1.3 Drinking Water Contaminants

Contaminants in surface and ground waters have the potential to cause childhood diseases such as acute gastrointestinal illness, learning disorders, and cancer. Contaminants of potential concern include bacterial, viral, and other microbial pathogens in sewage, nitrates from fertilizer, the chemical by-products of disinfection (the process used to kill microbial pathogens), lead released slowly from indoor plumbing, arsenic and radioactivity occurring naturally in groundwater, gasoline from spills and leaks, and the pharmaceuticals and personal care products left untreated by sewage systems, among others. Threats to drinking water are controlled through the application of water quality standards, regulations, and best practices; these efforts usually succeed in reducing contamination to low levels where the chance of harm is small and adverse effects are difficult to detect.

The protection of drinking water in public water systems is the central goal of the Safe Drinking Water Act. About 85 percent of Maryland's population uses public water systems, defined as systems that provide piped water for human consumption to at least fifteen service connections or regularly serve twenty-five individuals. Public water systems that serve residents year-round are referred to as community water systems. There are approximately 3,600 public water systems and 500 community water systems in Maryland. The two largest community systems serve the metropolitan Baltimore and Washington areas, providing water for approximately 60 percent of the state's population (EPA, 2005).

Public water supplies are closely regulated because they serve relatively large numbers of people. A system may fail to comply with safe drinking water rules in three basic ways:

1. The contaminants in treated water must be kept below the legal standard. EPA has created drinking water standards for approximately ninety contaminants.
2. Raw water must be treated by approved methods before it is piped to consumers. Notices of violation are issued when a system fails to follow treatment protocols.
3. Scheduled monitoring is required to ensure that the system is functioning properly. Notices of violation are issued when a system fails to test for contaminants on the proper schedule and report the results on time.

The standards and requirements for treatment and reporting under the Safe Drinking Water Act do not apply to small private systems, many of which use domestic wells. These small private systems serve approximately 43.5 million people in the U.S. and 900,000 people in Maryland (approximately 15 percent of the population) (EPA, 2005). Wells must be properly constructed and tested before use, after which monitoring and maintenance are usually left in the hands of the property owner. Many of these private wells are in rural and agricultural areas and may be at increased risk from nitrate and fecal contamination, as well as contamination from local chemical spills, petroleum tanks, pesticides, and natural mineral deposits. The State of Maryland requires that new domestic wells be properly constructed and tested for bacteria, nitrates, and several other routine constituents. Local county health departments may require tests for arsenic, radiation, and other compounds as a result of local conditions.

Analysis of data from the Maryland Department of the Environment shows that the percentage of Maryland children not on public water systems gradually increased from 8 – 14 percent from 1993 to 2004. Because there is no routinely collected data on water quality from these wells, it is not possible to assess the risk to children's health from this source. This is a significant limitation in interpreting risk from water-borne contaminants in Maryland.

Indicator E9: Percentage of Children Served by Community Water Systems That Did Not Meet All Applicable Health-based Drinking Water Standards

This indicator shows the percentage of children using community water systems where a drinking water standard was exceeded or treatment requirements were not met. It illustrates the collective performance of community water systems although it does not represent the actual frequency, severity, and cumulative impact of violations. Drinking water rules are periodically updated, thus the changes shown in Figures 13 and 14 are sometimes due to changes in rules and standards rather than actual changes in water quality.

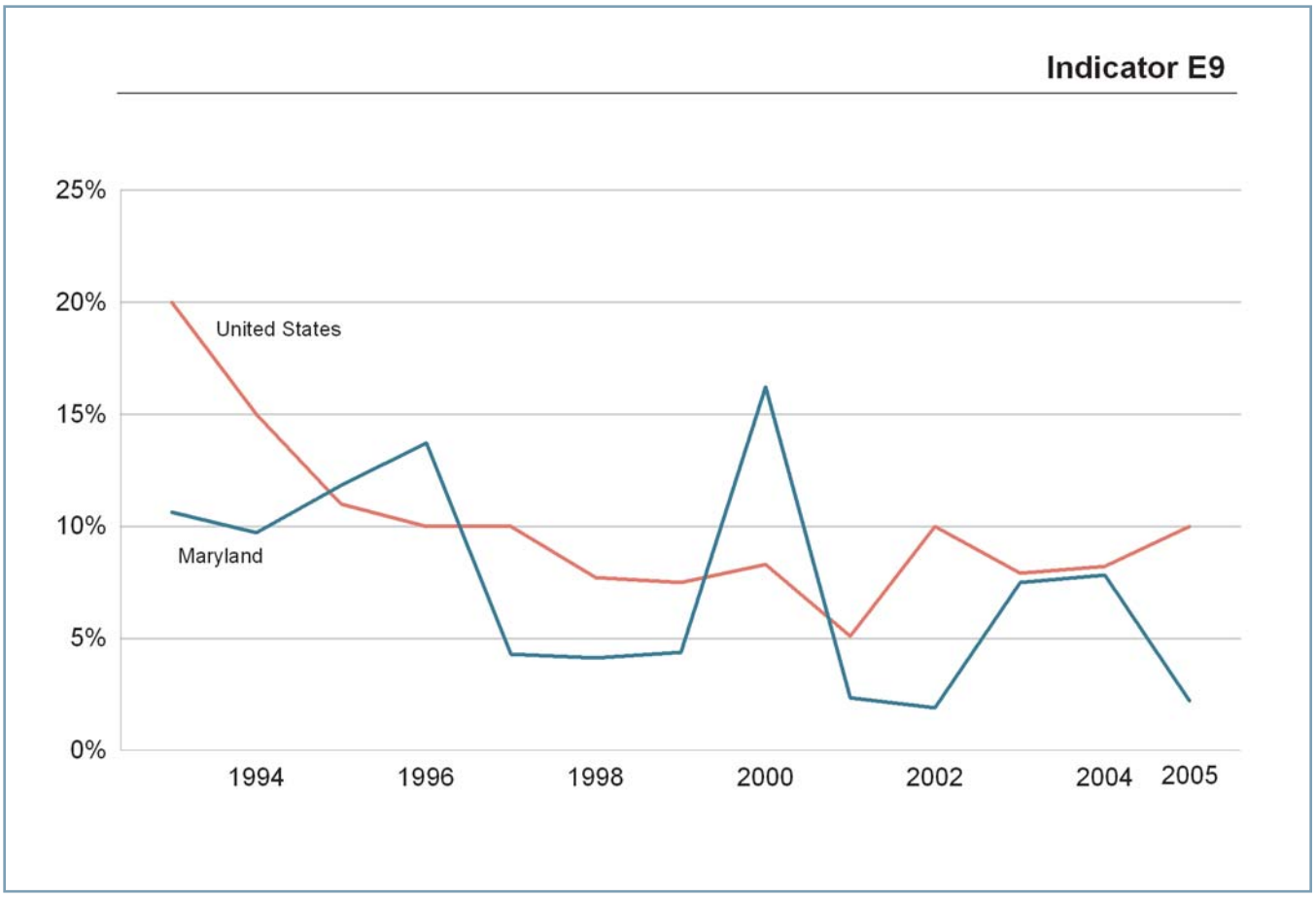

Figure 13. Percentage of Children Served by Community Water Systems that Exceeded at Least One Health-based Drinking Water Standard
Source: US Environmental Protection Agency, Office of Water, Safe Drinking Water Information System (percentages are estimated)

- Since 1993, a range of 2 – 16 percent of Maryland children and 5 – 20 percent of U.S. children have lived in areas served by community water systems that experienced one or more episodes of noncompliance with drinking water standards or treatment requirements. Single issues, such as elevated coliforms (bacteria, usually from contamination with sewage), tend to impact fewer than 5 percent of the childhood population. The peak in Maryland in 2000 was due to a treatment violation by a public water system in Baltimore City serving 1.6 million persons and an estimated 400,000 children.

- From 2004 to 2005, the percentage of children served by noncompliant systems in Maryland varied between racial and ethnic groups and between groups with household incomes above and below the poverty line. The percentages were highest for White non-Hispanic children and children living at or above the poverty line. No national comparison data are available.

Healthy People 2010: Objective 8-05 of Healthy People 2010 focuses on increasing the proportion of persons served by community water systems who receive a supply of drinking water that meets the regulations of the Safe Drinking Water Act.

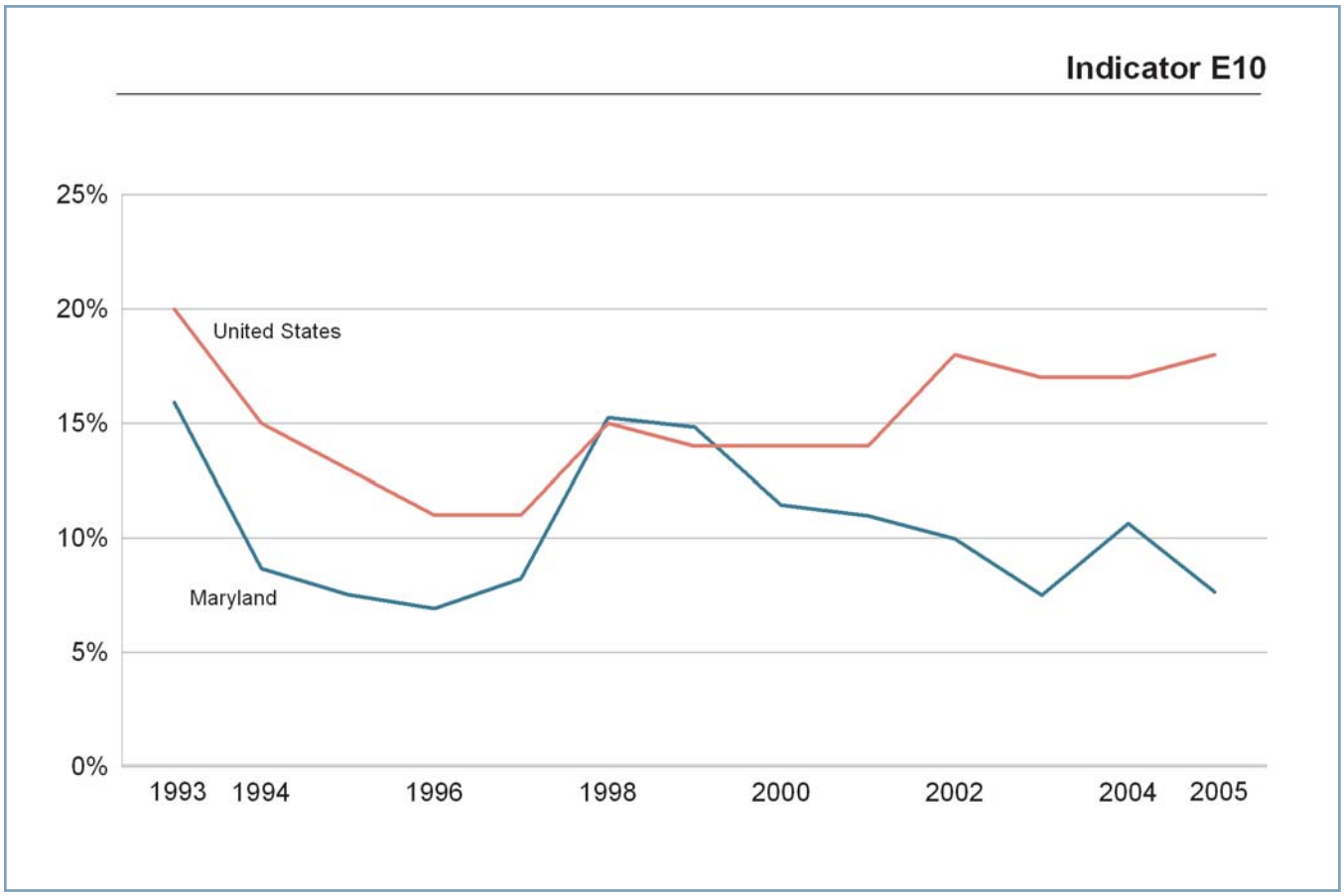

Figure 14. Percentage of Children Living in Areas Served by Community Water Systems with Violations of Drinking Water Monitoring and Reporting Requirements
Source: US EPA, Office of Water, Safe Drinking Water Information System (percentages are estimated)

Indicator E10: Percentage of Children Living in Areas Served by Community Water Systems With Violations of Drinking Water Monitoring and Reporting Requirements

This indicator shows the percentage of children using community water supplies that failed to correctly monitor or report their water quality. Without proper monitoring and reporting, episodes of poor water treatment and exposure to contaminants may not be detected in a timely fashion. The actual frequency and severity of monitoring and reporting violations are not reflected in this information.

- In the years since 1993, a range of 7 – 16 percent of Maryland children and 11 – 20 percent of U.S. children have lived in areas served by community water systems with at least one monitoring and reporting violation. The largest number of violations occurs in the category of lead and copper monitoring, which requires sampling in households throughout the community.
- In Maryland in 2004 – 2005, a range of 4 – 11 percent of children lived in areas served by water systems with violations in drinking water monitoring and reporting requirements. The percentages were highest for White Non-Hispanic and Native American children and children living at or above the poverty line. No national comparison data are available.

Healthy People 2010: Objective 8-05 of Healthy People 2010 focuses on increasing the proportion of persons served by community water systems who receive a supply of drinking water that meets the regulations of the Safe Drinking Water Act.

1.4 Pesticides

Pesticides are substances specifically produced and utilized to manage pests that are deleterious to humans and the human environment. Except for limited medical usages, they are not meant to be ingested or otherwise enter the human body. Specific categories of pesticides are in use to deter rodents (rodenticides), insects (insecticides), unwanted plants (herbicides), and fungi (fungicides).

Children may be unintentionally exposed to these products through contaminated food and water, by hand-to-mouth activity after contact with the product on floors and other surfaces, and by inhalation into their lungs and absorption through their skin following application of pesticides. Young children may also be exposed to pesticides by accidental ingestion of household or other products. Children can also potentially be exposed to these products through consumer use in their homes, schools and play areas, as well as through environmental contamination from farming and industrial usages. Children whose families work as pesticide applicators may be exposed through products brought into the home on their parent's work clothes. Young agricultural workers or children of agricultural workers may be contaminated in fields when inappropriate work practices exist.

Chemicals of particular concern are those that are persistent in the environment and enter drinking water or the food chain. Certain pesticides found to be long-lasting in the environment or highly toxic have been banned for use in the United States. These include substances such as DDT and other long-lived organochlorine products as well as some short-lived but highly toxic organophosphate insecticides. The EPA sets limits on pesticide residues on both domestic (interstate) and imported foods. However, some banned products are still used in international settings.

The effects of pesticides on children depend on the specifics of the chemical, the dose, and route of exposure. For example, at sufficiently high exposures, rodenticides can cause internal bleeding and organophosphates can lead to respiratory muscle paralysis, seizures and coma. Low-level exposures are much more common, but the adverse effects are harder to measure. Chronic, low-level exposures have been connected to neurologic and developmental findings, cancer, particularly central nervous system tumors and leukemia, as well as effects on reproductive organs. Much remains to be learned about the effects of these chemicals on children's developing organ systems.

There have been efforts to reduce pesticide exposures in children in Maryland. Maryland now requires parental notification when pesticides are applied in public schools and on school grounds (Md. Code Ann., Agricultural Article §5-208.1; COMAR 15.05.02). The Maryland Department of Agriculture, which regulates pesticide application and licenses applicators, promotes the use of integrated pest management (IPM) and pesticide application techniques that reduce potential exposures.

Data about pesticide use, exposures and pesticide-related illnesses exist but are limited. Surveys are used to collect information from commercial, private pesticide applicators, farmers and growers about when, where, and how they have applied pesticides. Researchers use crop patterns to predict the locations of agricultural pesticides. Public health agencies test food and raw and unfiltered drinking water. The CDC tests the blood and urine of U.S. residents to determine background levels and monitor trends in the population-at-large; the "Report on Human Exposure to Environmental Chemicals" includes biologic monitoring data in children as young as six years of age. (CDC, 2005)

In Maryland, the Maryland Poison Center and the state's Hospital Discharge Database capture information about acute pesticide poisonings. Although pesticide-related illnesses are reportable in Maryland, many mild-to-moderate symptoms of pesticide toxicity could easily be attributed to other conditions and cases are generally not reported to the state. More subtle illnesses from low-level pesticide exposures remain difficult to identify and diagnose, and effective surveillance systems for these types of illnesses do not exist. More research, including biological monitoring and epidemiologic studies, will be needed to clarify any contribution of childhood pesticide exposure to conditions that are being recognized more frequently in Maryland children in the twenty-first century, such as neurodevelopmental disturbances and asthma.

E11: Number of Pesticide-related Exposures in Children Reported to Maryland Poison Center

Two poison control centers serve Maryland: the Maryland Poison Center (MPC) at the University of Maryland School of Pharmacy, and the National Capitol Poison Center in the Washington metro area. Parents and children are familiar with and are encouraged to keep the phone number of a Poison Center readily available to call for advice in case of ingestion or other exposure to a toxic substance. Trends in the number and types of calls (see Figure 15) provide a glimpse of children's acute pesticide exposures, or at least concerns, in homes and other sites. Data are available by substance as well as by demographic characteristics of the subject of the call. It should be noted that while calls are verified where possible to ensure they refer to actual cases, the Poison Centers cannot determine the outcome of the cases or the severity. In general, drugs and cleaning agents are the most common agents for which the poison control centers receive calls (Maryland Poison Center, 2006).

- Each year, the Maryland Poison Center receives over 600 calls about children less than five years of age for pesticide-related concerns. In 2005, these calls represented 6 percent of all calls and included informational requests as well as reports of exposure. Most of these calls concerned insecticides, rodenticides, and insect repellents.

Healthy People 2010: Objective 8-13 focuses on reducing pesticide exposures that result in visits to a health care facility.

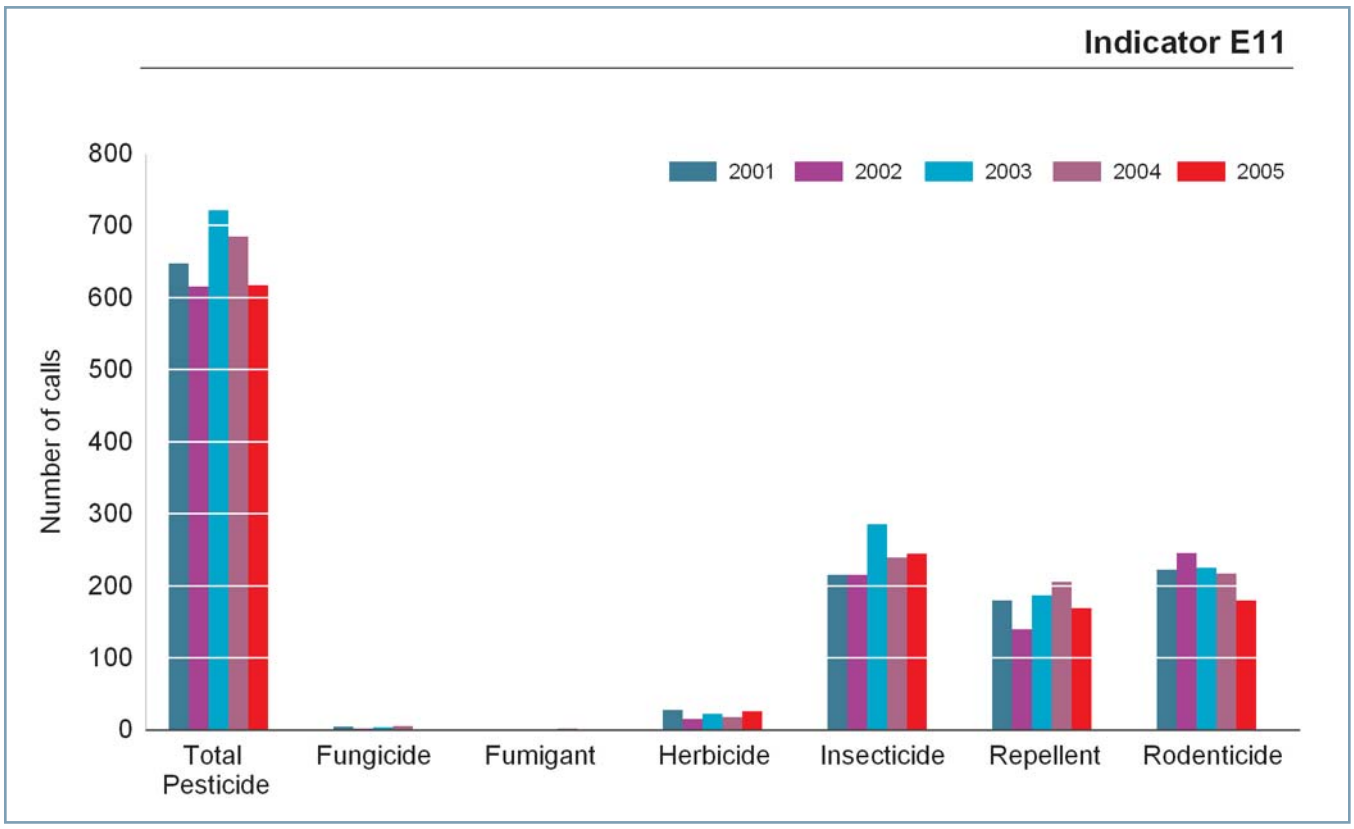

Figure 15. Pesticide-related Calls to Maryland Poison Center, 2001 – 2005
Source: Maryland Poison Center

1.5 Hazardous Substance Sites

The term "hazardous substance sites" refers to sites where hazardous substances have been improperly discarded or abandoned and present a threat of being released into the environment. In these settings, hazardous substances may migrate off-site, contaminating soil, water, air, and buildings on nearby properties. Maryland's 300-year industrial history has created a legacy of impacted properties requiring assessment and cleanup to protect public health.

Living, working, or playing near a hazardous substances site does not automatically represent a danger. A number of factors determines the risk associated with a site, such as the toxicity of the materials, their ability to move off-site, the distance to nearby populations, local geologic and hydrologic conditions, and access to the site by members of the public. When discovered, hazardous substances are controlled in several ways: contaminated soils and materials may be removed, restrictions may be placed on the use of the property and the use of local groundwater, and physical barriers such as paving and fencing may be installed.

Newly-identified sites of concern are evaluated in a systematic fashion to establish whether hazardous substances are present and whether they represent an active or potential risk to human health and the environment. The Maryland Department of the Environment evaluates risks to humans and wildlife, both on and off the property. This information is used to guide corrective actions.

Several categories of hazardous substances sites exist in Maryland. Many of the sites that are identified by the categories listed below may either have been remediated or are being assessed to determine potential risk to human health.

- ***Superfund sites.*** Also called National Priority List (NPL) sites, these sites pose the most significant risk to human health and the environment based on a grading system developed by the EPA. EPA and MDE coordinate the clean-up of these sites in Maryland.
- ***State Master List sites.*** These sites are also found on the federal Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS) database. These sites have been identified as either contaminated or perceived to be contaminated, but have not scored high enough using EPA's Hazard Ranking System to justify placing the site on the NPL. They usually present low or moderate risk to human health and the environment. MDE is responsible for their investigation and clean-up.
- ***Brownfield sites.*** These are sites where contamination, or perceived contamination, hinders the redevelopment or reuse of real properties. Such sites are typically abandoned or under-utilized industrial or commercial properties with real or perceived contamination. However, they also can include agricultural or residential properties where hazardous substances and/or petroleum have been or may have been released into the environment. In Maryland, these sites are being returned to use through the Voluntary Cleanup Program (VCP), the Controlled Hazardous Substance (CHS) Enforcement Program or the Hazardous Waste Enforcement Division at MDE.

Actual chemical exposures and health impacts in populations are difficult to measure and are not routinely collected. No indicator of either exposure or health impacts is readily available for hazardous substance sites in Maryland, and thus none is proposed in this report.

Healthy People 2010: Objective 8-12 of Healthy People 2010 focuses on minimizing the risk to human health and the environment posed by hazardous sites.

1.6 Contaminants in Fish

Fish are an important part of a healthy diet. They contain high-quality protein, essential nutrients, and omega-3 fatty acids, all of which can contribute to a child's proper growth and development. Fish are also recommended in the adult diet and contribute to a healthier heart.

Low levels of chemical contaminants are usually present in fish. To ensure that the health benefits outweigh the risks, it is important to know which fish are likely to be contaminated and to eat them in moderation or avoid them altogether. Eating fish low in contaminants is particularly important for women who are pregnant or may become pregnant, women who are nursing an infant, and young children. In Maryland, methylmercury and PCBs (polychlorinated biphenyls) are the primary contaminants of concern. Both have the potential to influence a child's neurological development, including subtle effects on intelligence, language development, attention, and memory.

Methylmercury and PCBs are global contaminants that enter the environment and pass up the food chain. Mercury can occur naturally but is in greater quantity in air, water, and food due to coal burning, incinerators, and industrial activity. In water environments, mercury may be converted to methylmercury and concentrate through the food chain, concentrating more in some fish species than others. In a national survey, 6 percent of women of childbearing age have methylmercury levels within a factor of 10 of the levels associated with neurodevelopmental effects in the fetus (CDC, 2005). PCBs are manmade chemicals that were used in electrical equipment and many other products until they were banned in the 1970s. Because of their chemical stability, they continue to persist and cycle in the environment at low levels. Fish, meat, and dairy products are our primary sources of exposure.

Pollution laws, environmental clean-ups, monitoring and public information are used to minimize human exposures to these compounds. Commercially sold fish, which are eaten more often and by more people, are monitored by the U.S. Food and Drug Administration and the EPA. These agencies recommend that women and young children eat two meals a week of a variety of fish low in mercury and avoid eating ocean species known to be high in mercury (shark, swordfish, king mackerel, and tile fish; http://www.epa.gov/waterscience/fishadvice/advice.html). Individual states monitor the populations of recreational fish. As of 2004, forty-four states had recommended that women and children limit consumption of one or more local fish species as a result of methylmercury. Maryland's advisories are created by the Maryland Department of the Environment and posted at http://www.mde.state.md.us/CitizensInfoCenter/FishandShellfish. These are updated as needed to reflect new information about the health risks and new results from fish monitoring.

Indicator E12: Average Concentrations of Contaminants in Recreational Fish

In Maryland, fish from most major water bodies have been tested for contaminants, and recommendations have been issued for fish species and crabs where warranted. Black bass (a group that includes both large and small mouth bass) is a useful group for following the occurrence of methylmercury in lakes, reservoirs, and streams, where mercury is the most common problem (see Figure 16). White perch are a useful indicator of PCB contamination in the tidal tributaries of the Chesapeake Bay, where PCBs are the most common cause of fish consumption advisories (see Figure 17).

- Contaminants can be found in both commercial and recreational fish. The majority of waterways in Maryland have recreational fish consumption guidelines for one or more species. This information is especially important for women of childbearing age and children.

- Methylmercury is common in large and small mouth bass throughout freshwaters in Maryland. There is no clear geographical trend, although several sites in western and eastern Maryland have higher values. The highest average value has been measured in Lake Lariat in Calvert County; women of childbearing age who catch and eat fish from this site are advised to eat less than one meal per month of small and large mouth bass.
- PCBs levels in white perch are higher in the northern tributaries of the Chesapeake Bay, suggesting a greater number of historical sources or persisting

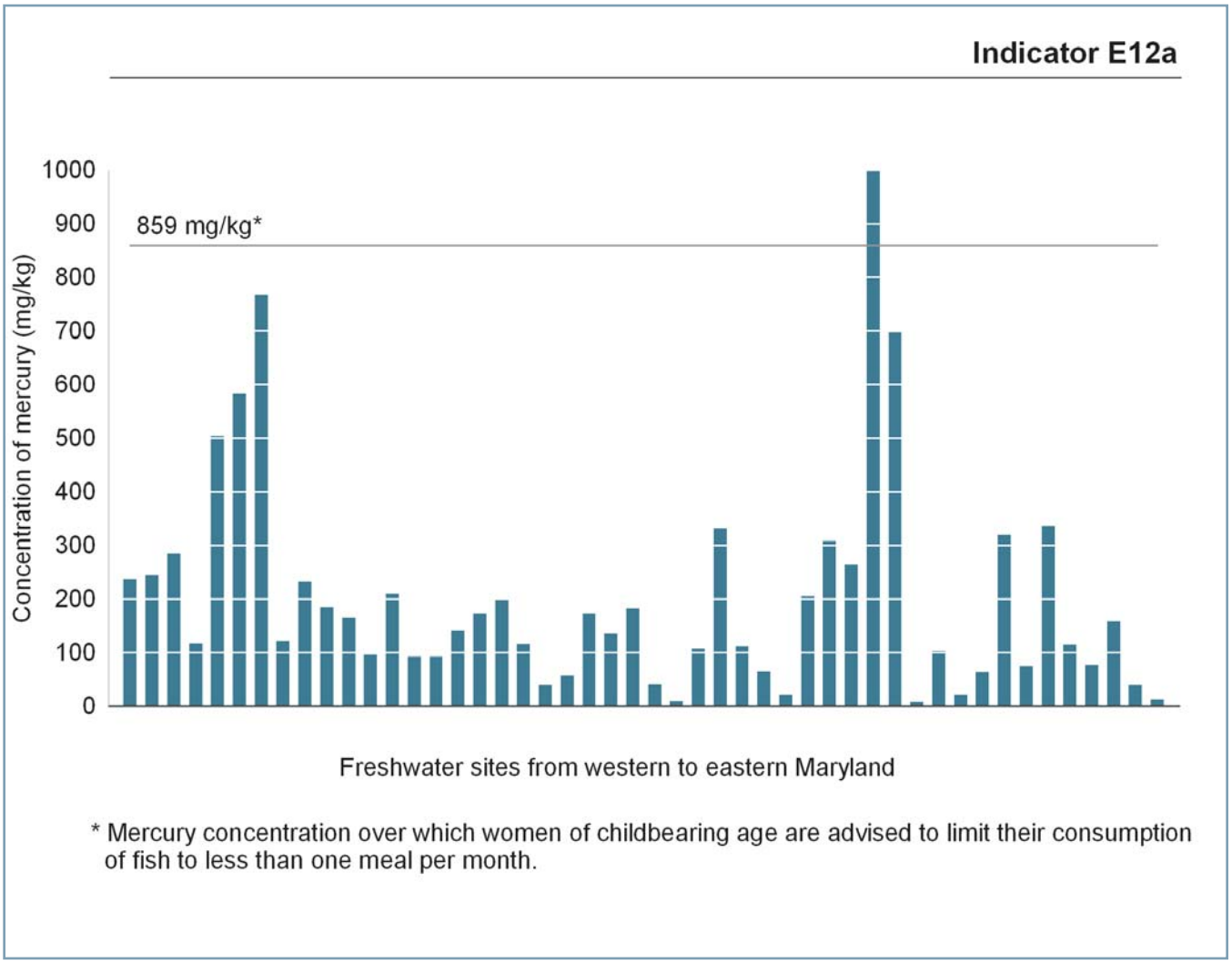

Figure 16. Average Mercury Concentrations in Black Bass from 48 Freshwater Sites in Maryland, 1999 – 2005
Source: Maryland Department of the Environment

low-level sources for this area. The highest average values occur in the Patapsco River, followed by the Elk, Middle, and Back Rivers, where women who catch and eat fish are advised to avoid eating white perch or eat less than one meal per month.

Important information about other fish species and locations is available at the MDE website.

Healthy People 2010: Objective 8-10 of Healthy People 2010 focuses on reducing the potential human exposure to persistent chemicals by decreasing fish contaminant levels.

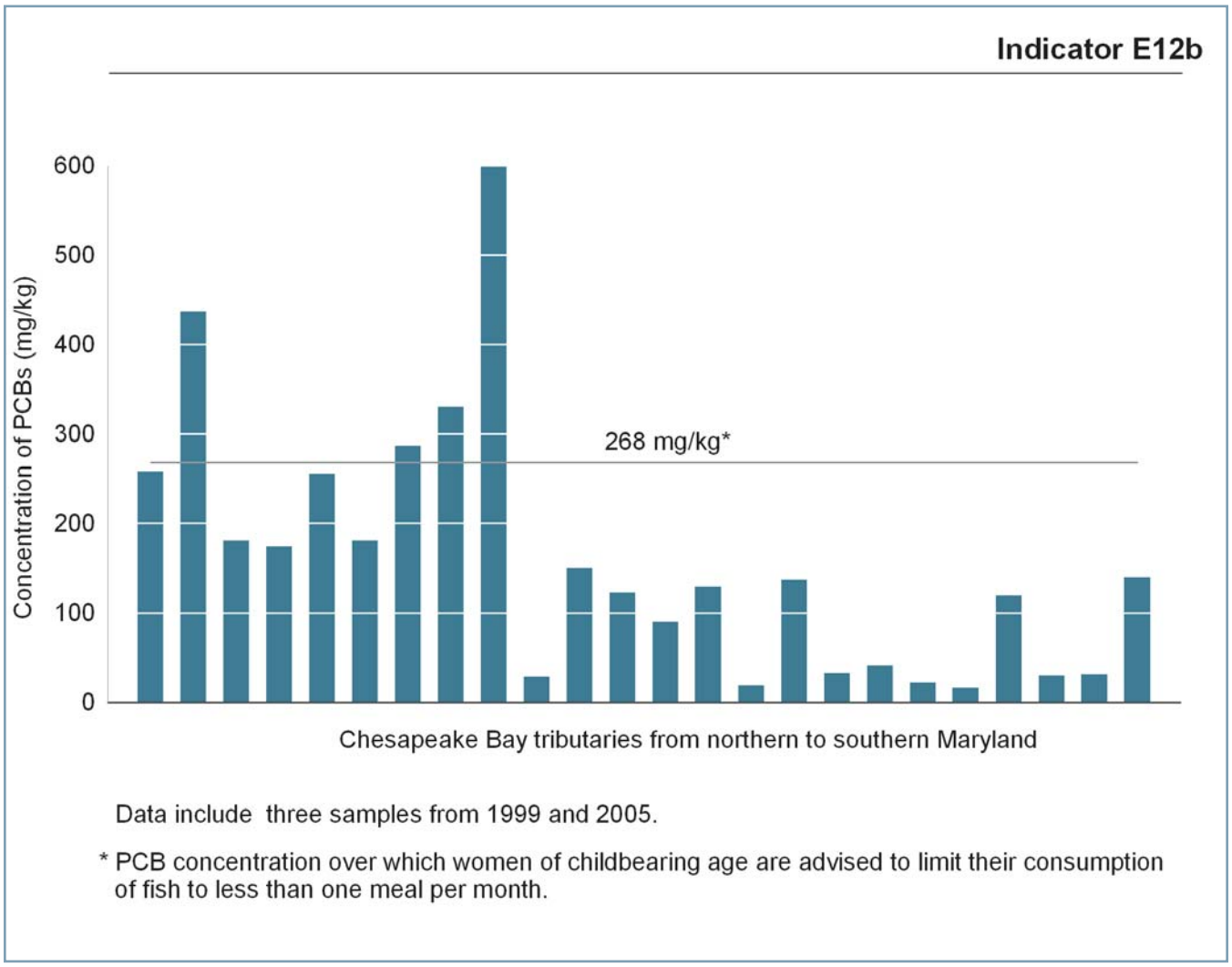

Figure 17. Average PCB Concentrations in White Perch from 24 Estuarine Sites in Maryland
Source: Maryland Department of the Environment