential sources of *E. coli* at this beach were determined by using a known-source DNA fingerprint library containing unique *E. coli* isolates from wildlife, waterfowl, and treated wastewater obtained near Duluth. Amounts of *E. coli* in the samples were enumerated by membrane filtration counting, and the presence of potentially pathogenic *E. coli* was determined. *E. coli* counts in all samples increased during the summer and early fall (July to

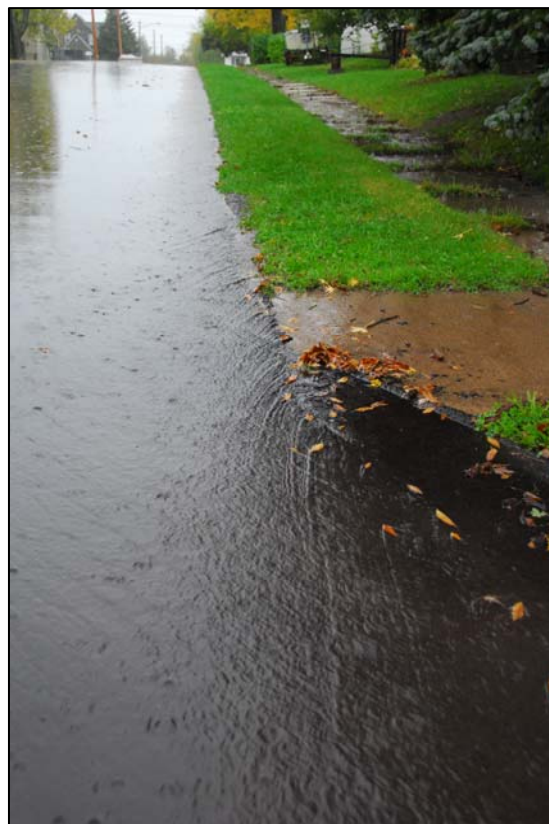


Figure 5-4. Stormwater runoff was identified as one of the primary sources of bacteria at Lakewalk Beach in Minnesota. Photo credit: Frank Koshere, Wisconsin Department of Natural Resources.

September). While *E. coli* in spring samples originated mainly from treated wastewater effluent, the percentage of *E. coli* from waterfowl increased from summer to fall. DNA fingerprint analyses indicated that some *E. coli* strains may be naturalized, and autochthonous members of the microbial community in the beach sand and sediments were examined. However, results indicated that <1 percent of the *E. coli* strains at the DBC Beach were potentially pathogenic. These results also suggest that wave action may influence the early colonization and homogeneous distribution of *E. coli* in beach sand and the subsequent release of sand or sediment-borne *E. coli* into lake water. Taken together, these results indicate that sand and sediment serve as temporal sources and sinks of human and waterfowl-derived *E. coli* that contribute to beach closures.

Source identification work is also being conducted by MPCA, which received a grant from US EPA to pilot a beach sanitary survey tool to identify pollution sources at two Great Lakes beaches: Lakewalk Beach and New DBC Beach. At the New DBC Beach, the primary source of bacteria was suspected to be the waterfowl population that lives and travels through the area. At Lakewalk Beach, stormwater runoff and sanitary sewer overflow were identified as the primary sources of bacteria.

Wisconsin's Beach Program. The Wisconsin Department of Natural Resources (WDNR) operates Wisconsin's Beach Monitoring and Notification Program. Since 2001, WDNR has received \$1,460,130 in BEACH Act grants to develop and implement monitoring and notification programs at beaches along Lake Michigan and Lake Superior. Passage of the BEACH Act has enabled WDNR to substantially increase the number of beaches it monitors. Along the Lake Superior shoreline, Ashland, Bayfield, Douglas, and Iron Counties have 15.35 miles of beaches. Among these counties, 40 beaches are monitored.

To design its state beach monitoring and notification program, the WDNR formed a workgroup composed of state-level environmental and public health officials, local health departments, and academic researchers. Using GPS technologies, 192 beaches were identified along Lake Michigan and Lake Superior. Additional GPS data layers were added to include the location of all wastewater treatment plant outfalls along with their proximity to the beaches. Additional information was collected for each beach, evaluating the potential for impacts from stormwater runoff, bather and



Figure 5-5. Many beaches on Lake Superior are monitored to ensure that water quality conditions are safe for swimming. Photo credit: Frank Koshere, WDNR.

waterfowl loads, and the location of outfalls and farms. This information was used to rank and classify beaches as high, medium, or low priority. These rankings indicate how often the beaches should be monitored to ensure that water quality conditions are safe for swimming.

The WDNR's public notification and risk communication measures were developed in collaboration with the workgroup and other stakeholders, including the public. These efforts included development of signs at beaches to give notice to the public that the coastal recreational waters are not meeting, or are not expected to meet, water quality standards. These signs, which are also in Spanish and Hmong, were designed based on feedback from a beach user survey and public meetings held around the state.

Other products that were developed include: an automatic e-mail service to which the public can subscribe to receive daily updates on beach conditions; a statewide informational brochure, approximately 100,000 copies of which were distributed at local beaches, parks, and health departments; a statewide Beach Health web page (www.wibeaches.us) for collecting monitoring and advisory data and reporting up-to-date as well as historical conditions at all Wisconsin coastal beaches; and an internal web site for local health departments to report their daily advisory and monitoring data in the format required for US EPA reporting at the end of the beach season.

Current Research Projects. The BEACH Act funding was inadequate for a comprehensive monitoring program, so other funding was sought. Several groups have been brought together to create a comprehensive monitoring and source-tracking program. The groups include: local health departments, Northland College, the University of Wisconsin-Oshkosh, and the Lake Superior Alliance. The following objectives have been completed by this collaboration:

- Investigation of high levels of *E. coli* with additional spatial sampling to assist in identifying the source of contamination. This includes investigation of tributaries, outfalls, and other inputs to Lake Superior in proximity to the beaches. This included vertical and horizontal sampling at several beach locations.
- Recovery of *E. coli* isolates from a variety of sources so that a database could be constructed to help determine the source of *E. coli* recovered from beach water samples. Over 2,000 *E. coli* isolates have been recovered from sources such as dogs, cattle, sheep, deer, gulls, geese, human sources, and from the beaches (beach water) under study.
- Investigated the implications of sampling at different water depths – 12, 24, 36, and 48 inches.
- Utilized genetic fingerprinting techniques (rep PCR), antibiotic resistance patterns, and spatial sampling to determine the source of beach water *E. coli* isolates.
- Conducted watershed investigations at select locations to determine impacts on beach water quality.
- Worked with local health officials to mitigate any source of *E. coli*; and beach contamination so that beaches can remain open and public health is protected.
- In 2007, the WDNR received funding from US EPA to conduct sanitary surveys at 18 Wisconsin Great Lakes beaches, including seven along Lake Superior. The project has allowed researchers to identify sources of microbial contamination at numerous

beaches around Wisconsin and initiate the process of planning for mitigation of some of the sources.

Many other successes have resulted from the beach program in northern Wisconsin:

- A State of Wisconsin Certified Lab was set up in an area that had no previous capability for beach testing. This lab also allows other local health departments and citizens to have samples collected and analyzed when they believe there is a problem with either a beach or another location in the area.



Figure 5-6. The BEACH Act has helped to protect public health at local beaches in Wisconsin. Photo credit: Frank Koshere, WDNR.

- Utilizing the Wisconsin Beach Monitoring and Notification Program as an example, the State of Wisconsin Health and Hygiene Laboratory and the WDNR have teamed up to provide a similar service for high-use inland beaches located at many Wisconsin State Parks. Up-to-date information is also provided on the Wisconsin Beach Health web site.⁹
- Testing Lake Superior's public beaches has spurred counties to test their local inland beaches as well. Vilas and Oneida Counties in northern Wisconsin modeled their inland beach programs after the Wisconsin Coastal Beach Program and sampled 16 beaches in the summer of 2005.
- Twenty-seven Lake Superior beaches now have baseline *E. coli* data, and beach management decisions can be based on good scientific data.
- The use of genetic testing, antibiotic resistance patterns, and spatial sampling has identified several likely sources of *E. coli*.
- Having identified potential sources of contamination, the process of source mitigation can begin.
- There have been several public meetings at several locations in the Lake Superior region to bring all interested parties together to discuss water quality and beach "health" issues.

The BEACH Act has established a foundation in an economically disadvantaged area so that it can acquire high-quality scientific data, protect public health at local beaches, help local officials acquire data to respond to questions from citizens regarding beach water quality and help mitigate any issues that may pose a risk to human health.

⁹ Wisconsin Beach Health web site: www.wibeaches.us.

Accomplishments Related to Communication to the Public. Because it has been shown that people who engage in recreational water sports have a higher incidence of symptomatic illnesses, it has become increasingly more important to make the public aware of the potential health hazards that are associated with recreational waters. Recent progress has been made on the national and local levels to provide the public with useful tools that can provide needed information regarding the use of recreational waters. At the national level, the following public communication tools are available:

BEACH Watch.¹⁰ This web site contains information about US EPA's BEACH Program, including grants, US EPA's reference and technical documents including US EPA's *Before You Go to the Beach* brochure, upcoming meetings and events, conference proceedings, and links to local beach programs. The web site also provides access to BEACON (Beach Advisory and Closing On-line Notification), US EPA's national beach water quality database.

Annual Great Lakes Beach Association (GLBA) Conference.¹¹ The GLBA is comprised of members from U.S. states, Environment Canada, local environmental and public health agencies, and several universities and non-governmental organizations (NGOs). The GLBA's mission is the pursuit of healthy beach water conditions in the Great Lakes area. Since 2001, the GLBA has held beach conferences annually to bring together beach managers, scientists, and agency officials to exchange information on improving recreational water quality. The next conference is planned for September 2008, in northwest Indiana.

BEACHNET.¹² BEACHNET is an email discussion list that seeks to facilitate communication among people interested in the improvement of recreational beach water quality in the Great Lakes basin. The listserv is sponsored by the GLBA and is hosted by the Great Lakes Information Network (GLIN). Both the GLBA and the listserv are open to anyone interested in improving beach water quality, understanding bacterial contamination, developing better ways to detect and monitor pollution, or monitoring and assuring beach visitors' health. There are currently several hundred subscribers to BEACHNET.

BeachCast.¹³ This web site provides Great Lakes beach goers with access to information on Great Lakes beach conditions, including health advisories, water temperature, wave heights, monitoring data, and more. BeachCast is a service of the Great Lakes Commission and its GLIN.

5.1.4 Fish Consumption Advisory Programs Outreach Efforts and Meetings

The Great Lakes states met in 2007 to discuss fish consumption advisories across the Great Lakes basin:

¹⁰ US EPA BEACH Watch web site: www.epa.gov/OST/beaches.

¹¹ Great Lakes Beach Association web site: www.great-lakes.net/glba/.

¹² BEACHNET Discussion web site: <http://www.great-lakes.net/glba/beachnet.html>.

¹³ Great Lakes Commission BeachCast web site: <http://www.glc.org/announce/03/07beachcast.html>.

- As part of the 2007 *National Forum on Contaminants in Fish* – Great Lakes Basin Break-out Session, held in Portland, Maine, in July 2007, the Great Lake states met for a two-day session to discuss fish consumption advisories, the mercury fish consumption protocol, and the development and implementation of a basinwide fish consumption message.
- During the *Lake Michigan: State of the Lake 2007* Conference on October 2-3, 2007, the Great Lakes Environmental and Molecular Science Center (GLEAMS) brought the Great Lakes states together to discuss the potential for using Decision Support Systems (DSS) to communicate fish consumption advisories by making greater use of tools such as online mapping applications and new genomics tools. The second day of the meeting focused on having fish consumption experts discuss their communication outreach plans.
- During the *Making a Great Lake Superior 2007* conference, three presentations focused on contaminants in fish, including an overview of fish consumption advisory topics, a presentation on tribal assessment of PBT contaminant concentrations in four commonly harvested Lake Superior fish, and a presentation on fish advisory outreach to vulnerable populations in the Upper Peninsula of Michigan. Following these presentations, there was good discussion on promoting consumption of low-contaminant fish species.
 - The Lake Superior Human Health Session also included presentations on a variety of topics, including: beach monitoring, identifying seasonal sources of *E. coli* at beaches, amphibole mineral fiber issues on the Mesabi Range, and rip currents. Further information and the Human Health Conference abstracts can be found at www.seagrant.umn.edu/superior2007.

5.1.5 Research Projects in the Great Lakes

New Projects

Advisory Awareness among Volunteers in a 2004 Mercury Exposure Study. This project with the Wisconsin Department of Health and Family Services will help determine whether hair mercury measurement has a long-term effect on an individual's fish consumption habits and reduces their risk of exposure to methylmercury.

In 2004, two thousand and thirty-one Wisconsin volunteers completed a fish consumption questionnaire and provided hair for mercury analysis. Each volunteer received a result letter that provided individualized fish consumption advice.

In order to evaluate the effectiveness of the 2004 project as an educational tool, the State of Wisconsin plans to conduct a follow-up survey of these individuals and invite them to have their hair re-analyzed for mercury. All data from the surveys and laboratory hair analyses will be entered into an electronic database and merged with 2004 records for each participant in the follow-up study.

Mercury Levels in Blood from Newborns from the Lake Superior Basin. US EPA GLNPO has funded a project to measure levels of mercury in the blood of newborns from the Lake Superior

basin to determine if newborns have been exposed to mercury from maternal fish consumption. The project will help characterize this population's exposure to mercury and assist health departments in targeting health protective outreach and advice on fish consumption.

This project is proposed to prospectively measure levels of mercury in the blood of newborns from the Lake Superior basin. People are exposed to mercury through consumption of fish. Measuring mercury exposure in newborns within the Lake Superior basin will help characterize this population's exposure to mercury. The data collected will assist public health departments in targeting health protective outreach and advice on fish consumption, which is the major source of methylmercury exposure. Public health agencies will also use these data to provide primary care providers with direction on targeting subpopulations for services (such as screening questions and blood tests) similar to the services that have been used for lead poisoning prevention.

Ongoing Projects

Great Lakes Sportfish Consumption Advisory Consortium – Outreach Toolkit. The Great Lakes Sportfish Consumption Advisory Consortium is in the process of developing a basinwide outreach toolkit, including printing educational materials related to mercury-contaminated fish. This toolkit will include several educational and outreach components focusing on the following groups: children, Area of Concern (AOC) residents, healthcare professionals, and restaurant and culinary school professionals. Each component of the toolkit will be implemented and evaluated for its effectiveness. The toolkit will be available for all of the states to use and implement. The consortium would like to expand and improve the most successful components of the toolkit.



Figure 5-7. A Great Lakes basinwide outreach toolkit that includes educational materials related to mercury-contaminated fish will focus on children, among other targeted groups. Photo credit: Frank Koshere, WDNR.

5.1.6 Opportunities for Future Collaboration – Healthcare Professionals

According to experts in the field of fish consumption advice, healthcare professionals are the primary and most trusted source of information regarding fish consumption advisories. At the present, there is limited environmental health training in the healthcare community, inconsistent evaluation of environmental health by healthcare accreditation boards, and no uniform approach used by healthcare professionals to assess whether patients are aware of the benefits and risks of eating fish.

The Great Lakes states and US EPA are interested in working with the healthcare professional sector (associations of physicians, nurses, and midwives) to evaluate opportunities to improve effective communication of fish consumption benefits and risks to patients, especially those patients who are most susceptible to the risks of exposure from contaminants in fish (women of child-bearing age and children).

5.1.7 Pollution Prevention

IL-IN Sea Grant Unwanted Medicine Disposal Community Toolkit. In the U.S., the use of prescription medicine increases every year. Often when prescriptions expire or are no longer needed, they are flushed or discarded. However, pharmaceuticals can pass through sewage plants and contaminate waterways.

With funding from US EPA GLNPO, Illinois-Indiana Sea Grant created a toolkit entitled *Disposal of Unwanted Medicines: A Resource for Action in Your Community*.¹⁴ Over 160 resource kits have been distributed, and Sea Grant has held workshops for over 100 local officials. As a result, a number of communities or counties in the Great Lakes region have begun collection programs.

The collection of resources in the toolkit is intended for waste management officials and others who are interested in addressing the problem of unwanted medicines in the environment. A panel of expert reviewers, including solid waste managers, pharmaceutical and personal care product researchers, pharmacists, doctors, and communication specialists, reviewed this resource kit, and their comments and suggestions were incorporated into the final version.

Illinois-Indiana Sea Grant focuses on collection events for the public as a partial solution to the problem on unwanted medicines in the environment. To assist event organizers, the kit provides a set of case studies and sample educational materials along with the Northeast Recycling Council's step-by-step advice for running a collection. Background information on the science behind the issue and a bibliography of news stories and articles from scientific journals are also featured.

Illinois-Indiana Sea Grant continues to post updated materials to the toolkit web site in an effort to provide users with the most current content available on this issue.

EarthKeepers Pharmaceutical and Personal Care Products Collection Event. In 2007, US EPA Headquarters and GLNPO funded an Earth Day Pharmaceutical and personal care product collection event in the Upper Peninsula of Michigan. Held by EarthKeepers, an environmental faith-based organization, the one-day event collected over one ton of unwanted medicines and personal care products, including a number of illegal, controlled drugs.

Prescription medication and over-the-counter medicines were collected across a 400-mile area at about two dozen free drop-off sites across northern Michigan during this third annual EarthKeeper Clean Sweep on Earth Day 2007. Volunteers collected tens of thousands of drugs,

¹⁴ IL-IN Sea Grant. *Disposal of Unwanted Medicines: A Resource for Action in Your Community*. Available at <http://www.iisgcp.org/unwantedmeds/>.

pills, and personal care products, and pulled off what US EPA called “the largest geographical pharmaceutical collection in U.S. history.” The collections prevented these medicines from being released into rivers, tributaries, lakes, and other waterways where they have been shown to cause harm to aquatic and ecosystem health. Recent nationwide studies found that 80 percent of rivers sampled tested positive for a range of pharmaceuticals, including antibiotics, birth control hormones, antidepressants, veterinary drugs, and other medications.

5.1.8 Pharmaceuticals and Personal Care Products in the Canadian Environment

A national workshop called “Pharmaceuticals and Personal Care Products (PPCP) in the Canadian Environment: Research and Policy Directions” took place March 5th to 7th, 2007, in Niagara-on-the-Lake, Ontario. This workshop assessed the current state of Canada’s research on PPCPs in the environment in government, academia, and industry sectors. Invited speakers provided overviews on environmental exposure and monitoring, effects of PPCPs on aquatic ecosystems, alternatives for reduction of human and environmental exposure to PPCPs, risk assessment process and needs, international, industry activities, provincial, and municipal activities. A principal focus of the workshop was setting priorities for research, monitoring, and regulation of PPCPs. A workshop report was produced and can be found at: <http://www.nwri.ca/ppcp-pppsp/i-cover-e.html>. The report also provides an overview of policy and management issues.

5.2 CHALLENGES

Although there continues to be a decline in fish contaminant levels, this decline has slowed in recent years and at levels still high enough to warrant fish consumption advisories. In addition, new pathogens and viruses have appeared in the Great Lakes with the potential to cause ecosystem harm. Chemicals of emerging concern, personal care products, and pharmaceuticals are coming under increased scrutiny for their presence in the Great Lakes and potential to cause harm to aquatics, and human and ecosystem health.

5.2.1 Fish Contaminant Levels in Lake Superior

US EPA GLNPO collects data under the Great Lakes Fish Monitoring Program (GLFMP). This program annually collects and composites 15 salmon filets into three composites in the small, medium, and large size categories from a variety of sites on each of the Great Lakes. Figures 5-8 through 5-13 below represent general contaminant trends in Great Lakes sport fish. Data shown in the figures reflect the changing nature of the Sport Fish Fillet Monitoring piece of the fish monitoring program. Sites have been continuously added and removed over the life of the program, and samples themselves have varied from year to year according to collection, location, and size. For that reason, only general trends can be gathered from these data.

Without remediation of contaminated sediments or restriction of contaminated atmospheric deposition, fish tissue concentrations will continue to warrant fish consumption advisories. US EPA does not issue fish consumption advice—the Great Lakes states and tribes are responsible for this task. However, concentrations measured in GLFMP sport fish can be compared to

categories in the *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory*.¹⁵ Table 5-2 presents PCB, mercury, and chlordane consumption limits for sensitive populations created for the *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory*.

Current concentrations of total PCBs in Lake Superior coho and chinook salmon fillets fall into the one meal per month consumption advice categories (see Figures 5-8 and 5-11). Total PCBs are a summation of all PCB congeners analyzed.

No DDT protocols exist to compare Lake Superior coho and chinook salmon fillet concentrations (see Figures 5-9 and 5-12).

Current concentrations of total chlordane in Lake Superior coho and chinook salmon fillets fall into the unlimited consumption category of the draft chlordane addendum to the protocol (see Figures 5-10 and 5-13). Total chlordane is a summation of *cis* and *trans* chlordane, *cis* and *trans* nonachlor, and oxychlordane.

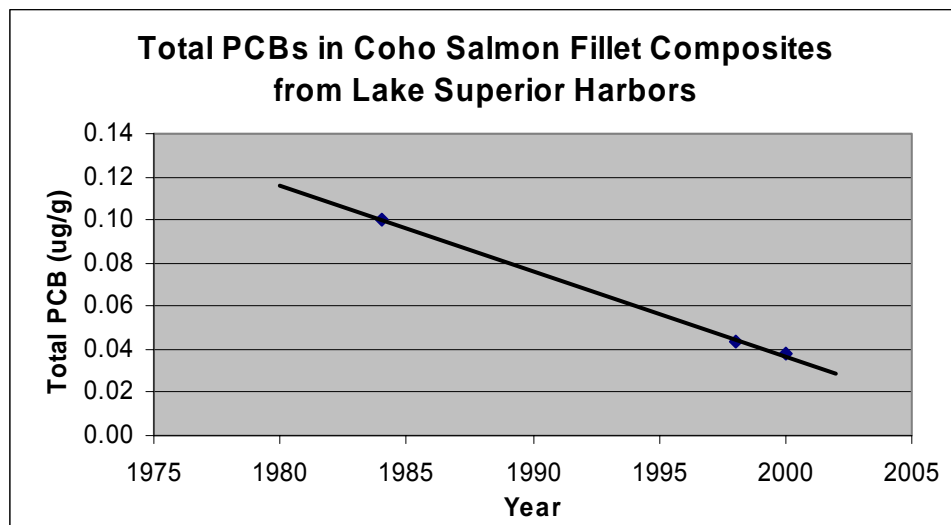


Figure 5-8. Total PCBs in Coho Salmon Fillet Composites from Lake Superior Harbors¹⁶

¹⁵ Great Lakes Sport Fish Advisory Task Force. The PCB Protocol is available at <http://fn.cfs.purdue.edu/anglingindiana/HealthRisks/TaskForce.pdf> (1993). The Mercury Protocol is available at http://dhfs.wisconsin.gov/eh/Fish/FishFS/2007Hg_Add_Final_05_07.pdf (2007).

¹⁶ Source: US EPA Great Lakes National Program Office – Great Lakes Fish Monitoring Program, 2008.

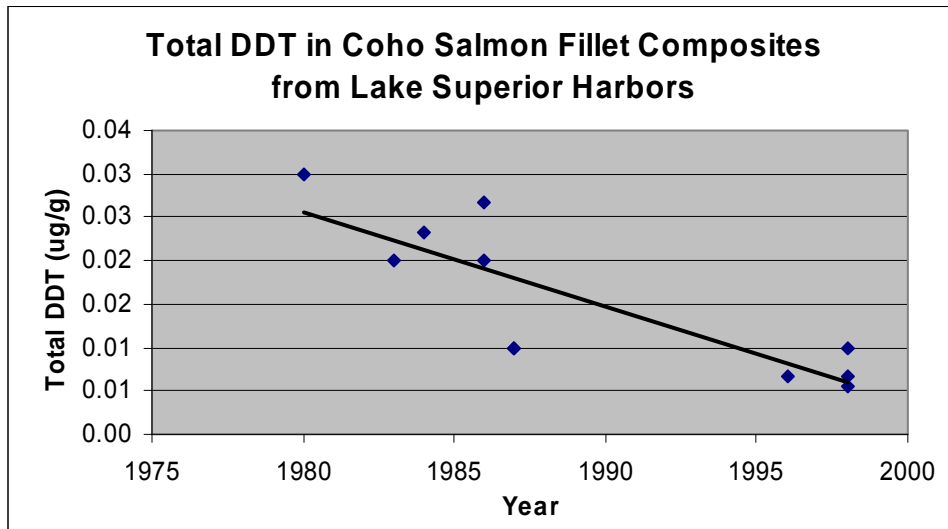


Figure 5-9. Total DDT in Coho Salmon Fillet Composites from Lake Superior Harbors¹⁷

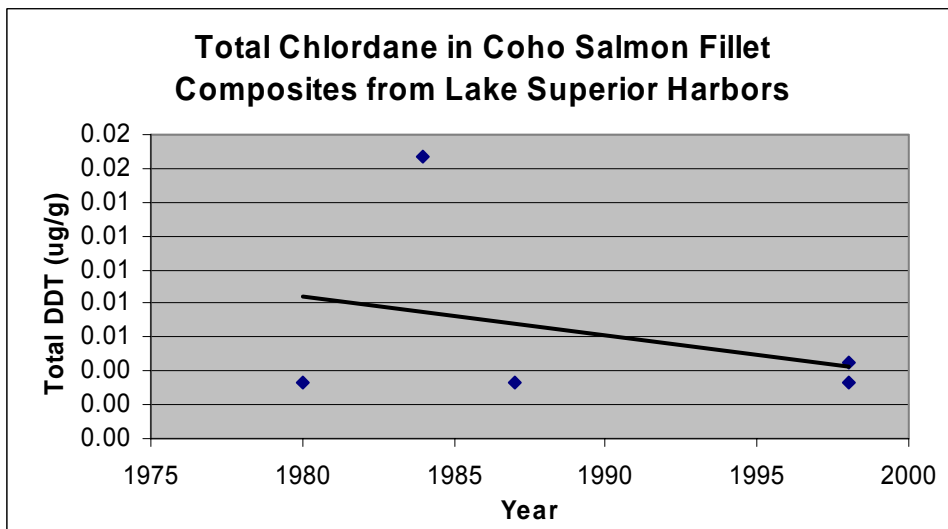


Figure 5-10. Total Chlordane in Coho Salmon Fillet Composites from Lake Superior Harbors¹⁸

¹⁷ Source: US EPA Great Lakes National Program Office – Great Lakes Fish Monitoring Program, 2008.

¹⁸ Source: US EPA Great Lakes National Program Office – Great Lakes Fish Monitoring Program, 2008.

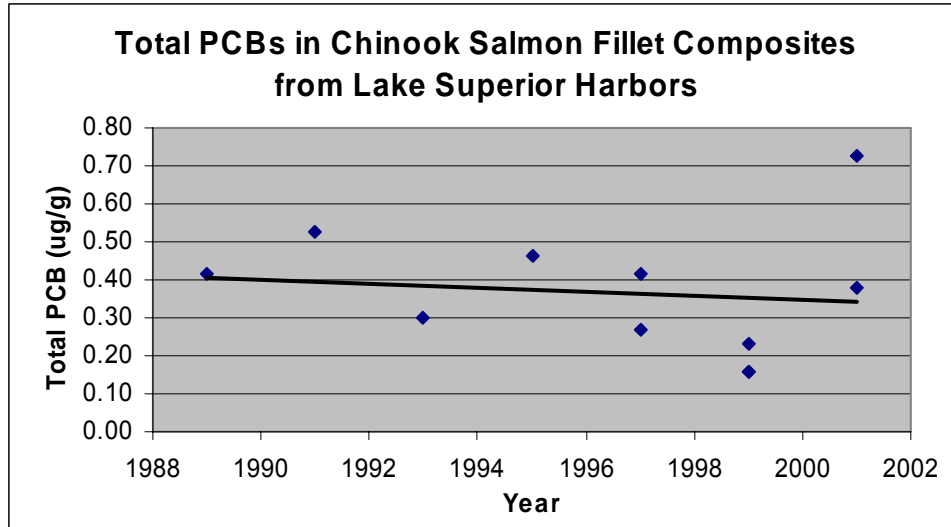


Figure 5-11. Total PCBs in Chinook Salmon Fillet Composites from Lake Superior Harbors¹⁹

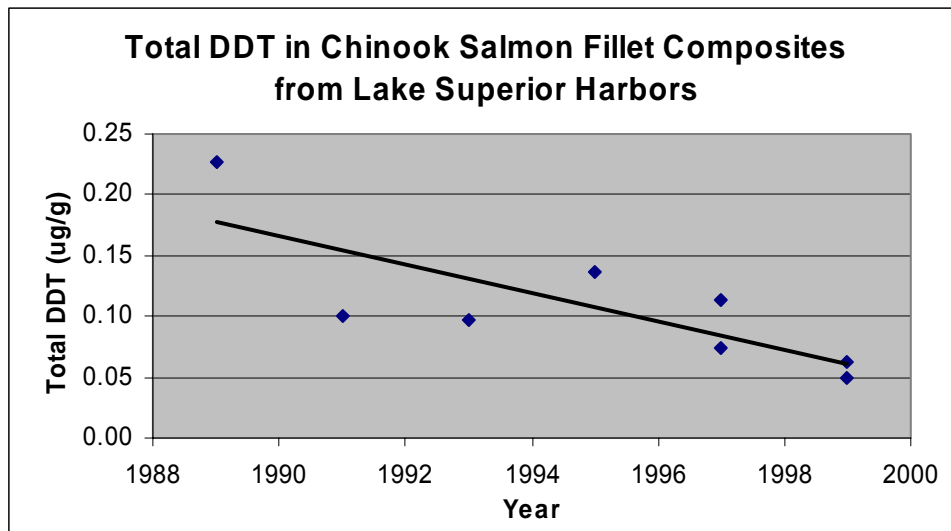


Figure 5-12. Total DDT in Chinook Salmon Fillet Composites from Lake Superior Harbors²⁰

¹⁹ Source: US EPA Great Lakes National Program Office – Great Lakes Fish Monitoring Program, 2008.

²⁰ Source: US EPA Great Lakes National Program Office – Great Lakes Fish Monitoring Program, 2008.

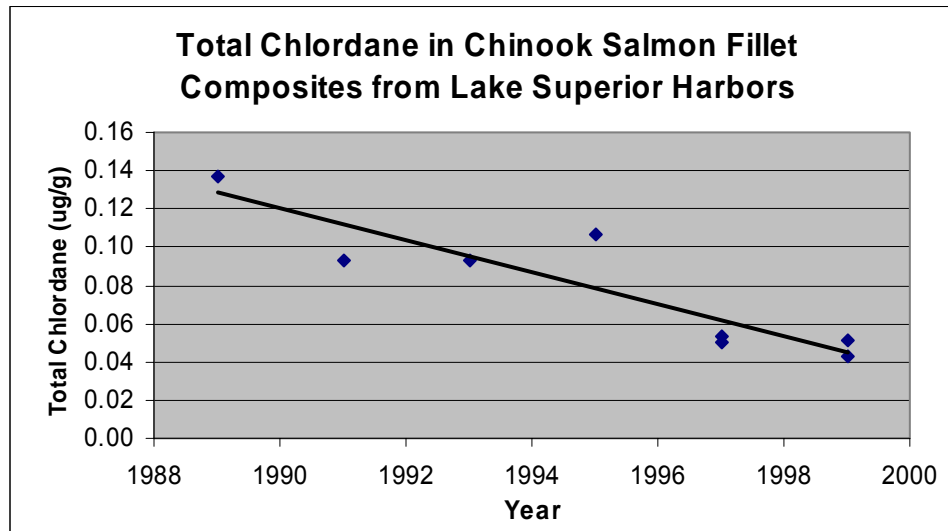


Figure 5-13. Total Chlordane in Chinook Salmon Fillet Composites from Lake Superior Harbors²¹

Table 5-2. Consumption limits for sensitive populations created for the *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory***

Consumption Advice			
Consumption Advice Groups*	Concentration of PCBs (ppm)	Concentration of Mercury (ppm)*	Concentration of Chlordane (ppm)**
Unrestricted Consumption	0 – 0.05	0 ≤ 0.05	0 – 0.15
2 meals/ week		> 0.05 ≤ 0.11	
1 meal/ week	0.06 – 0.2	>0.11 ≤ 0.22	0.16 – 0.65
1 meal/ month	0.21 – 1.0	>.22 ≤ 0.95	0.66 – 2.82
6 meals/ year	1.1 – 1.9		2.82 – 5.62
Do not eat	>1.9	>0.95	>5.62

*Women of childbearing age and children under age 15.

**The chlordane protocol is draft.

²¹ Source: US EPA Great Lakes National Program Office – Great Lakes Fish Monitoring Program, 2008.

5.3 HUMAN HEALTH AND CHEMICAL RISKS

5.3.1 Process by which US EPA Evaluates Chemicals for Human Risk

US EPA utilizes the Integrated Risk Information System (IRIS) to evaluate the health effects of individual substances. IRIS provides hazard identification and dose-response assessment information. The information in IRIS can be used in combination with exposure information to characterize the public health risks of a given substance in a given situation. These risk characterizations can form the basis for risk-based decision-making, regulatory activities, and other risk management decisions designed to characterize and protect public health.

US EPA's process for developing IRIS assessments consists of: (1) an annual Federal Register announcement of US EPA's IRIS agenda and call for scientific information from the public on the selected substances, (2) a search of the current literature, (3) development of a draft Toxicological Review (other support document) and IRIS Summary, (4) internal peer consultation, (5) Agency Review, (6) Interagency Review, (7) external peer review and public comment, (8) final Agency Review, Interagency Review, and US EPA Office of Research and Development management approval, and (9) posting on the IRIS database.

For more information on the chemicals currently being evaluated by IRIS, go to <http://cfpub.epa.gov/ncea/iris/index.cfm>.

5.3.2 Sources of Exposure to PBDEs

Although the use of flame retardants saves lives and property, there have been unintended consequences of the use of polybrominated diphenyl ethers (PBDEs). There is growing evidence that PBDEs persist in the environment and accumulate in living organisms, as well as toxicological testing that indicates these chemicals may cause liver toxicity, thyroid toxicity, and neurodevelopmental toxicity. Environmental monitoring programs in Europe, Asia, North America, and the Arctic have found traces of several PBDEs in human breast milk, fish, aquatic birds, and elsewhere in the environment. Particular congeners, tetra- to hexabrominated diphenyl ethers, are the forms most frequently detected in wildlife and humans.

The mechanisms or pathways through which PBDEs get into the environment and humans are not known yet, but could include releases from manufacturing or processing of the chemicals into products like plastics or textiles, aging and wear of the end consumer products, and direct exposure during use (e.g., from furniture). Some research has evaluated PBDE levels in market basket foods.²² This research suggests that dietary exposure does not account for the high body burdens that have been observed in people. The latest research suggests that household dust and air from the indoor environment may play a significant role in PBDE body burden levels.²³

²² Schechter A, Pöpke O, Harris TR, Tung KC, Musumba A, Olson J, and Birnbaum L. 2006. Polybrominated Diphenyl Ether (PBDE) Levels in an Expanded Market Basket Survey of U.S. Food and Estimated PBDE Dietary Intake by Age and Sex. *Environmental Health Perspectives*, Volume 114, Number 10.

²³ US EPA. Office of Pollution Prevention and Toxics, Polybrominated diphenylethers (PBDEs) web site: <http://www.epa.gov/oppt/pbde/>.

5.4 IS THERE A HUMAN HEALTH RISK?

5.4.1 Viral Hemorrhagic Septicemia

Viral Hemorrhagic Septicemia (VHS) virus is a serious fresh and saltwater fish pathogen that is increasingly observed in the Great Lakes region of the U.S. and Canada.²⁴ VHS virus is a rhabdovirus that affects fish of all size and age ranges but does not pose any threat to human health. VHS cannot infect humans if they eat fish that have the pathogen.²⁵

VHS, known for its damaging effects in Europe and the Pacific Northwest, was first detected in the Great Lakes in 2005 and was later confirmed in fish captured in 2003. Since its arrival, VHS has caused widespread mortality of fish in the lower Great Lakes, affecting thousands, perhaps hundreds of thousands of fish in a single event. VHS has proven to be broadly pathogenic in the Great Lakes, affecting dozens of fish species across several families. Recent genetic work indicates that Great Lakes VHS isolates are most closely related to isolates from the Atlantic seaboard of North America, and that the introduction of VHS to the Great Lakes likely occurred within the past 5-10 years. Despite the rapid spread of VHS through the lower Great Lakes, VHS has not yet been reported from Lake Superior or its watershed.

In 2007, the U.S. National Park Service prohibited all ballast water from being released in the boundaries of Isle Royale National Park to prevent possible VHS contamination of its waters. The National Park Service, in conjunction with other state and federal agencies, has drafted a VHS prevention, containment, and response plan. For more information, please see:

www.dec.ny.gov/animals/25328.html or
www.aphis.usda.gov/publications/animal_health/content/printable_version/sa_vhsfo_vs.pdf.

5.4.2 Botulism

Type E botulism poisoning of fish and wildlife has recently increased in the Great Lakes with the most recent example in Michigan near the Sleeping Bear Dunes National Lakeshore. Many people are concerned not only of the ecological impacts of this type of botulism but also of the human health impacts.

In the past, a few Type E botulism cases were reported in humans. However, this was due to improperly prepared smoked or cooked fish, and these cases were rare. Most media reports of botulism issues in humans are from Type A and B botulism. These types of botulism occur in food as a result of improperly canned or jarred food. Cooking food to proper temperatures will destroy bacteria, including botulism.

²⁴ U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2007. Stakeholders Announcement: USDA Amends Viral Hemorrhagic Septicemia-Susceptible Species List. Available at: http://www.aphis.usda.gov/publications/animal_health/content/printable_version/sa_vhsfo_vs.pdf.

²⁵ New York State Department of Environmental Conservation website: <http://www.dec.ny.gov/animals/25328.html>.

When fishing or hunting water fowl in the Great Lakes, it is important to choose healthy fish and to discard fish or waterfowl that are sick or act abnormally. Improper cooking may not destroy the botulism Type E toxin.

5.5 NEXT STEPS

Challenges and next steps related to improving human health include:

- Continue to implement actions outlined in the Great Lakes Regional Collaboration's Coastal Health Strategy;
- Continue to improve beach monitoring and public notification;
- Promote measures that will reduce or eliminate pollution sources at Great Lakes beaches;
- Develop and disseminate a standardized sanitary survey tool to identify contamination sources at Great Lakes beaches;
- Continue pharmaceutical outreach and education to collect unwanted medications;
- Continue pollution prevention actions to prevent chemicals of emerging concern from entering waterways;
- Disseminate information and training tools on the use of forecast models at Great Lakes beaches; and
- Work with the International Joint Commission to evaluate standardization of criteria for posting beaches in the U.S. and Canada.

5.6 INFORMATION

Web links listed below provide reference material for information cited in beach LaMP updates. In addition, a collection of useful resources (journal articles, publications, published abstracts, and technical reports) has been compiled for future use.

Lake Superior States' Beach Web Pages

Michigan: www.michigan.gov/deq/1,1607,7-135-3313_3686_3730---C1,00.html

Minnesota: www.pca.state.mn.us/water/beaches/

Wisconsin: www.dnr.state.wi.us/org/water/wm/wqs/beaches/

Great Lakes Sea Grant

Great Lakes Sea Grant Network: <http://www.greatlakesseagrant.org/>

Michigan Sea Grant: <http://www.seagrant.umich.edu/>

Minnesota Sea Grant: <http://www.seagrant.umn.edu/>

Wisconsin Sea Grant: <http://www.seagrant.wisc.edu/>

US EPA

US EPA's BEACH Watch home page, including links to the BEACH Act, the *National Beach Guidance and Required Performance Criteria for Grants*, US EPA's national beach water quality database, and technical and reference documents:

<http://www.epa.gov/waterscience/beaches/>

US EPA Great Lakes National Program Office: <http://www.epa.gov/glnpo/>

US EPA's *Report to Congress: Impacts and Control of CSOs and SSOs* (delivered August 26, 2004): http://cfpub.epa.gov/npdes/cso/cpolicy_report2004.cfm

Great Lakes Monitoring – The Swimmability Index:

<http://www.epa.gov/glnpo/glindicators/water/beachb.html>

Great Lakes Strategy 2002 – A Plan for the New Millennium:

<http://www.epa.gov/grtlakes/gls/gls04.html>

BEACON – Beach Advisory and Closing On-line Notification:

http://oaspub.epa.gov/beacon/beacon_national_page.main

Other Web Sites

Alliance for the Great Lakes Citizen's Center for Beach Health:

http://www.greatlakes.org/conservation/beach_health_index.asp

Great Lakes Water Institute – Bacterial Genetics Research Lab:

<http://www.uwm.edu/Dept/GLWI/ecoli/>

Great Lakes Beach Association: <http://www.great-lakes.net/glba/>

Great Lakes Information Network (GLIN): <http://www.great-lakes.net/>

Beaches in the Great Lakes Region: <http://www.great-lakes.net/tourism/rec/beach.html#new>

Center for Disease Control - Healthy Swimming: <http://www.cdc.gov/healthyswimming/>

Great Lakes BeachCast – Great Lakes Beach Information (many links from this site):

http://www.great-lakes.net/beachcast/nr_moreinfo.html

Great Lakes Research Consortium: <http://www.esf.edu/glrc/>

NOAA Great Lakes Environmental Research Laboratory (GLERL)

Center of Excellence for Great Lakes and Human Health:

<http://www.glerl.noaa.gov/res/Centers/HumanHealth/>

USGS Great Lakes Science Center: <http://www.glsc.usgs.gov/>

Great Lakes Commission: <http://www.glc.org/>

International Joint Commission: <http://www.ijc.org/>

Council of Great Lakes Research Managers – Great Lakes-St. Lawrence Research Inventory:
<http://ri.ijc.org>

Great Lakes Protection Fund: <http://www.glpf.org/>

International Association for Great Lakes Research: <http://www.iaglr.org/>

Lake Superior Duluth Streams: www.DuluthStreams.org

Wisconsin Beach Health Web site: www.wibeaches.us