Appendix A. ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency in Atlanta, Georgia, with 10 regional offices in the United States. ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases from toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. For additional questions or comments, call ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Ambient
Surrounding (for example, ambient air).

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cohort Study (or Prospective Study)
An epidemiologic study comparing those with an exposure of interest to those without the exposure. These two cohorts are then followed over time to determine the differences in the rates of disease between the exposure subjects.

Comparison value
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The comparison value is used as a screening level during the public health assessment process. Substances found in amounts greater than their comparison values might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Confounding Factor
A condition or variable that is both a risk factor for disease and associated with an exposure of interest. This association between the exposure of interest and the confounder (a true risk factor for disease) may make it falsely appear that the exposure of interest is associated with disease.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

Food Chain
A community of organisms where each member is eaten in turn by another member [compare with food web].

Food Web
A community of organisms where there are several interrelated food chains [see food chain].

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals in a study.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals in a study.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL
[see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

Risk
The probability that something will cause injury or harm.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, gender, or behaviors (for example, cigarette smoking). Children, pregnant women, nursing mothers, and older people are often considered special populations.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect level (LOAEL) or the no-observed-adverse-effect level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

Appendix B. Summary of Other Public Health Activities

Agency for Toxic Substances and Disease Registry (ATSDR)

Clinical Laboratory Analysis. In June 1992, William Reid, M.D., an Oak Ridge physician, notified the Oak Ridge Health Agreement Steering Panel (ORHASP) and the Tennessee Department of Health (TDOH) that he believed that about 60 of his patients had been exposed to numerous heavy metals through their occupation or through the environment. Dr. Reid felt that these exposures had caused a number of adverse health outcomes, including immunosuppression, increased cancer incidence, neurological diseases, bone marrow damage, chronic fatigue syndrome, autoimmune disease, and abnormal blot clots. Howard Frumkin, M.D., Dr.PH., of Emory University's School of Public Health, requested clinical laboratory support to evaluate Dr. Reid's patients. As a result, ATSDR and the Center for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH) facilitated this laboratory support from 1992 to 1993 through the NCEH Environmental Health Laboratory (ATSDR and ORREHS 2000; ORHASP 1999).

Because of the confidentiality among physicians, as well as the confidentiality between physicians and their patients, the findings of these clinical analyses were not provided to public health agencies (ATSDR and ORREHS 2000). In an April 26, 1995 letter to the Commissioner of the TDOH. Dr. Frumkin suggested, however, that one should "not evaluate the patients seen at Emory as if they were a cohort for whom group statistics would be meaningful. This was a self-selected group of patients, most with difficult-to-answer medical questions (hence their trips to Emory), and cannot in any way be taken to typify the population of Oak Ridge. For that reason, I have consistently urged Dr. Reid, each of the patients, and officials of the CDC and the Tennessee Health Department, not to attempt group analyses of these patients."

Review of Clinical Information on Persons Living in or Near Oak Ridge. Following a request by William Reid, M.D., ATSDR evaluated the medical histories and clinical data associated with 45 of Dr. Reid's patients. The objective of this review was to assess the clinical data for patients who were tested for heavy metals and to establish whether exposure to metals was related to these patients' illnesses. ATSDR determined that the case data were insufficient to support an association between these diseases and low levels of metals. TDOH also evaluated the information and reached the same conclusion as ATSDR. In September 1992, ATSDR provided a copy of its review to Dr. Reid (ATSDR and ORREHS 2000).

ATSDR Science Panel Meeting on the Bioavailability of Mercury in Soil, August 1995. After reviewing an evaluation of the U.S. Department of Energy (DOE) studies conducted on mercury, ATSDR concluded that outside expertise was needed to assess technical details related to mercury. As a result, a science panel was created that consisted of experts from various government agencies (e.g., U.S. Environmental Protection Agency [EPA]), private consultants, and other individuals with experience in metal bioavailability research. The panel's goal was to select procedures and strategies that could be used by health assessors to create site-specific and data-supported estimates with regard to the bioavailability of inorganic mercury and other metals (e.g., lead) from soils. ATSDR applied the data from the panel to its assessment of the mercury cleanup level in East Fork Poplar Creek soil. In 1997, the International Journal of Risk Analysis

(Volume 17:5) published three technical papers and an ATSDR overview paper that detailed this meeting's results (ATSDR and ORREHS 2000).

Health Consultation on Proposed Mercury Cleanup Levels, January 1996. Following a request from community members and the city of Oak Ridge, ATSDR prepared a health consultation to assess DOE's cleanup levels for mercury in the East Fork Poplar Creek floodplain soil. The final health consultation, released in January 1996, concluded that DOE's clean up levels of 180 milligrams per kilogram (mg/kg) and 400 mg/kg would protect public health and would not present a health risk to adults or to children (ATSDR and ORREHS 2000).

Health Professional Education on Cyanide. In January 1996, an employee from East Tennessee Technology Park (formerly the K-25 facility) requested ATSDR's assistance with occupational cyanide exposure. As a result, in August 1996, ATSDR held a physician health education program in Oak Ridge to teach physicians about health effects that could result from potential cyanide intoxication. The purpose of the education program was to help community health care providers respond to concerns from ETTP employees. ATSDR gave the following materials to the concerned employee and to area physicians: the ATSDR public health statement for cyanide, the NIOSH final health hazard evaluation, and the ATSDR Case Studies in Environmental Medicine publication entitled *Cyanide Toxicity*. ATSDR led the environmental health education workshop for physicians at the Methodist Medical Center in Oak Ridge, Tennessee. The session focused on supplying area physicians and other health care providers with information to assist with the diagnosis of acute and chronic cyanide intoxication, and also to assist with answering patient's questions. ATSDR also established a system that area physicians could use to make patient referrals directly to the Association of Occupational and Environmental Clinics (AOEC) (ATSDR and ORREHS 2000).

Workshops on Epidemiology. ATSDR responded to Oak Ridge Reservation Health Effects Subcommittee (ORRHES) members' requests, by conducting two epidemiology workshops for the subcommittee. The first session took place at the June 2001 ORRHES meeting. Both Ms. Sherri Berger and Dr. Lucy Peipins of ATSDR's Division of Health Studies presented an overview of the science of epidemiology at the first session. Dr. Peipins also presented at the second epidemiology workshop at the December 2001 ORRHES meeting. The purpose of this second session was to help the ORRHES members build the skills that are required for analyzing scientific reports (ATSDR and ORREHS 2000). At the August 28, 2001 Public Health Assessment Work Group meeting, Dr. Peipins demonstrated the systematic and scientific approach of epidemiology by guiding the group as they critiqued a sample report (Mangano J. 1994. *Cancer Mortality Near Oak Ridge, Tennessee*. International Journal of Health Services: 24(3):521). Based on this critique, ORRHES concluded:

1. The Mangano paper is not an adequate, science-based explanation of cancer mortality rates of the off-site public.
2. The Mangano paper fails to establish that radiation exposure from the ORR contributed to cancer mortality rates in the general public.
3. ORRHES recommended that in the ORR public health assessment process, ATSDR exclude the Mangano paper from consideration (ATSDR and ORREHS 2000).

Assessment of Cancer Incidence in the Eight-county Area Surrounding the DOE Oak Ridge Reservation, March 2006. Some area residents expressed concerns about the number of cancer cases in communities around the Oak Ridge Reservation (ORR). To address these concerns, the ORRHES requested that ATSDR conduct an assessment of cancer incidence to evaluate cancer rates in these communities. For the consultation, ATSDR obtained cancer incidence data—data on newly diagnosed cases of cancer—from the Tennessee Cancer Registry for 42 different cancer types. Data from 1991–2000 were obtained for the eight-county area surrounding the ORR, including Anderson, Blount, Knox, Loudon, Meigs, Morgan, Rhea, and Roane Counties. To analyze the data and determine any increases of cancer incidence, ATSDR compared the number of observed cases in each of the eight counties to the expected number of cases in the state of Tennessee. The findings indicated both higher and lower rates of certain cancers in some of the counties examined when compared to the cancer incidence rates in the state. No consistent pattern of cancer occurrence was identified however, and the reasons for the increases and decreases of cancer occurrence remain unknown. For more information, the assessment of cancer incidence is available at http://www.atsdr.cdc.gov/HAC/oakridge/phact/cancer_oakridge/index.html.

Public Health Assessments (PHAs). In addition to evaluating the releases of polychlorinated biphenyls (PCBs) from the ORR, ATSDR scientists are conducting PHAs on uranium releases from Y-12, mercury releases from Y-12, iodine-131 releases X-10, radionuclides released to White Oak Creek from X-10, uranium and fluorides release from K-25, and on other topics, such as the Toxic Substances Control Act (TSCA) incinerator and off-site groundwater. In addition, ATSDR is screening current (1990 to 2003) environmental data to identify any other chemicals that will require further evaluation. In these PHAs, ATSDR scientists evaluate and analyze the data and findings from previous studies and investigations to assess the public health implications of past and current exposure.

Tennessee Department of Health (TDOH)

Pilot Survey of Mercury Levels in Oak Ridge. In the fall of 1983, TDOH set an interim soil mercury level to use for environmental management decisions. CDC evaluated the methodology for this mercury level and advised the TDOH to conduct a pilot survey to determine whether populations with the greatest risk for mercury exposure had elevated mercury body burdens. From June to July 1984, TDOH and CDC surveyed the inorganic mercury levels of Oak Ridge residents who had the greatest risk of being exposed to mercury via contaminated fish and soil. The survey also assessed whether exposure to mercury through contaminated fish and soil represented an immediate health hazard for the Oak Ridge community. In the October 1985 release of the pilot survey findings, results showed people living and working in Oak Ridge were unlikely to have a greater risk for significantly high mercury levels. The mercury concentrations in hair and urine samples were lower than levels associated with health effects (ATSDR and ORREHS 2000).

Health Statistics Review to Address Oak Ridge Physician's Concerns. In June 1992, William Reid, M.D., an Oak Ridge physician, told ORHASP and TDOH he believed that about 60 of his patients had been exposed to heavy metals through their occupation or environment. Dr. Reid felt that these exposures had caused a number of adverse health outcomes, including immunosuppression, increased cancer incidence, neurological diseases, bone marrow damage, chronic fatigue syndrome, autoimmune disease, and abnormal blot clots. That year, TDOH conducted a health statistics review that evaluated the cancer incidence rates for the counties around the reservation between 1988 and 1990, and compared these rates to the state rates for Tennessee. The health statistics review found some counties' rates were low and some were high compared to the state's rates, but could find no site-related patterns. These findings are detailed in an October 19, 1992 TDOH memorandum to Dr. Mary Yarbrough from Mary Layne Van Cleave. Handouts and minutes from Ms. Van Cleave's presentation at the ORHASP meeting on December 14, 1994, are available from TDOH (ATSDR and ORREHS 2000).

Health Statistics Review of Amyotrophic Lateral Sclerosis and Multiple Sclerosis Mortality Rates. In 1994, area residents reported that several community members had amyotrophic lateral sclerosis (ALS) and multiple sclerosis (MS). TDOH, in consultation with Peru Thapa, M.D., M.P.H. of Vanderbilt University's School of Medicine, performed a health statistics review of mortality rates for ALS and MS within certain Tennessee counties. TDOH also received technical support for the health statistics review from ATSDR (ATSDR and ORREHS 2000).

Because ALS and MS are not reportable, TDOH could not calculate reliable incidence rates for these diseases. Mortality rates for 1980 and 1992, in the counties surrounding ORR were analyzed and compared with mortality rates for the state of Tennessee. The mortality rates did not differ significantly from the rates in the rest of the state (ATSDR and ORREHS 2000). At the August 18, 1994 OHHASP public meeting, TDOH reported the following results.

- In none of the counties did ALS mortality differ significantly from that in the rest of the state.

- For Anderson County, the age-adjusted mortality rate for chronic obstructive pulmonary disease (COPD) was significantly higher than that for the rest of the state. But for 1979 to 1988, rates for total deaths, deaths from stroke, deaths from congenital anomalies, and deaths from heart disease were significantly lower than statewide. The cancer rate overall did not significantly differ from that for the rest of the state. Mortality rates from uterine and ovarian cancer were significantly higher than in the rest of the state. Deaths from liver cancer were, however, significantly lower than that for the rest of the state.

- For Roane County, between 1979 and 1988 the rates of total deaths and deaths from heart disease were significantly lower than the rates in the rest of the state. Although the total cancer death rate was significantly lower than the rate in the rest of the state, the rate of deaths from lung cancer was significantly higher than the rate in the rest of the state. Rates of deaths from colon cancer, female breast cancer, and prostate cancer were all significantly lower than the rates in the rest of the state.

- For Knox County, the rates for total deaths and deaths from heart disease were significantly lower than the rates in the rest of the state. A comparison of the Knox County total cancer death rate with the statewide rate revealed no significant difference.

- No cause of mortality studied in Knox, Loudon, Rhea, and Union Counties significantly exceeded its counterpart in the rest of the state.

- Rates of total deaths were significantly higher in Campbell, Claiborne, and Morgan Counties than in the rest of the state.

- Cancer mortality was significantly higher in Campbell County than in the rest of the state. The excess in number of deaths from cancer were primarily in the earlier part of the time period (1980 to 1985). The rate of deaths from cancer was not higher in Campbell County than in the rest of the state from 1986 to 1988 and from 1989 to 1992.

- From 1980 to 1982, cancer mortality was significantly higher in Meigs County than in the rest of the state, but from 1983 to 1992, it was not.

Knowledge, Attitude, and Beliefs Study. TDOH coordinated a study to evaluate the attitudes, beliefs, and perceptions of residents living in eight counties around Oak Ridge, Tennessee. The purpose of the study was to: 1) examine the public's attitudes and perceptions regarding environmental contamination and public health problems associated with the ORR; 2) determine the public's level of awareness and their assessment of the ORHASP; and 3) gather recommendations from the residents for improving public outreach programs. The results of the study were released on August 12, 1994, and are available from TDOH (ATSDR and ORREHS 2000). Following is a summary of the findings (Benson et al. 1994):

- Most respondents considered their local environmental quality to be better than the national environmental quality. Most people rated the quality of their air and drinking water as good or excellent. Almost half of those surveyed rated the local groundwater as good or excellent.

- Most respondents thought activities at the ORR created some health problems for nearby residents, and most thought activities at the ORR created health problems for site employees. Most respondents felt researchers should examine the actual disease rates among Oak Ridge residents. Of those surveyed, 25 percent knew of a specific local environmental condition that they believed had adversely affected people's health; but many of these appeared unrelated to the ORR. Less than 0.1 percent of those surveyed had personally experienced a health problem they attributed to the ORR.

- About 25 percent of the respondents had heard of the Oak Ridge Health Study, and newspapers were their primary source of information. Approximately 33 percent of the people surveyed rated the study performance as good or excellent, and 40 percent thought that the study would improve public health. Also, 25 percent thought that communication about the study was good or excellent.

Presentation. On February 16, 1995, Dr. Joseph Lyon of the University of Utah gave a TDOH-sponsored presentation at an ORHASP public meeting. The presentation informed the public and the ORHASP that several studies had been conducted on the fallout from the Nevada Test Site, including the study of thyroid disease and leukemia (ATSDR and ORREHS 2000).

Feasibility of Epidemiologic Studies. Another study examined the feasibility of performing analytical epidemiological studies (e.g., case-control or cohort) to address health concerns of people living near the ORR. TDOH and the ORHASP contracted with a physician from

Vanderbilt University's Department of Preventive Medicine to conduct the study, which was released July 1996 (ATSDR and ORREHS 2000). The study found the dose reconstruction results would significantly impact the feasibility of conducting analytical epidemiologic studies because the dose reconstruction would clarify the extent and potential human exposure from past releases of radioactive iodine, mercury, PCBs, uranium, and other radionuclides, including cesium-137 (Thapa 1996).

Health Assessment of the East Tennessee Region. TDOH conducted a health assessment on the eastern region of Tennessee. This health assessment reviewed the health status of the population, evaluated accessibility and utilization of health services, and developed priorities for resource allocation. The East Tennessee Region released its first edition of *A Health Assessment of the East Tennessee Region* in December 1991; this edition reviewed data from 1986 to 1990. The second edition, released in 1996, reviewed data from 1990 to 1995. A copy can be obtained from the East Tennessee Region of TDOH (ATSDR and ORREHS 2000).

Loudon County Hazardous Air Pollutants Public Health Assessment, May 2006. Under a cooperative agreement with ATSDR, TDOH examined available environmental data on hazardous air pollutants in Loudon County, Tennessee, and possible health impacts. Seven hazardous air pollutants were carefully evaluated; none, however, were detected at levels that presented a health concern. To more thoroughly understand disease trends and community concerns about respiratory and heart-related illnesses, TDOH also studied health data for 40 specific diseases and reported two major findings: 1) Loudon County's increased in-patient and out-patient hospitalization rates for chronic rhinitis and sinusitis are statistically significant compared to Franklin County and to Tennessee for females, males, and both sexes combined and 2) Loudon County is ranked first in overall cancer rate in Tennessee for both sexes combined, is ranked second in overall cancer rate for males, and is ranked third in overall cancer rates for females (TDOH 2006).

Centers for Disease Control and Prevention (CDC)

Scarboro Community Health Investigation. In November 1997, a Nashville newspaper published an article about children's illnesses in the Scarboro community—a neighborhood close to the Y-12 plant. The article said that Scarboro residents had frequent respiratory illness, and that 16 children repeatedly had "severe ear, nose, throat, stomach, and respiratory illnesses." The reported respiratory illnesses included asthma, sinus infections, hay fever, ear infections, and bronchitis. The article suggested ORR releases caused these illnesses, especially because these children live in the vicinity of the Y-12 plant (ATSDR and ORREHS 2000; Johnson et al. 2000).

On November 20, 1997, the Commissioner of TDOH responded to this article with a request that CDC assist TDOH with an investigation of the Scarboro community. TDOH coordinated the *Scarboro Community Health Investigation* to examine the reported excess of pediatric respiratory illness within the Scarboro community. The investigation consisted of a community health survey of parents and guardians, and a follow-up medical examination for children less than 18 years of age. Both the survey and the exam were designed to measure the rates of common respiratory illnesses among Scarboro children, compare these rates to national rates for pediatric respiratory illnesses, and determine if these illnesses had any unusual characteristics.

The investigation was not designed to determine the cause of the illnesses (ATSDR and ORREHS 2000; Johnson et al. 2000).

In 1998, the Scarboro Community Environmental Justice Oversight Committee joined CDC and TDOH in the development of a study protocol. After the protocol was created, a community health survey was administered to members of households in the Scarboro neighborhood. The purpose of the survey was to compare rates of specific diseases in Scarboro to rates in the rest of the United States, and to identify factors that increased Scarboro residents' risk for health problems. The survey collected information from adults about their occupations, occupational exposures, and general health concerns. The health investigation survey had an 83 percent response rate, interviewing members of 220 out of 264 households. The surveys collected 119 questionnaires about children and 358 questionnaires about adults in these households (ATSDR and ORREHS 2000; Johnson et al. 2000).

In September 1998, CDC released the initial survey findings. Scarboro children's asthma rate was 13 percent. Nationally, the estimated rate was 7 percent for children from birth to 18 years old, and 9 percent for African American children birth to 18 years old. The Scarboro rate fell within the range of rates (6 percent to 16 percent) found in comparable studies across the United States, however. The wheezing rate was 35 percent for Scarboro children. The worldwide estimated rates fell between 1.6 percent and 36.8 percent. With the exception of unvented gas stoves, the study found no statistically significant link between asthma or wheezing illness and typical environmental asthma triggers (e.g., pests and environmental tobacco smoke) or occupational exposures (i.e., living with an ORR employee) (ATSDR and ORREHS 2000; Johnson et al. 2000).

Using the survey results, 36 children, including those discussed in the 1997 newspaper article, were invited for physical examinations. In November and December 1998, the medical examinations were conducted to verify the community survey results, to evaluate whether the children with respiratory illnesses were receiving necessary medical care, and to verify that the children detailed in the newspaper actually had those reported respiratory medical problems. The invited children had one or more of the following: 1) severe asthma, defined as more than three wheezing episodes or going to an emergency room as a result of these symptoms; 2) severe undiagnosed respiratory illness, defined as more than three wheezing episodes and going to an emergency room as a result of these symptoms; 3) respiratory illness and no source for regular medical care; or 4) identified in newspaper reports as having respiratory illness. Out of the 36 children invited, 23 participated in the physical examination. Some eligible children had moved away from Scarboro; others were not available or opted not to participate (ATSDR and ORREHS 2000; Johnson et al. 2000).

During the physical examinations nurses asked the participating children and their parents questions about the children's health. Volunteer physicians evaluated the findings from the nurse interviews and examined the children. The children were also given blood tests and a special breathing test. On a case-by-case basis, the physician ordered x-rays. The tests, examinations, and transportation to and from the examinations were free of charge (Johnson et al. 2000).

When the examinations were completed, the results were evaluated to see if any children required immediate intervention—none of the children needed urgent care. Several laboratory tests revealed levels that were either above or below the normal range, which included blood hemoglobin level, blood calcium level, or breathing test abnormality. After a preliminary review of the findings, the children's parents and doctors were notified about the results by letter or telephone. If the parents did not want their child's results sent to a physician, then the parents alone received the results over the telephone. The parents of children who had any health problems identified from the physical examination were sent a personal letter from Paul Erwin, M.D., of the East Tennessee Regional Office of the TDOH, advising the parents to follow up with their medical provider. If the children did not have a medical provider, the parents were told to contact Brenda Vowell, R.N.C., a Public Health Nurse with the East Tennessee Regional Office of the TDOH, to help them find a provider or register with TennCare or Children's Special Service (ATSDR and ORREHS 2000; Johnson et al. 2000).

Physicians from the CDC, TDOH, the Oak Ridge medical community, and the Morehouse School of Medicine met on January 5, 1999, and thoroughly reviewed the findings from the community health survey, the physical examinations, the laboratory tests, and the nurse interviews. Of the 23 children examined, 22 evidenced some type of respiratory illness discovered during the nurse interviews or during the doctor's physical examinations. Otherwise, the children appeared healthy and had no problems that would necessitate immediate assistance. Many children had mild respiratory illnesses, but a lung abnormality was diagnosed in only one child. None of the children wheezed during examination. No unusual illness pattern was identified among Scarboro community children. The severity of the identified illnesses was not more than would be expected, and they were typical of illnesses in any community. The results of these examinations validated the results from the community health survey. On January 7, 1999, the results from this team review were presented at a Scarboro community meeting. In July 2000, the final report was released (ATSDR and ORREHS 2000; Johnson et al. 2000).

Efforts to telephone the examined children's parents followed 3 months after the letters to the parents and physicians about the results. Eight parents (of 14 child participants) were contacted successfully. Despite multiple attempts, the parents of nine children could not be reached (Johnson et al. 2000).

The contacted parents said that 7 of the 14 children had been to a doctor since the examinations. In general, the children's health was about the same. But one child had been in the hospital because of asthma and another child's asthma had worsened, requiring increased medication. Several parents reported their children had nasal allergies, and many parents noted problems getting medicines because of the expense and the lack of coverage by TennCare. Subsequently, TDOH nurses helped these parents obtain the needed medicines (Johnson et al. 2000).

U.S. Department of Energy (DOE)

Lower East Fork Poplar Creek Remedial Investigation/Feasibility Study. Under the Federal Facility Agreement, DOE, EPA, and Tennessee Department of Environment and Conservation (TDEC) prepared a Remedial Investigation/Feasibility Study at Lower East Fork Poplar Creek that was released in 1994. The study was conducted to evaluate the floodplain soil contamination in Lower East Fork Poplar Creek, which has resulted from Y-12 plant discharges since 1950. The goals of the study were to 1) establish the degree of floodplain contamination, 2) prepare a baseline risk analysis of contamination levels, and 3) determine if remedial action was necessary.

The investigation found that sections of the floodplain were contaminated with mercury, and that floodplain soil with mercury concentrations above 400 parts per million (ppm) represented an unacceptable risk to human health and to the environment. As a result, a September 1995 Record of Decision requested remedial action at the creek. Remedial activities began in June 1996 and were completed in October 1997. The activities consisted of 1) excavating four sections of floodplain soil with mercury concentrations above 400 ppm, 2) confirming the mercury concentration by sampling during excavation, 3) disposing of contaminated soil at a Y-12 plant landfill, 4) refilling the excavated areas with clean soil, and 5) providing new vegetative cover over the excavated areas (ATSDR and ORREHS 2000).

Scarboro Community Environmental Study. In May 1998, soil, sediment, and surface water were sampled in the Scarboro community to address residents' concerns about previous environmental monitoring in the Scarboro neighborhood (i.e., validity of past measurements). The study was designed to integrate input from the community with the requirements of an EPA evaluation. The Environmental Sciences Institute of Florida Agriculture and Mechanical University (FAMU), along with its contractual partners at the Environmental Radioactivity Measurement Facility at Florida State University and the Bureau of Laboratories of the Florida Department of Environmental Protection, as well as DOE subcontractors in the Neutron Activation Analysis Group at the ORNL, conducted laboratory analysis for this study. These results were compared with findings from an October 1993 report by DOE, entitled *Final Report on the Background Soil Characterization Project (BSCP) at the Oak Ridge Reservation, Oak Ridge, Tennessee*. In general, mercury was detected within the range that was seen in the BSCP (i.e., 0.021 to 0.30 ppm). The radionuclide findings were within the predicted ranges, including concentrations of total uranium. Uranium 235 was, however, enriched in about 10 percent of the soil samples. In one sample alpha-chlordane, gamma-chlordane, heptachlor, and heptachlor epoxide exceeded the detection limits. Concentrations of lead and zinc in this sample were twice as high as those found in the BSCP. On September 22, 1998, the final Scarboro Community Environmental Study was released (ATSDR and ORREHS 2000).

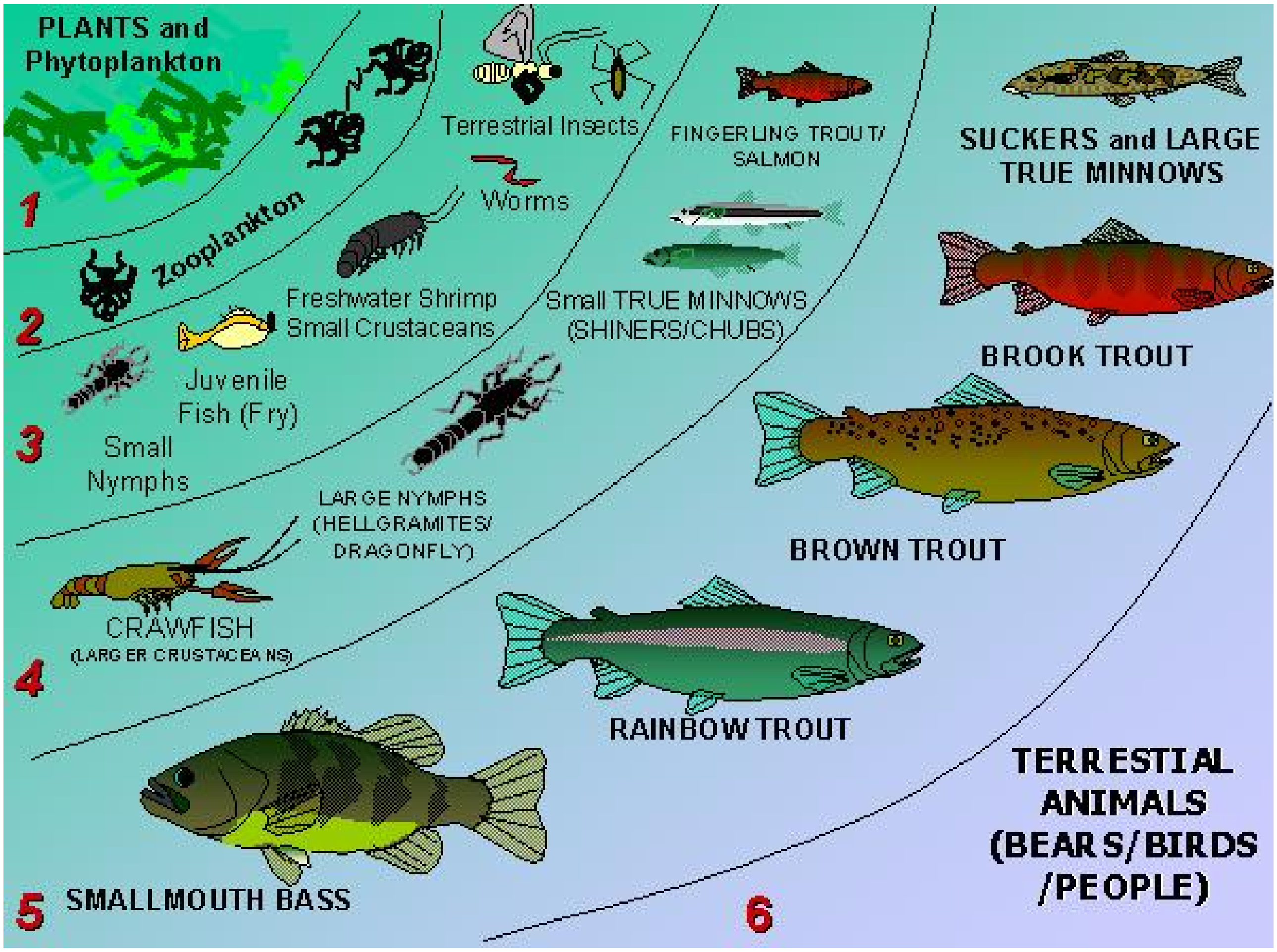
Scarboro Community Assessment Report. Since 1998, the Joint Center for Political and Economic Studies (with the support of DOE's Oak Ridge Operations) has worked with the Scarboro community on residents' economic, environmental, health, and social needs. In 1999, the Joint Center for Political and Economic Studies surveyed the Scarboro community to identify environmental and health concerns. The surveyors achieved an 82 percent response rate. Because Scarboro is a small community, this community assessment provided new information about the area and its residents not available from sources that evaluate more populated areas, such as the U.S. Census Bureau. The assessment illustrated the relatively low rank of environmental and health issues among the community's primary concerns. The community was more concerned about crime and security, children, and economic development. The Joint Center for Political and Economic Studies recommended an increase in active community involvement in city and community planning (Friday and Turner 2001).

U.S. Environmental Protection Agency (EPA)

Scarboro Community Environmental Sampling Validation Study. To respond to community concerns, to identify data gaps, and to validate the May 1998 sampling by FAMU, in 2001 EPA's Science and Ecosystem Division Enforcement Investigation Branch collected sediment, soil, and surface water samples in Scarboro. EPA analyzed these samples and compared the results to those from May 1998. EPA concluded that its findings supported the 1998 sampling, and that residents within the sampled areas in Scarboro were not currently exposed to harmful levels of substances from the Y-12 plant. Because of its findings, EPA did not recommend additional action for the Scarboro community (U.S. EPA 2003).

Appendix C. Examples of Various Aquatic Food Webs[12]

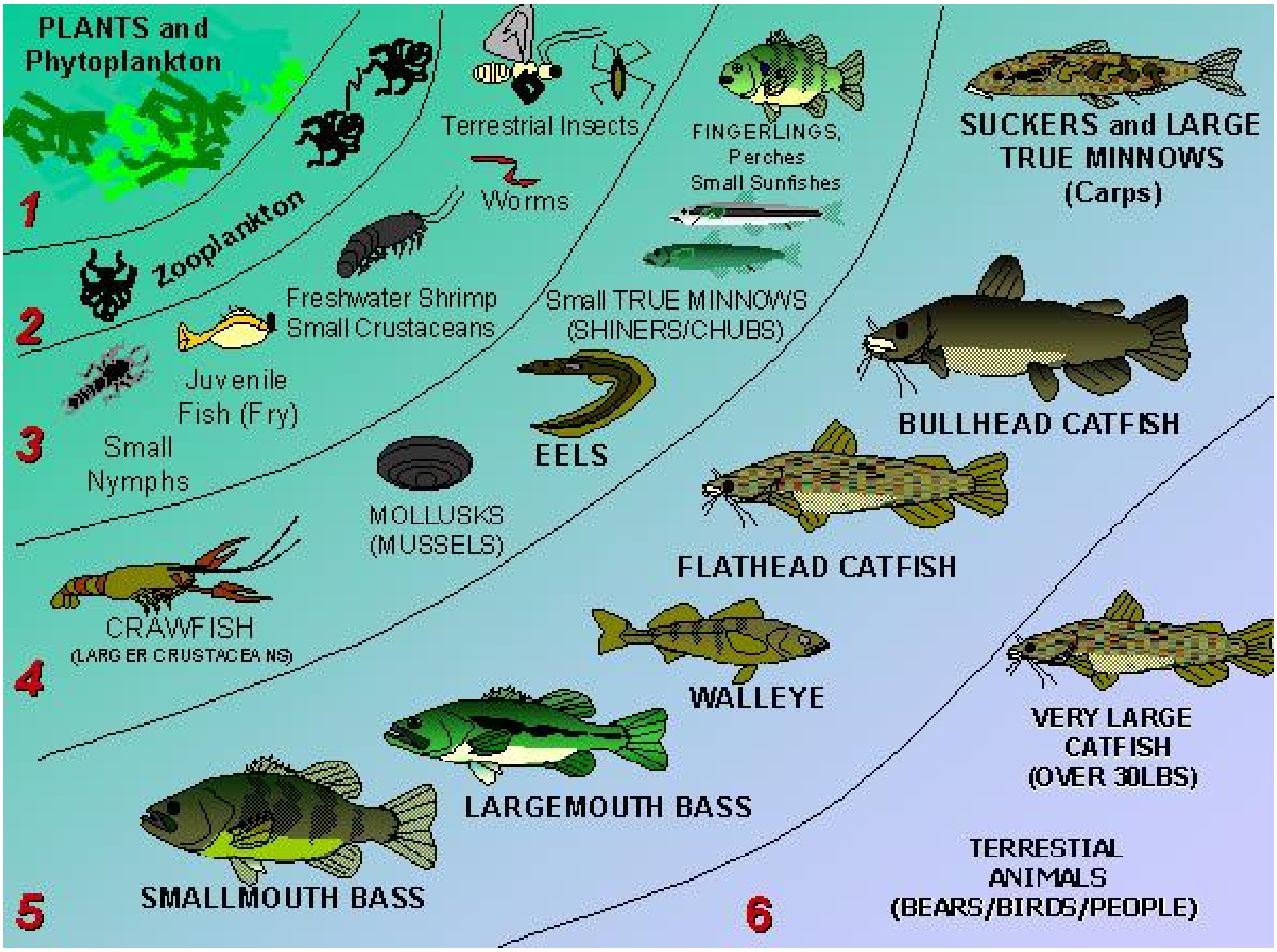
Figure C-1. Food Web for a Upper River—Cold Water Stream System



Courtesy of Bryce Meyer, Webmaster for http://www.combat-fishing.com/streamecology.html.

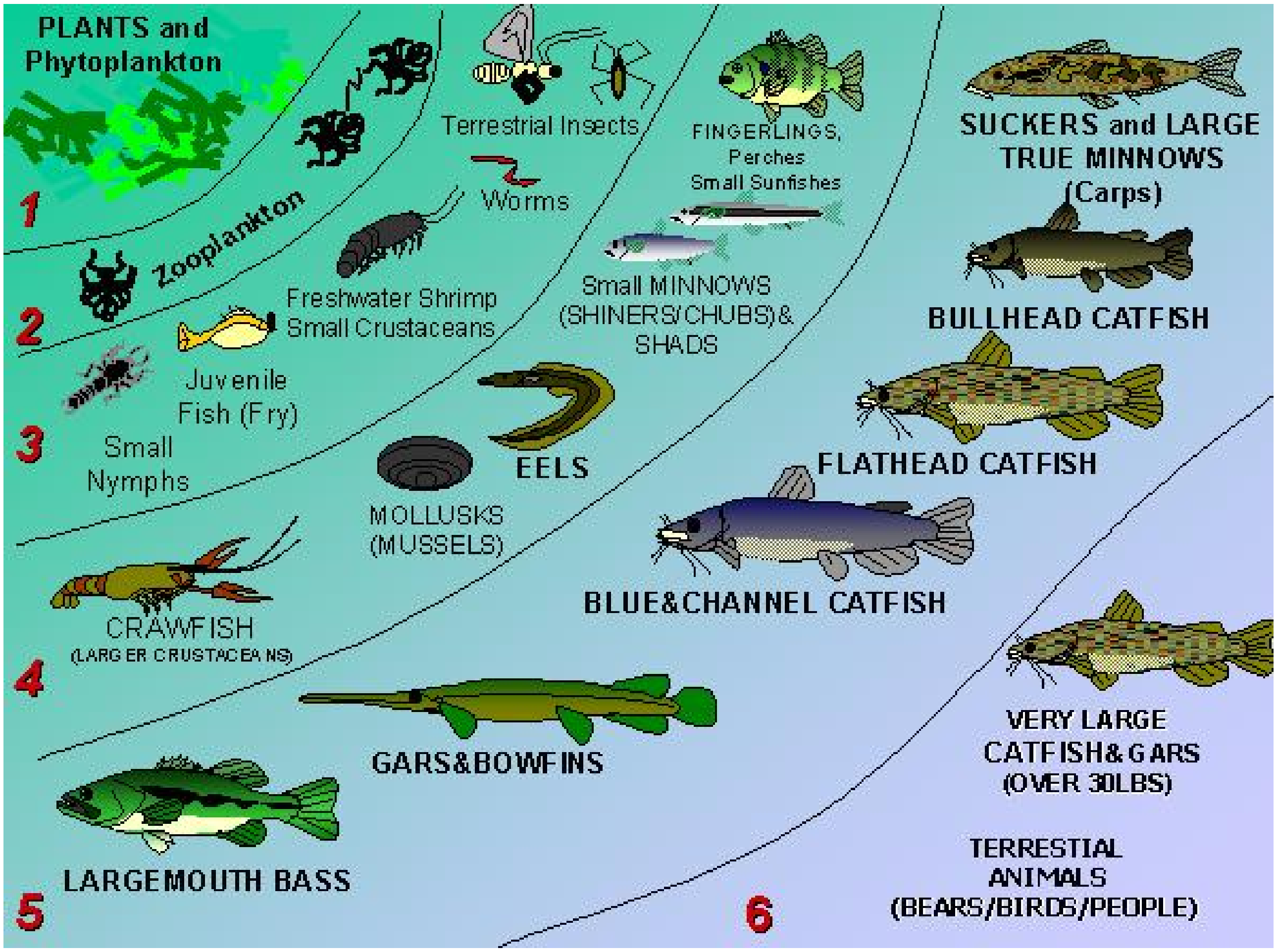
[12] A food web is a community of organisms where there are several interrelated food chains (a community of organisms where each member is eaten in turn by another member).

Figure C-2. Food Web for a Mid River—Cool Water River System



Courtesy of Bryce Meyer, Webmaster for http://www.combat-fishing.com/streamecology.html.

Figure C-3. Food Web for a Lower River—Warm River System



Courtesy of Bryce Meyer, Webmaster for http://www.combat-fishing.com/streamecology.html.

Appendix D. ATSDR's Validation of Task 3 Screening Results

Surface Water and Groundwater

ATSDR agrees with Task 3: eliminate exposure pathways dependent on drinking water contaminated by ORR activities. Surface water itself was not a major source of exposure. PCBs are poorly soluble. These oils, when directly spilled into water, drift down to and are absorbed by underlying sediments and nearby soils. That historical and recent data on surface water PCBs reviewed by ChemRisk were nearly all below levels of detection is not surprising (ChemRisk 1999a). ATSDR also reviewed surface water in all three arms of the Watts Bar Reservoir (the Lower Watts Bar Reservoir, the Clinch River up to the Melton Hill Dam at Mile 23, and the Tennessee River between Miles 567 and 602) and found no PCBs detected (OREIS).

Groundwater often received releases of waste PCBs, but was unable to transport significant quantities of the poorly soluble oils off site. Groundwater thus became a barrier to migration by depositing PCBs onto the surrounding (largely inaccessible) on-site surface soils (ChemRisk 1999a), as well as the inaccessible subsurface soil. Some soluble metals can be transported by groundwater, but even for these substances off-site migration was infrequent. Groundwater is contaminated with metals throughout much of the on-site Upper East Fork Poplar Creek area; no one, however, is currently using the groundwater in the area where a groundwater plume extends past the ORR boundary (i.e., in Union Valley to the east of ORR) (U.S. DOE 2002b). ATSDR evaluated exposures to off-site groundwater in a pathway-specific public health assessment, which was released final in 2006, and can be accessed at http://www.atsdr.cdc.gov/HAC/pha/oakridge_gw_7-06/gor_toc.html.

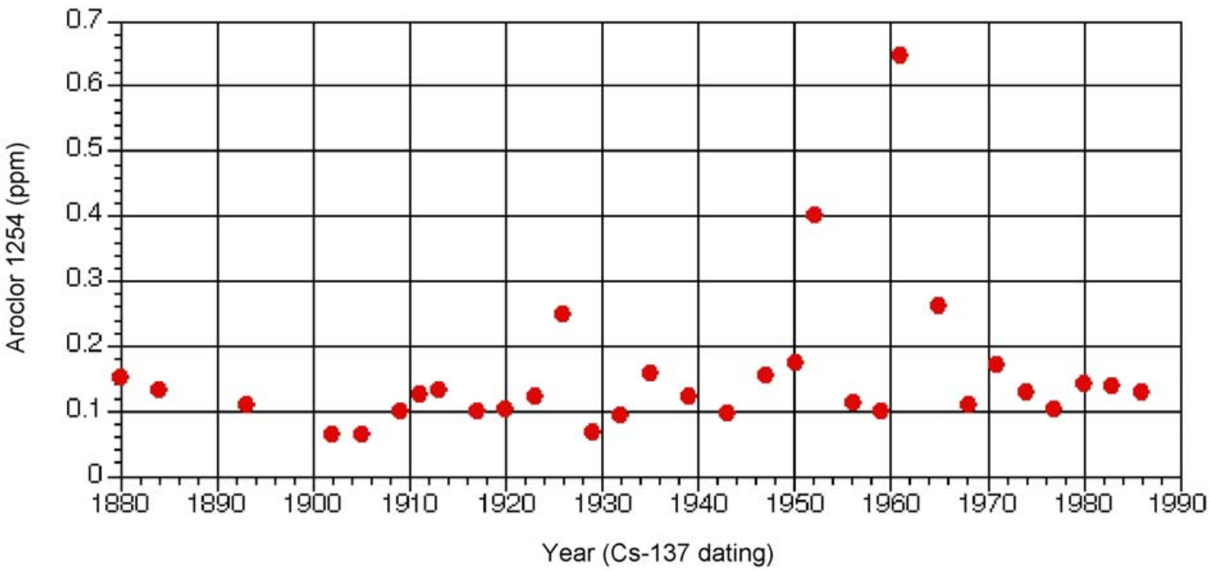
Task 3 based its analysis leading to the elimination of PCB drinking water pathways on the assumption that PCBs could have been present at its limit of detection. PCBs were undetected in surface water. Thus Task 3 scientists assumed them to be at the 100-ppb detection limit even though dissolved PCBs partition with underlying sediment that could absorb 3 million to 6 million times the PCBs that remain in water (from log octanol-water coefficients for Aroclors 1254 and 1260) (ATSDR 2000; ChemRisk 1999a). Total sediment PCB concentrations found beneath surface water was consistently below 1,000 ppb, so PCBs in the water could not have been above 0.00032 ppb. Given Task 3's elimination of drinking water as a significant exposure pathway—assuming its concentration averaged 100 ppb—and this agency's demonstration that PCB's physical properties prevent surface water from containing levels higher than 0.00032 ppb, ATSDR can quite confidently eliminate drinking water as a significant pathway.

Clinch River Sediment

Task 3 eliminated direct ingestion or contact with Clinch River sediment. But ATSDR found so much more recreational and commercial activity on this waterway than on East Fork Poplar Creek, which Task 3 retained, that ATSDR also screened Clinch River sediment.

Clinch River sediment deposited in layers annually. Although river flow can mix layers to some degree, a rough correlation of depth to age can be constructed using peak cesium-137 during 1960s maximum atmospheric fallout for calibration. Minimum PCB detection levels were well below comparison values (see Figure 22), but they were not always high enough to show PCB deposition layers. Nevertheless, one core sediment sample at CRM 9.5 yielded a timeline that allowed comparison of PCBs deposited while ORR was active to recent data. See Figure D-1 for the core's PCB distribution.

Figure D-1. PCBs in Sediment Core from Clinch River at CRM 9.5



From the discussion above and Figure D-1, ATSDR constructed a timeline:

Table D-1. Timeline for PCB Deposition to Sediment

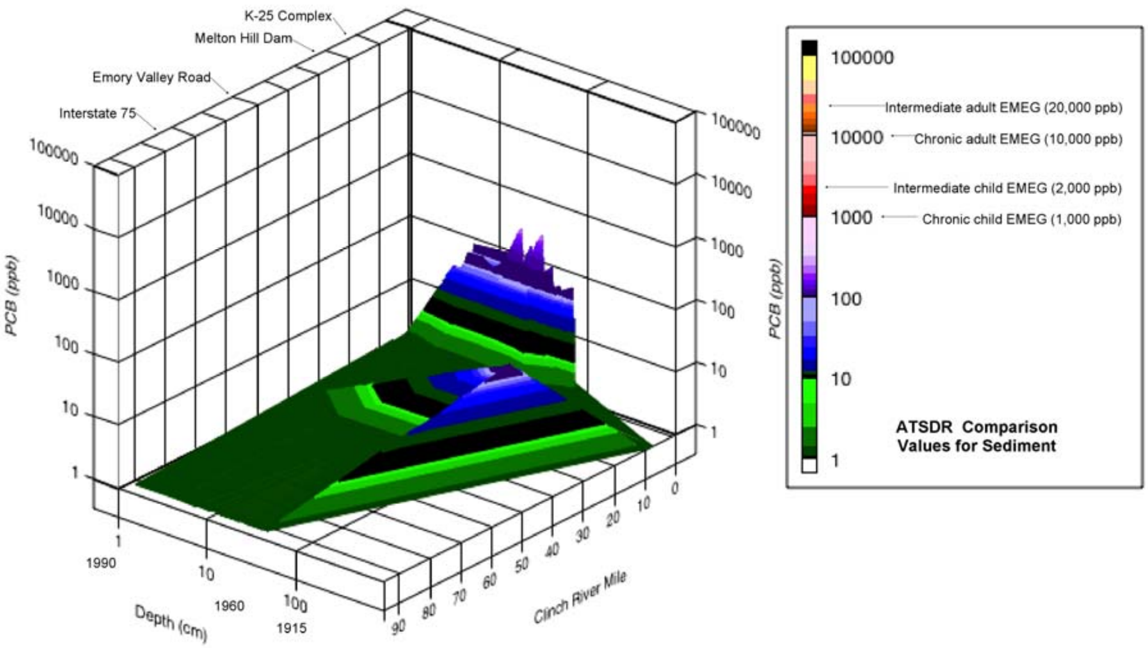
cm depth	***100***	***90***	***80***	***70***	***60***	***50***	***40***	***30***	***20***	***10***	***0***
deposited	***1910***	***1918***	***1927***	***1935***	***1944***	***1952***	***1960***	***1968***	***1977***	***1985***	***1993***
event			A		B——————>C				D		
Dividing the data into three time periods:											
PCB (ppm)	Before 1930				1950–1970				1980–1993		
mean	0.13				0.26				0.14		
range	0.07–0.24				0.10–0.62				0.13–0.14		

A PCBs first manufactured on commercial scale 1927–1929.
B ORR started up in 1942.
C ORR operations using PCBs continued to 1970.
D ORR PCB use and disposal discontinued and remediation began.

This analysis differs from that in Task 3, which used the CRM 9.5 core to argue for consistent environmental loading of PCBs over time. ATSDR finds contamination from PCB deposits during ORR operations is twice the 1993 level of PCB contamination, which in turn, is close to the level before PCBs were commercially manufactured in quantities adequate for electrical power transmission. ATSDR used a graphic technique similar to the one described for East Fork Poplar Creek sediment to display Clinch River sampling, with the exception that for the *y* axis, ATSDR used depth (or time of deposition), instead of distance from the river bed, *versus* CRM on the *x* axis.

Figure D-2 confirms that the highest deposited contamination in the Clinch River was during ORR operation, but shows that contamination levels never exceeded any of ATSDR's comparison values at any location along the river. Over the years, less-than-toxic levels declined still further. As with East Fork Poplar Creek, sediment contamination is (and was) insufficient to cause illness. ATSDR agrees with Task 3 that Clinch River sediment exposure pathways need not be retained for further consideration.

Figure D-2. PCBs Detected* in Clinch River Sediment Before 1996



*Samples with no detected PCBs are shown as having one half the lowest detected concentration of Aroclor 1254 (■)

Source: OREIS

Tennessee River Sediment

Even though the limit of detection for sediment PCBs is well below all ATSDR comparison values, none of the sediment samples taken from 1983 to 1993, from more than 25 stations on the Tennessee River, yielded detectible PCBs (OREIS 2004).

Appendix E. PCBs Measured as Total Congeners or Total Aroclors

Polychlorinated biphenyls (PCBs) are a class of related chemicals. They have in common a molecular structure in which two six-member benzene rings of carbon atoms are joined by a single carbon-carbon bond, and one or more of the available carbon atoms are bonded to chlorine atoms. There are 209 possible ways to distribute 1–10 chlorines among the 10 available carbon atoms on the two rings. Individual members of the class of 209 chemicals are called congeners. Commercial mixtures of the congeners were once widely used in electrical components, for example. Some mixtures were called Aroclors, and they were named after the percentage of chlorine in their chemical compositions—Aroclor 1260 was 60 percent chlorine when manufactured; Aroclor 1254 was 54 percent chlorine, and so on.

Some PCB analytical methods use the congeners present in the Aroclor mixtures and the ratios of their concentrations to estimate the amounts of each Aroclor mixture in a sample. Because less-chlorinated congeners degrade fastest, estimates of Aroclor concentrations determined from more highly chlorinated compounds overstate contamination, especially when concentrations of reported Aroclors sharing common congeners are totaled to estimate total PCB concentration.

PCBs in some fish samples were reported as individual congeners. Adding the congeners present in a sample provides a more accurate total of PCBs present than adding the Aroclors. But laboratories did not measure all 209 congeners, only the most common 40, and so contamination could be understated if rare congeners are present. PCBs in samples of fish taken before 1996 were sometimes reported as Aroclors, sometimes as individual congeners, and sometimes as both. Samples of fish taken during and after 1996 were generally only reported as Aroclors.

To provide an overview of the distribution of the different congeners in Watts Bar Reservoir fish in the database, ATSDR used data for congeners in all 370 samples for which congener data were reported. Data were available for 40 congeners in 366 of these samples. Of the 40 congeners, 16 were among the 21 congeners for which human serum samples were also analyzed in ATSDR's 1998 Watts Bar Reservoir Exposure Investigation (ATSDR 1998). ATSDR calculated the median (50^{th} percentile) concentration in Watts Bar Reservoir fish for each of these 16 shared congeners.

ATSDR also calculated the concentration for each congener at the 10^{th}, 25^{th}, 75^{th}, 90^{th}, and 95^{th} percentile. The concentration of congener number 105 at, for example, the 25^{th} percentile, is the concentration for which 25 percent of all samples had a lower concentration of PCB number 105. At least half the samples did not exceed the declared limit of detection (LOD, or 10 ppb) for one or more of the congeners. But concentrations less than the declared LOD were sometimes estimated for congeners. To use the entire database for these calculations, ATSDR substituted 2.5 ppb, or one half of the lowest concentration (5 ppb) as an estimate of the undetected congeners.

An analytical method has a range of concentrations for which it is most valid, and that range generally starts at two or three times the method's LOD. Therefore, in Table E-1, there is more confidence in congener concentrations greater than 20 ppb. To show how all congeners were distributed within a sample relative to one of them (intra-sample distribution), ATSDR calculated each congener as a percent of the one congener most retained by humans (PCB number 153) for each of the 156 samples in which PCB number 153 exceeded its LOD. This distribution is displayed in Table E-2. This table represents a "fingerprint," or database-specific characterization, of the way congeners are distributed in Watts Bar Reservoir fish.

Table E-1. Concentration of Congeners in Watts Bar Reservoir Fish by Percentile

Percentile	Congener #															
	28	52	66	99	101	105	118	138	153	156	170	180	183	194	195	201
10th	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
25th	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
50th	2.5	2.5	2.5	2.5	10	2.5	10	10	10	2.5	2.5	2.5	2.5	2.5	2.5	2.5
75th	10	10	2.5	20	20	2.5	40	40	60	10	10	40	10	7	2.5	10
90th	10	10	10	110	40	10	80	90	120	20	10	100	30	10	10	20
95th	10	30	20	130	60	10	100	150	230	30	40	160	50	30	10	40

Concentrations as parts per billion (ppb).

Table E-2. Fish Congeners as Percent of PCB #153 by Percentile

Percentile	Congener #															
	28	52	66	99	101	105	118	138	153	156	170	180	183	194	195	201
10th	1.1	1.5	2.3	1.2	3.1	1.3	9.1	3.3	100	2.8	1.1	4.2	2.8	2.5	2.1	2.8
25th	2.5	4.2	3.1	2.8	8.3	2.8	19	6.3	100	4.2	2.8	8.3	6.7	4.2	3.1	4.2
50th	5	10	6.3	5.3	20	5	27.1	12.5	100	8.3	6.3	38.1	12.5	8.3	6.3	8.3
75th	9.1	25	12.5	33.3	50	12.5	50	33.3	100	12.5	12.5	81.8	20	12.5	12.5	12.5
90th	12.5	33.3	20	80	100	16.7	83.3	66.7	100	25	33.3	140	33.3	18.8	16.7	20
95th	20	45	25	280	100	25	100	191.7	100	50	50	171	47.7	25	22.5	26.7

Concentrations as ppb.

Appendix F. Summary Briefs and Fact Sheets

TDOH's Phase I Dose Reconstruction Feasibility Study
TDOH's Task 3 Study: PCBs in the Environment Near the Oak Ridge Reservation, A Reconstruction of Historical Doses and Heath Risks
TDEC's Watts Bar Reservoir and Clinch River Turtle Sampling Survey
ATSDR's Health Consultation on the Y-12 Weapons Plant Chemical Releases Into East Fork Poplar Creek
ATSDR's Health Consultation on the Lower Watts Bar Reservoir
ATSDR's Exposure Investigation, Serum PCB and Blood Mercury Levels in Consumers of Fish and Turtles from Watts Bar Reservoir
EPA and ATSDR's A Guide to Healthy Eating of the Fish You Catch
Tennessee Fish Advisories

ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Dose Reconstruction Feasibility Study
Oak Ridge Health Study Phase I Report

Site: Oak Ridge Reservation
Study area: Oak Ridge Area
Time period: 1942–1992
Conducted by: Tennessee Department of Health and the Oak Ridge Health Agreement Steering Panel

Purpose

The Dose Reconstruction Feasibility Study had two purposes: first, to identify past chemical and radionuclide releases from the Oak Ridge Reservation (ORR) that have the highest potential to impact the health of the people living near the ORR; and second, to determine whether sufficient information existed about these releases to estimate the exposure doses received by people living near the ORR.

Background

In July 1991, the Tennessee Department of Health initiated a Health Studies Agreement with the U.S. Department of Energy (DOE). This agreement provides funding for an independent state evaluation of adverse health effects that may have occurred in populations around the ORR. The Oak Ridge Health Agreement Steering Panel (ORHASP) was established to direct and oversee this state evaluation (hereafter called the Oak Ridge Health Studies) and to facilitate interaction and cooperation with the community. ORHASP was an independent panel of local citizens and nationally recognized scientists who provided direction, recommendations, and oversight for the Oak Ridge Health Studies. These health studies focused on the potential effects from off-site exposures to chemicals and radionuclides released at the reservation since 1942. The state conducted the Oak Ridge Health Studies in two phases. Phase 1 is the Dose Reconstruction Feasibility Study described in this summary.

Methods

The Dose Reconstruction Feasibility Study consisted of seven tasks. During Task 1, state investigators identified historical operations at the ORR that used and released chemicals and radionuclides. This involved interviewing both active and retired DOE staff members about past operations, as well as reviewing historical documents (such as purchase orders, laboratory records, and published operational reports). Task 1 documented past activities at each major facility, including routine operations, waste management practices, special projects, and accidents and incidents. Investigators then prioritized these activities for further study based on the likelihood that releases from these activities could have resulted in off-site exposures.

During Task 2, state investigators inventoried the available environmental sampling and research data that could be used to estimate the doses that local populations may have received from chemical and radionuclide releases from the ORR. This data, obtained from DOE and other federal and state agencies (such as the U.S. Environmental Protection Agency, Tennessee Valley

Authority, and the Tennessee Division of Radiological Health), was summarized by environmental media (such as surface water, sediment, air, drinking water, groundwater, and food items). As part of this task, investigators developed abstracts which summarize approximately 100 environmental monitoring and research projects that characterize the historical presence of contaminants in areas outside the ORR.

Based on the results of Tasks 1 and 2, investigators identified a number of historical facility processes and activities at ORR as having a high potential for releasing substantial quantities of contaminants to the off-site environment. These activities were recommended for further evaluation in Tasks 3 and 4.

Tasks 3 and 4 were designed to provide an initial, very rough evaluation of the large quantity of information and data identified in Tasks 1 and 2, and to determine the potential for the contaminant releases to impact the public's health. During Task 3, investigators sought to answer the question: How could contaminants released from the Oak Ridge Reservation have reached local populations? This involved identifying the exposure pathways that could have transported contaminants from the ORR site to residents.

Task 3 began with compiling a list of contaminants investigated during Task 1 and Task 2. These contaminants are listed in Table 1. The contaminants in the list were separated into four general groups: radionuclides, nonradioactive metals, acids/bases, and organic compounds. One of the first steps in Task 3 was to eliminate any chemicals on these lists that were judged unlikely to reach local populations in quantities that would pose a health concern. For example, acids and bases were not selected for further evaluation because these compounds rapidly dissociate in the environment and primarily cause acute health effects, such as irritation. Likewise, although chlorofluorocarbons (Freon) were used in significant quantities at each of the ORR facilities, they were judged unlikely to result in significant exposure because they also rapidly disassociate. Also, some other contaminants (see Table 2) were not selected for further evaluation because they were used in relatively small quantities or in processes that are not believed to be associated with significant releases. Investigators determined that only a portion of contaminants identified in Tasks 1 and 2 could have reached people in the Oak Ridge area and potentially impacted their health. These contaminants, listed in Table 3, were evaluated further in Tasks 3 and 4.

The next step in Task 3 was to determine, for each contaminant listed in Table 3, whether a complete exposure pathway existed. A complete exposure pathway means a plausible route by which the contaminant could have traveled from ORR to offsite populations. Only those contaminants with complete exposure pathways would have the potential to cause adverse health effects. In this feasibility study, an exposure pathway is considered complete if it has the following three elements:

- A source that released the contaminant into the environment;
- A transport medium (such as air, surface water, soil, or biota) or some combination of these media (e.g., air ➔ pasture ➔ livestock milk) that carried the contaminant off the site to a location where exposure could occur; and
- An exposure route (such as inhalation, ingestion, or—in the case of certain radionuclides that emit gamma or beta radiation—immersion) through which a person could come into contact with the contaminant.

In examining whether complete exposure pathways existed, investigators considered the characteristics of each contaminant and the environmental setting at the ORR. Contaminants that lacked a source, transport medium, or exposure route were eliminated from further consideration because they lacked a complete exposure pathway. Through this analysis, investigators identified a number of contaminants with complete exposure pathways.

During Task 4, investigators sought to determine qualitatively which of the contaminants with complete exposure pathways appeared to pose the greatest potential to impact off-site populations. They began by comparing the pathways for each contaminant individually. For each contaminant, they determined which pathway appeared to have the greatest potential for exposing off-site populations, and they compared the exposure potential of the contaminant's other pathways to its most significant pathway. They then divided contaminants into three categories—radionuclides, carcinogens, and noncarcinogens—and compared the contaminants within each category based on their exposure potential and on their potential to cause health effects. This analysis identified facilities, processes, contaminants, media, and exposure routes believed to have the greatest potential to impact off-site populations. The results are provided in Table 4.

The Task 4 analysis was intended to provide a preliminary framework to help focus and prioritize future quantitative studies of the potential health impacts of off-site contamination. These analyses are intended to provide an initial approach to studying an extremely complex site. However, care must be taken in attempting to make broad generalizations or draw conclusions about the potential health hazard posed by the releases from the ORR.

In Task 5, investigators described the historical locations and activities of populations most likely to have been affected by the releases identified in Task 4. During Task 6, investigators compiled a summary of the current toxicologic knowledge and hazardous properties of the key contaminants. Task 7 involved collecting, categorizing, summarizing, and indexing selected documents relevant to the feasibility study.

Study Group

A study group was not selected.

Exposures

Seven completed exposure pathways associated with air, six completed exposure pathways associated with surface water, and ten completed exposure pathways associated with soil/sediment were evaluated for radionuclides and chemical substances (metals, organic compounds, and polycyclic aromatic hydrocarbons) released at the ORR from 1942 to 1992.

Outcome Measures

No outcome measures were studied.

Conclusions

The feasibility study indicated that past releases of the following contaminants have the greatest potential to impact off-site populations.

- **Radioactive iodine**
  The largest identified releases of radioactive iodine were associated with radioactive lanthanum processing from 1944 through 1956 at the X-10 facility.

- **Radioactive cesium**
  The largest identified releases of radioactive cesium were associated with various chemical separation activities that took place from 1943 through the 1960s.

- **Mercury**
  The largest identified releases of mercury were associated with lithium separation and enrichment operations that were conducted at the Y-12 facility from 1955 through 1963.

- **Polychlorinated biphenyls**
  Concentrations of polychlorinated biphenyls (PCBs) found in fish taken from the East Fork Poplar Creek and the Clinch River have been high enough to warrant further study. These releases likely came from electrical transformers and machining operations at the K-25 and Y-12 plants.

State investigators determined that sufficient information was available to reconstruct past releases and potential off-site doses for these contaminants. The steering panel (ORHASP) recommended that dose reconstruction activities proceed for the releases of radioactive iodine, radioactive cesium, mercury, and PCBs. Specifically they recommended that the state should continue the tasks begun during the feasibility study, and should characterize the actual release history of these contaminants from the reservation; identify appropriate fate and transport models to predict historical off-site concentrations; and identify an exposure model to use in calculating doses to the exposed population.

The panel also recommended that a broader-based investigation of operations and contaminants be conducted to study the large number of ORR contaminants released that have lower potentials for off-site health effects, including the five contaminants (chromium VI; plutonium 239, 240, and 241; tritium; arsenic; and neptunium 237) that could not be qualitatively evaluated during Phase 1 due to a lack of available data. Such an investigation would help in modifying or reinforcing the recommendations for future health studies.

Additionally, the panel recommended that researchers explore opportunities to conduct epidemiologic studies investigating potential associations between exposure doses and adverse health effects in exposed populations.

TABLE 1

LIST OF CONTAMINANTS INVESTIGATED DURING TASK 1 AND TASK 2

X-10	K-25	Y-12
Radionuclides		
Americium-241 Argon-41 Barium-140 Berkelium Californium-252 Carbon-14 Cerium-144 Cesium-134, -137 Cobalt-57, -60 Curium-242, -243, -244 Einsteinium Europium-152, -154, -155 Fermium Iodine-129, -131, -133 Krypton-85 Lanthanum-140 Niobium-95 Phosphorus-32 Plutonium-238, -239, -240, -241 Protactinium-233 Ruthenium-103, -106 Selenium-75 Strontium-89, -90 Tritium Uranium-233,-234, -235, -238 Xenon-133 Zirconium-95	Neptunium-237 Plutonium-239 Technetium-99 Uranium-234, -235, -238	Neptunium-237 Plutonium-239, -239, -240, -241 Technetium-99 Thorium-232 Tritium Uranium-234, -235, -238
Nonradioactive Metals		
None Initially Identified	Beryllium Chromium (trivalent and hexavalent) Nickel	Arsenic Beryllium Chromium (trivalent and hexavalent) Lead Lithium Mercury
Acids/Bases		
Hydrochloric acid Hydrogen peroxide Nitric acid Sodium hydroxide Sulfuric acid	Acetic acid Chlorine trifluoride Fluorine and fluoride compounds Hydrofluoric acid Nitric acid Potassium hydroxide Sulfuric acid	Ammonium hydroxide Fluorine and various fluorides Hydrofluoric acid Nitric acid Phosgene
Organic Compounds		
None Initially Identified	Benzene Carbon tetrachloride Chloroform Chlorofluorocarbons (Freons) Methylene chloride Polychlorinated biphenyls 1,1,1-Trichloroethane Trichloroethylene	Carbon tetrachloride Chlorofluorocarbons (Freons) Methylene chloride Polychlorinated biphenyls Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene

TABLE 2

CONTAMINANTS NOT WARRANTING FURTHER EVALUATION IN TASK 3 AND TASK 4

Radionuclides
Americium-241 Californium-252 Carbon-14 Cobalt-57 Cesium-134 Curium-242, -243, -244 Europium-152, -154, -155 Phosphorus-32 Selenium-75 Uranium-233 Berkelium Einsteinium Fermium
Nonradioactive Metals
Lithium
Organic Compounds
Benzene Chlorofluorocarbons (Freons) Chloroform
Acids/Bases
Acetic acid Ammonium hydroxide Chlorine trifluoride Fluorine and various fluoride compounds Hydrochloric acid Hydrogen peroxide Hydrofluoric acid Nitric acid Phosgene Potassium hydroxide Sulfuric acid Sodium hydroxide

TABLE 3

CONTAMINANTS FURTHER EVALUATED IN TASK 3 AND TASK 4

Radionuclides	Nonradioactive Metals	Organic Compounds
Argon-41 Barium-140 Cerium-144 Cesium-137 Cobalt-60 Iodine-129, -131, -133 Krypton-85 Lanthanum-140 Neptunium-237 Niobium-95 Plutonium-238, -239, -240, -241 Protactinium-233 Ruthenium-103, -106 Strontium-89, -90 Technetium-99 Thorium-232 Tritium Uranium-234 -235, -238 Xenon-133 Zirconium-95	Arsenic Beryllium Chromium (trivalent and hexavalent) Lead Mercury Nickel	Carbon tetrachloride Methylene chloride Polychlorinated biphenyls Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene

TABLE 4

HIGHEST PRIORITY CONTAMINANTS, SOURCES, TRANSPORT MEDIA, AND EXPOSURE ROUTES

Contaminant	Source	Transport Medium	Exposure Route
Iodine-131, -133	X-10 Radioactive lanthanon (RaLa) processing (1944-1956)	Air to vegetable to dairy cattle milk	Ingestion
Cesium-137	X-10 Various chemical separation processes (1944-1960s)	Surface water to fish Soil/sediment Soil/sediment to vegetables; livestock/game (beef); dairy cattle milk	Ingestion Ingestion Ingestion
Mercury	Y-12 Lithium separation and enrichment operations (1955-1963)	Air Air to vegetables; Livestock/game (beef); dairy cattle milk Surface water to fish Soil/sediment to livestock/game (beef); vegetables	Inhalation Ingestion Ingestion Ingestion
Polychlorinated biphenyls	K-25 and Y-12 Transformers and machining	Surface water to fish	Ingestion

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

PCBs in the Environment Near the Oak Ridge Reservation-A Reconstruction of Historical Doses and Health Risks, July 1999 (Task 3 Report)

Site: Oak Ridge Reservation

Conducted by: Areas surrounding the Oak Ridge Reservation, including the East Fork Poplar Creek, Poplar Creek, Clinch River, and Watts Bar Reservoir

Time period: Early 1940s to 1990

Conducted by: McLaren/Hart-ChemRisk for the Tennessee Department of Health

Purpose

The purpose of the Task 3 study was to assess the releases of polychlorinated biphenyls (PCBs) from the Oak Ridge Reservation (ORR) and the potential for adverse effects in populations living in the vicinity of the ORR. Specifically, the study investigated historical releases of PCBs from the government complexes at Oak Ridge, evaluated PCB levels in environmental media in the ORR area, described releases of PCBs from other sources in the Oak Ridge area, and evaluated the potential human exposures and health impacts associated with the historical presence of these contaminants in the off-site environment.

Background

In July 1991, the U.S. Department of Energy signed an agreement with the State of Tennessee to fund an independent health study of the population living around the ORR. The purpose of the study was to estimate exposures to chemicals and radioactive materials released at ORR since 1942. The first stage of the study, the Dose Reconstruction Feasibility Study, identified which chemicals and radionuclides released from the ORR in the past 50 years had the greatest potential to cause harmful health effects in people living off site. Contaminants identified during the Feasibility Study were then addressed during the Dose Reconstruction Study in separate tasks. One of these, Task 3, investigated PCBs.

PCBs were used extensively at the Y-12, K-25, and X-10 facilities at the ORR, for several purposes:

- In electrical equipment such as transformers, capacitators, hydraulic fluids, and heat-transfer fluids. ORR was one of the largest consumers of electrical energy in the United States from the 1940s to the 1980s.
- As cutting fluid, lubrication, and cooling in the machining operations for the fabrication of metal weapon parts and related process equipment.
- As a component of several products, such as paints, coatings, adhesives, inks, and gaskets.

PCB wastes were disposed of in burial facilities, holding ponds, and outdoor storage areas. They were also placed in waste management units at the Bear Creek Disposal Area and may have been sold (in waste oil form) to the public.

During the first 30 years of operations at the ORR, little or no attention was paid to the use, disposal, or contamination of the environment with PCBs. Few attempts were made to control the release of PCBs to the environment, and minimal efforts were made to track or document the amounts of PCBs used, disposed of on site, or released off site. This was because the carcinogenicity of PCBs in laboratory animals was not discovered until the 1970s. In 1977, the manufacture of PCBs was banned in the United States because of evidence that PCBs accumulated in the environment and caused harmful health effects.

Exposures

The possible routes of exposure are numerous:

- Ingestion of beef and milk from cows.
- Ingestion of fish and turtles.
- Ingestion of vegetables.
- Incidental ingestion of surface water, sediment, and soil.
- Dermal contact with surface water, sediment, and soil.
- Inhalation of dust and vapor.
- Contact during the sale or use of contaminated surplus oil.

Study Subject

The Task 3 team identified five off-site populations potentially exposed via the identified pathways:

- Farm families that raised beef and dairy cattle and grew vegetables on the East Fork Poplar Creek floodplain.
- People who may have purchased beef and milk from cattle raised in the East Fork Poplar Creek floodplain.
- Commercial and recreational fish consumers.
- People who may have consumed turtles.
- Users of surface water for recreational activities.

The sizes of affected populations vary greatly. The population eating fish from East Fork Poplar Creek and the number of farm families are expected to have been small, perhaps less than 20 individuals. However, it is estimated that more than 100,000 anglers (or members of anglers' families) consumed fish caught in the Watts Bar Reservoir and the Clinch River in the years since ORR activities began.

Methods and Results

In the absence of detailed historical records regarding PCB use and disposal at the ORR, the project team identified and evaluated all available information regarding processes and disposal practices that might have resulted in the release of PCBs. Data were obtained from a variety of sources, such as ORR contractors, the Tennessee Valley Authority, and the U.S. Environmental Protection Agency (EPA). Historical records maintained at the ORR were also reviewed to identify relevant processes, accidental spills, and general disposal practices that might have resulted in releases of PCBs. Information regarding undocumented events was obtained through interviews with active and retired employees of the ORR and residents of Oak Ridge living adjacent to the facilities.

Based on the available information, the project team determined that developing quantitative estimates of PCB releases from specific release points as a function of time (often called "source terms") would be difficult, if not impossible, due to widespread use of PCBs on ORR and absence of release documentation. Rather than basing the Task 3 risk assessments on estimates of the quantities of PCBs historically released, the project team estimated past exposures largely based on available environmental sampling data. Air-related pathways were an exception—they were evaluated using estimates of releases and air dispersion models.

The Task 3 team identified populations near ORR that may have been at risk from exposure to PCBs and determined the degree of risk to these populations. They used a three-level iterative quantitative risk assessment process, which refined exposure pathways and risks to certain target communities. Level I and II risk estimates were intended to overestimate risks to ensure that pathways that deserved additional study were not excluded, while the level III analysis attempted to provide an unbiased estimate of the distribution of risks across affected populations and to fully disclose the uncertainty of those risk estimates.

Level I

Level I analysis determined all potential pathways of PCB exposure to off-site populations. These pathways were grouped into three categories: pathways associated with releases to surface water bodies, pathways associated with air releases, and pathways associated with exposures to PCBs in waste oils. The project team selected conservative upper-bound exposure parameter values and developed exposure point concentrations to estimate potential exposure intakes. Intake estimates were compared with toxicity values to estimate the risks associated with each pathway.

The risk estimates were compared to established decision guides to screen exposure pathways for additional study. A nominal hazard quotient of 1 (the estimated dose divided by the EPA reference dose) for noncancer health effects and a 1×10^{-4} excess lifetime cancer risk (an excess cancer risk of 1 in 10,000) were used as the decision guides. Pathways that did not exceed the decision guides were excluded from further evaluation. Likely exposed off-site populations were identified for pathways that exceeded the decision guide, and these pathways were subject to level II analysis.

In some instances pathways and associated populations were deferred from additional analysis if there were insufficient data to meaningfully reduce the uncertainty in exposure and risk estimates. In these cases, the absence of data was identified as a data gap and included in the recommendations for additional studies.

The conservative level I screening eliminated many of the pathways from further study: all air-related pathways (except milk consumption), pathways associated with exposures to waste oil, dermal contact with sediment, incidental ingestion of sediment (except East Fork Poplar Creek), ingestion of drinking water, dermal contact with surface water, and ingestion of surface water. The following pathways were retained for level II evaluation:

- Ingestion of fish from East Fork Poplar Creek, Poplar Creek, the Clinch River, and Watts Bar Reservoir.

- Ingestion of beef from cattle and milk from cows raised in the East Fork Poplar Creek floodplain.

- Ingestion of vegetables grown in the East Fork Poplar Creek floodplain.

- Ingestion of East Fork Poplar Creek sediment and soil.

- Dermal contact with East Fork Poplar Creek floodplain soil.

Level II

In the level II evaluation, the Task 3 team estimated the distribution of doses and associated risks to the populations exposed via the pathways retained during the level I screening evaluation. The level II analysis risk estimates are based on the total exposure from multiple pathways. Any scenario in which the risk for 5 percent or more of the population was found to exceed the decision guides was regarded as warranting additional assessment. Those for which less than 5 percent of the estimates exceeded the decision guides were not further evaluated. The risk estimates were based on the total exposure from multiple pathways. A Monte Carlo analysis, a numerical simulation technique that allows any parameter in an equation or model to be represented by a range (distribution) of values, was used to investigate the uncertainty in the risk estimates.

The level II evaluation confirmed the results of the level I evaluation—the majority of the populations that exceeded the decision criteria during the level I screening also had risk estimates at the 95th percentile that exceeded the decision criteria. More specifically:

- Risks for recreational users of East Fork Poplar Creek were below levels of concern. Exposure to PCBs from the consumption of fish from the creek was also low, but slightly exceeded the noncancer decision guide. However, due to the limited productivity of the creek and the uncertainty in the estimates of fish consumption, this pathway was not retained for level III analysis.

- Families who lived on affected farms had the highest potential for exposure to PCBs if assumptions regarding PCBs in floodplain soil are correct. Risk for farm families exceeded the noncancer and cancer decision guides. However, farm families were not evaluated further due to the small number of potentially affected individuals and the high level of uncertainty associated with historical PCB concentrations.

- Risks to commercial and recreational fish consumers of the Watts Bar Reservoir, Clinch River, and Poplar Creek were below the cancer decision guides, but above the noncancer decision guides. Therefore, the uncertainties involved with estimating risk for people eating fish from these water bodies were further evaluated in the level III analysis. However, commercial anglers were not evaluated further because the population size was small and it was believed that recreational anglers had exposures comparable to those experienced by commercial anglers.

The only pathway retained for further evaluation during the level III analysis was eating fish from Watts Bar Reservoir, Clinch River, and Poplar Creek. Only noncancer health effects were evaluated, since cancer risk estimates were not exceeded during the level II evaluation.

Level III

Level III analysis assessed the variation and uncertainty in noncancer risks posed by PCBs to recreational anglers using Watts Bar Reservoir, Clinch River, and Poplar Creek. A two-dimensional Monte Carlo model was used to characterize the uncertainty and variability in the risk estimates. To investigate the incremental impact from PCB releases from ORR, the project team conducted two analyses: an initial analysis assuming no release from the ORR and an analysis including both background sources of PCBs and ORR releases. The two analyses were then compared to determine the incremental change in risk estimates associated with ORR releases.

Conclusions

The results of the level III evaluation suggested that there was a reasonable chance, but not a certainty, that anglers who ate large amounts of fish from Watts Bar, Poplar Creek, and Clinch River were at risk from experiencing noncarcinogenic health effects. An unknown portion of these people had a high probability of receiving PCB doses that exceeded the threshold for adverse health effects. The uncertainty in the risk estimates would be lower if better information on fish consumption rates and body burdens of PCBs in these anglers were available.

The majority of the risks to Watts Bar Reservoir anglers appear to be due to PCBs from sources upstream along the Tennessee River rather than the ORR. The Task 3 investigation evaluated the incremental risks posed by ORR releases to anglers already exposed to other sources, and determined that ORR releases resulted in an additional 1 to 2 percent of anglers receiving doses in excess of the population threshold. Had there been no releases from other Tennessee River sources, the ORR releases would not have resulted in doses that exceeded the population threshold level for Watts Bar Reservoir anglers. However, for Poplar Creek and Clinch River, it appears that ORR discharges were likely to have raised some anglers' doses above the population threshold for adverse effects.

Conservative estimates of the carcinogenic risks ORR releases pose to anglers on Watts Bar Reservoir and the Clinch River range from less than 1 in 1,000,000 to 2 in 10,000. Given the population size, approximately three excess cases of cancer would be expected to occur. However, because the estimates are conservative by design, the actual risks and the number of cases are likely to be smaller and could be zero.

The Task 3 team recommended collecting additional data and performing additional analyses to reduce the uncertainty in the estimates of risk.

- Characterize fish consumption rates for Poplar Creek, Clinch River, and Watts Bar Reservoir.
- Collect core samples from Poplar Creek, Clinch River, and Watts Bar Reservoir.
- Perform additional sampling of soils near East Fork Poplar Creek.
- Measure PCB levels in cattle currently grazing near East Fork Poplar Creek.
- Revise risk estimates to reflect additional survey data.
- Model body burdens of PCBs.
- Estimate response rates for noncarcinogenic effects.

ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Report on Turtle Sampling in Watts Bar Reservoir and Clinch River, May 1997

Site: Oak Ridge Reservation

Conducted by: Tennessee Department of Environment and Conservation

Time period: 1996

Study area: Watts Bar Reservoir and Clinch River

Purpose

The purpose of this study was to investigate levels of contaminants—especially polychlorinated biphenyls (PCBs)—in snapping turtles in the Watts Bar Reservoir and Clinch River/Poplar Creek water systems. The results of this study were used to assess exposure levels of people who might use the turtles for food.

Background

For more than 50 years, the U.S. Department of Energy's (DOE) Oak Ridge Reservation released radionuclides, metals, and other hazardous substances into the Clinch River and its tributaries. Subsequent studies conducted by DOE and the Tennessee Valley Authority (TVA) documented elevated levels of PCBs in certain species of fish in the Watts Bar Reservoir and Clinch River. As a result, the Tennessee Department of Environment and Conservation (TDEC) issued several consumption advisories on fish. Although noncommercial fishermen are known to harvest turtles, as well as fish, from the Watts Bar Reservoir, TDEC did not issue any consumption advisories on turtles. Since little information was available on contaminant levels in turtles and previous studies from other states indicated that snapping turtles have a tendency to accumulate PCBs (for example, in their fat tissue), the Agency for Toxic Substances and Disease Registry's (ATSDR) health consultation on the Lower Watts Bar Reservoir recommended sampling of turtles for PCBs.

Study Design and Methods

To evaluate levels of contaminants in turtles, TDEC collected 25 snapping turtles from 10 sampling stations in the Watts Bar Reservoir and Clinch River between April and June 1996. As recommended by the U.S. Environmental Protection Agency (EPA), the turtles were euthanized by freezing. Fat tissue and muscle tissue were analyzed separately, as were eggs when present. The samples were processed according to EPA guidelines.

Muscle tissue, fat tissue, and eggs were analyzed for PCBs using EPA methods. TDEC also conducted a PCB-congener[1] -specific analysis on the muscle tissue of two large turtles.To compare contaminant levels in turtles to contaminant levels previously detected in fish, TDEC analyzed turtle muscle tissue for metals and pesticides. Mercury analysis was performed on 13 turtles according to EPA method 245.6, and the remaining metals were analyzed using EPA method 200.1.

Specific pesticides and organic compounds analyzed for included chlordane, DDE, DDT, endrin, hexachlorobenzene, lindane, methoxychlor, and nonachlor. Specific metals analyzed for included arsenic, cadmium, chromium, copper, lead, and mercury.

[1] PCBs are mixtures of up to 209 individual chlorinated compounds referred to as congeners. For more information, see ATSDR's toxicological profile for PCBs at *http://www.atsdr.cdc.gov/toxprofiles/tp17.html*.

Study Group

Levels of contaminants were measured in turtles only. Human exposure levels were not investigated.

Exposures

No human exposure was assessed in this study.

Outcome Measure

Health outcomes were not evaluated.

Results

PCB concentrations were highest in the fat tissue of snapping turtles. Levels in fat tissue, muscle tissue, and eggs ranged from 0.274 parts per million (ppm) to 516 ppm, 0.032 ppm to 3.38 ppm, and 0.354 ppm to 3.56 ppm, respectively. Mean values for fat and muscle tissue were 64.8 ppm and 0.5 ppm, respectively.

Ten PCB congeners considered of highest concern by EPA were identified in the two turtles analyzed for congeners. The distribution of congeners in the two turtles was similar, but the concentrations varied considerably. The turtle with the higher concentrations of PCB congeners was caught from Poplar Creek.

Mercury and copper were the only metals detected in muscle tissue. Mercury concentrations were below the U.S. Food and Drug Administration (FDA) guidance level of 1.0 ppm, and ranged from 0.1 ppm to 0.35 ppm. Copper concentrations ranged from 0.2 ppm to 2.6 ppm.

Of the pesticides studied, *cis*-nonachlor, *trans*-nonachlor, and endrin were detected. They were detected at low levels: 0.001 ppm to 0.036 ppm for *cis*-nonachlor, 0.003 ppm to 0.045 ppm for *trans*-nonachlor, and 0.043 ppm to 0.93 ppm for endrin.

Conclusions

Turtle consumption practices should be further investigated before conducting quantitative assessments to evaluate risks to human health. In particular, it is important to determine which parts of the turtle are most commonly consumed (for example, fat or muscle tissue), as well as the frequency of consumption.

While it appears that PCBs concentrate at higher levels in turtles than in fish, caution is advised in comparing fish results to turtles. Unlike the turtle studies, previous fish studies did not analyze muscle tissue and fat tissue separately.

When assessing potential human health risks related to PCBs, it is important to consider the uncertainty in the toxicity values for PCBs. Because there are no toxicity values for individual PCB congeners, uncertainty in the toxicity of PCB mixtures remains.

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Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Consultation, Y-12 Weapons Plant Chemical Releases into East Fork Poplar Creek, Oak Ridge, Tennessee, April 5, 1993

Site: Oak Ridge Reservation

Conducted by: Agency for Toxic Substances and Disease Registry

Time Period: Early 1990s

Location: East Fork Poplar Creek and Floodplain Area

Purpose

The purpose of the health consultation was to evaluate published environmental data and to assess health risks associated with Y-12 Weapons Plant releases at the Oak Ridge Reservation.

Background

Between 1950 and 1963, the Department of Energy (DOE) Y-12 Weapons Plant used mercury in a lithium separation process. DOE officials estimate that 110 metric tons of mercury were released to the East Fork Poplar Creek (EFPC), and that an additional 750 metric tons of mercury used during that period could not be accounted for. Releases of mercury to the creek contaminated instream sediments, and periodic flooding contaminated floodplain soils along the creek. Land uses along the floodplain are residential, commercial, and recreational. Furthermore, residents used the sediment to enrich private gardens, and the city of Oak Ridge used creek sediment as fill material on sewer belt lines. In 1983, the state of Tennessee publicly disclosed that sediment and soil in the EFPC floodplain were contaminated with mercury. That same year, the Oak Ridge Task Force initiated remediation of public and private lands within the city of Oak Ridge.

In 1992, during Phase IA of the EFPC remedial investigation, DOE conducted preliminary sampling of soil, sediment, surface water, and groundwater from the EFPC floodplain area. During 1990 and 1991, DOE sampled for contaminants in EFPC fish through its Biological Monitoring and Abatement Program.

Study design and method

This was a health consultation conducted by the Agency for Toxic Substances and Disease Registry (ATSDR). An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, chemical release, or the presence of hazardous material. In this case, DOE requested that ATSDR comment on the health threat posed by past and present chemical releases from the Y-12 Weapons Plant to the East Fork Poplar Creek. To conduct the consultation, ATSDR evaluated DOE's preliminary environmental sampling data for metals, volatile and semivolatile organic compounds, radionuclides, and polychlorinated biphenyls (PCBs).

Health consultations may lead to specific actions, such as environmental sampling, restricting site access, or removing contaminated material, or ATSDR may make recommendations for other activities to protect the public's health.

Study group

ATSDR did not conduct a study.

Exposures

ATSDR estimated human exposure to contaminated EFPC floodplain soil, sediments, surface water, groundwater, fish, and air.

Outcome measure

ATSDR did not review health outcome data.

Results

Only mercury in soil and sediment, and PCBs and mercury in fish, are at levels of public health concern. Other contaminants, including radionuclides found in soil, sediment, and surface water, are not at levels of public health concern. Data were not available on radionuclides in fish.

Elevated levels of mercury, up to 2,240 parts per million (ppm), were found in a few soil and sediment samples from all three creek areas sampled. The mercury in the EFPC soil consisted primarily of some relatively insoluble inorganic forms of mercury (mercury salts and metallic mercury), with less than 1% of the mercury in organic form.

Mercury Salts in Soil

The primary routes of inorganic mercury exposure for people (particularly for children) who fish, play, or walk along the creek and floodplain, are through ingestion of soil from hand-to-mouth activities and from excessive dermal exposure. Following ingestion, absorption of inorganic mercury compounds across the gastrointestinal tract to the blood is low in both people and animals. Long-term exposure to the EFPC floodplain soil containing elevated levels of mercury may result in body burdens of mercury that could result in adverse health effects. The kidney is the organ most sensitive to the effects of ingestion of inorganic mercury salts. Effects on the kidney include increased urine protein levels and, in more severe cases, a reduction in the glomerular filtration rate, which is a sign of decreased blood-filtering capacity.

Metallic Mercury in Soil

The metallic mercury vapor levels in the ambient air at the three creek areas sampled are not at levels of public health concern. However, excavation of contaminated soil may result in mercury vapor being released from the soil, especially as the air temperature increases. Such releases may increase ambient air levels of mercury vapor, which could pose a health risk to unprotected workers and the public. Once inhaled, metallic mercury vapors are readily absorbed across the lungs into the blood; however, metallic mercury is poorly absorbed through dermal and oral routes. Exposure to mercury vapor may elicit consistent and pronounced neurologic effects.

Organic Mercury in Fish

Organic mercury is the primary form of mercury found in fish. Frequent ingestion of EFPC fish over the long term may result in neurotoxic effects. Concentrations of mercury in EFPC fish samples ranged from 0.08 ppm to 1.31 ppm. Studies on the retention and excretion of mercury have shown that approximately 95% of an oral dose of organic mercury is absorbed across the gastrointestinal tract. Neurodevelopmental effects have been seen in infants following prenatal exposure via maternal ingestion of organic mercury in fish.

PCBs in Fish

Frequent and long-term ingestion of EFPC fish could result in a moderate increased risk of developing cancer. Concentrations of PCBs in EFPC fish samples ranged from 0.01 ppm to 3.86 ppm. PCBs are widely distributed environmental pollutants commonly found in blood and fat tissue of the general population. PCBs are classified as a probable human carcinogen by the U.S. Environmental Protection Agency. PCBs have been shown to produce liver tumors in mice and rats following intermediate and chronic oral exposure. Groundwater samples collected from shallow monitoring wells along the EFPC floodplain were shown to contain elevated levels of metals and volatile organic compounds. There was no evidence, however, that groundwater from shallow aquifers was being used for domestic purposes. The municipal water system, which is used by most Oak Ridge residents, receives water from Clinch River upstream of the DOE reservation.

Conclusions

In some locations along the creek, mercury levels in soil and sediment pose a threat to people (especially children) who ingest, inhale, or have dermal contact with contaminated soil, sediment, or dust while playing, fishing, or taking part in other activities along the creek's floodplain.

Mercury and PCBs were found in fish fillet samples collected from the creek. Although people who eat fish from the creek are not at risk for acute health threats, people who frequently ingest contaminated fish over a prolonged period have a moderate increased risk of (1) adverse effects to the central nervous system and kidney and (2) developing cancer.

ATSDR did not have enough information on groundwater use along the East Fork Poplar Creek to comment on the contamination of groundwater in shallow, private wells along the creek. However, contamination detected in wells along the creek does not pose a threat to people who receive municipal water.

ATSDR made the following recommendations.

- Determine the depth and extent of mercury contamination in the EFPC sediments and floodplain soil.
- As an interim measure, restrict access to the contaminated soil and sediment, or post advisories to warn the public of the hazards.
- Continue the Tennessee Department of Environment and Conservation EFPC fish advisory.
- Continue monitoring fish from the creek for the presence of mercury and PCBs.
- Complete the survey of well water use along the EFPC floodplain.
- Sample shallow private wells near the creek for PCBs, volatile organic compounds, and total and dissolved metals.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

Health Consultation, U.S. DOE Oak Ridge Reservation, Lower Watts Bar Operable Unit, February 1996

Site: Oak Ridge Reservation
Study authors: Agency for Toxic Substances and Disease Registry
Time period: 1980s and 1990s
Target population: Lower Watts Bar Reservoir Area

Purpose

This health consultation was conducted to evaluate the public health implications of chemical and radiological contaminants in the Watts Bar Reservoir and the effectiveness of the Department of Energy's proposed remedial action plan for protecting public health.

Background

In March 1995, the Department of Energy (DOE) released a proposed plan for addressing contaminants in the Lower Watts Bar Reservoir. The plan presented the potential risk posed by contaminants and DOE's preferred remedial action alternative. DOE's risk assessment indicated that consumption of certain species of fish from the Lower Watts Bar Reservoir and the transfer of sediment from deeper areas of the reservoir to areas on land where crops were grown could result in unacceptable risk to human health.

The September 1995 Record of Decision for the Lower Watts Bar Reservoir presented DOE's remedial action plan for the reservoir. This remedial action included maintaining the fish consumption advisories of the Tennessee Department of Environment and Conservation (TDEC), continuing environmental monitoring, and implementing institutional controls to prevent disturbance, resuspension, removal, or disposal of contaminated sediment. The U.S. Environmental Protection Agency (EPA) and TDEC concurred with the remedial action plan.

Concerned about the sufficiency of DOE's plan, local residents asked the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate the health risk related to contaminants in the Lower Watts Bar Reservoir. These residents asked ATSDR to provide an independent opinion on whether DOE's selected remedial actions would adequately protect public health.

Methods

ATSDR agreed to provide a health consultation. A health consultation is conducted in response to a specific request for information about health risks related to a specific site, a specific chemical release, or the presence of other hazardous material. The response from ATSDR may be verbal or written.

To assess the current and recent past health hazards from the Lower Watts Bar Reservoir contamination, ATSDR evaluated environmental sampling data. ATSDR evaluated reservoir studies conducted by DOE and the Tennessee Valley Authority during the 1980s and 1990s. ATSDR also evaluated TVA's 1993 and 1994 Annual Radiological Environmental Reports for the Watts Bar nuclear plant. ATSDR first screened the voluminous environmental data to determine whether any contaminants were present at levels above health–based comparison values. ATSDR next estimated exposure doses for any contaminants exceeding comparison values. It is important to note that the fact that a contaminant exceeds comparison values does not necessarily mean that the contaminant will cause adverse health effects. Comparison values simply help ATSDR determine which contaminants to evaluate more closely.

ATSDR estimated exposure doses, using both worst case and realistic exposure scenarios, to determine if current chemical and radiological contaminant levels could pose a health risk to area residents. The worst case scenarios assumed that the most sensitive population (young children) would be exposed to the highest concentration of each contaminant in each media by the most probable exposure routes.

Target population

Individuals living along the Watts Bar Reservoir and individuals visiting the area.

Exposures

The exposures investigated were those to metals, radionuclides, volatile organic compounds, polychlorinated biphenyls (PCBs), and pesticides in surface water, sediment, and fish.

Outcome measure

ATSDR did not review health outcome data.

Results

Reservoir Fish and Other Wildlife: Using a realistic exposure scenario for fish consumption that assumed an adult weighing 70 kilogram (kg) consumed one 8-ounce sport fish meal per week, or per month, for 30 years, ATSDR determined that PCB levels in reservoir fish were at levels of health concern. ATSDR estimated ranges of PCB exposure doses from 0.099 to 0.24 micrograms of PCBs per kilogram of human body weight every day (μg/kg/day) for the one fish meal a week scenario and 0.023 to 0.055 μg/kg/day for the one fish per month scenario.

At these exposure doses, ATSDR estimates that approximately one additional cancer case might develop in 1,000 people eating one fish meal a week for 30 years and three additional cancer cases might develop in 10,000 people eating one fish meal a month for 30 years.

At these exposure doses, ATSDR also determined that ingestion of reservoir fish by pregnant women and nursing mothers might cause adverse neurobehavioral effects in infants. Although the evidence that PCBs cause developmental defects in infants is difficult to evaluate and inconclusive, ATSDR's determination was made on the basis of the special vulnerability of developing fetuses and infants.

Using a worst case scenario that assumed adults and children consumed two 8-ounce fish meals a week, containing the maximum concentration of each radioactive contaminant, ATSDR determined that the potential level of radiological exposure, which was less than 6 millirem per year (mrem/yr), was not a public health hazard.

Reservoir Surface Water: Using a worst case exposure scenario that assumed a child would daily ingest a liter of unfiltered reservoir water containing the maximum level of contaminants, ATSDR determined that the levels of chemicals in the reservoir surface water were not a public health hazard.

Levels of radionuclides in surface water were well below the levels of the current and proposed EPA drinking water standards. In addition, the total radiation dose to children from waterborne radioactive contaminants would be less that 1 mrem/yr, which is well below background levels. The radiation dose was estimated using the conservative assumption that a 10-year-old child would drink and shower with unfiltered reservoir water and swim in the reservoir daily.

Reservoir Sediment: ATSDR determined that the maximum chemical and radioactive contaminant concentrations reported in the recent surface sediments data (mercury, Co-60, Sr–89/90, and Cs-137) would not present a public health hazard. The estimated dose from radioactive contaminants was less than 15 mrem/yr, which is below background levels.

ATSDR also evaluated the potential exposure a child might receive if the subsurface sediments were removed from the deep reservoir channels and used as surface soil in residential properties. Using a worst case exposure scenario that included ingestion, inhalation, external, and dermal contact exposure routes, ATSDR determined that the potential radiation dose to individuals living on these properties (less than 20 mrem/yr) would not pose a public health hazard.

Conclusions

ATSDR found that only PCBs in the reservoir fish were of potential public health concern. Other contaminants in the surface water, sediment, and fish were not found to be a public health hazard.

On the basis of current levels of contaminants in the water, sediment, and wildlife, ATSDR concluded the following.

- The levels of PCBs in the Lower Watts Bar Reservoir fish posed a public health concern. Frequent and long-term ingestion of fish from the reservoir posed a moderately increased risk of cancer in adults and increased the possibility of developmental effects in infants whose mothers consumed fish regularly during gestation and while nursing. Turtles in the reservoir might also contain PCBs at levels of public health concern.

- Current levels of contaminants in the reservoir surface water and sediment were not a public health hazard. The reservoir was safe for swimming, skiing, boating, and other recreational purposes. It is safe to drink water from the municipal water systems, which draw surface water from tributary embayments in the Lower Watts Bar Reservoir and the Tennessee River upstream from the Clinch River and Lower Watts Bar Reservoir.

- DOE's selected remedial action was protective of public health.

ATSDR made the following recommendations.

- The Lower Watts Bar Reservoir fish advisory should remain in effect to minimize exposure to PCBs.

- ATSDR should work with the state of Tennessee to implement a community health education program on the Lower Watts Bar fish advisory and the health effects of PCB exposure.

- The health risk from consumption of turtles in the Lower Watts Bar Reservoir should be evaluated. The evaluation should investigate turtle consumption patterns and PCB levels in edible portions of turtles.

- Surface and subsurface sediments should not be disturbed, removed, or disposed of without careful review by the interagency working group.

- Sampling of municipal drinking water at regular intervals should be continued. In addition, at any time a significant release of contaminants from the Oak Ridge Reservation is discharged into the Clinch River, DOE should notify municipal water systems and monitor surface water intakes.

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Exposure Investigation, Serum PCB and Blood Mercury Levels in Consumers of Fish and Turtles from the Watts Bar Reservoir, March 5, 1998

Site: Oak Ridge Reservation
Conducted by: ATSDR
Time period: 1997
Study area: Watts Bar Reservoir

Purpose

The purpose of this exposure investigation was to determine whether people consuming moderate to large amounts of fish and turtles from the Watts Bar Reservoir were being exposed to elevated levels of polychlorinated biphenyls (PCBs) or mercury.

Background

Previous investigations of the Watts Bar Reservoir and Clinch River evaluated many contaminants, but identified only PCBs in reservoir fish as a possible contaminant of current health concern. The U.S. Department of Energy (DOE) and the Tennessee Department of Environment and Conservation (TDEC) detected PCBs at levels up to approximately 8 parts per million (ppm) in certain species of fish from the reservoir. PCBs were detected in turtles at levels up to 3.3 ppm in muscle tissue and up to 516 ppm in adipose tissue. Mercury is a historical contaminant of concern for the reservoir due to the large quantities released from the Oak Ridge Reservation. However, recent studies have not detected mercury at levels of health concern in surface water, sediments, or fish and turtles from the Watts Bar Reservoir.

The 1994 DOE remedial investigation for the Lower Watts Bar Reservoir and the 1996 DOE remedial investigation for Clinch River/Poplar Creek concluded that the fish ingestion pathway had the greatest potential for adverse human health effects. The Agency for Toxic Substance and Disease Registry's (ATSDR's) 1996 health consultation of the Lower Watts Bar Reservoir reached a similar conclusion. These investigations based their conclusions on estimated PCB exposure doses and estimated excess cancer risk for people consuming large amounts of fish over an extended period of time. Fish ingestion rates, however, provide large uncertainty to these risk estimates. In addition, these estimated exposure doses and cancer risks do not consider consumption of reservoir turtles because of the uncertainties regarding turtle consumption.

ATSDR conducted this investigation primarily because of the uncertainties involved in estimating exposure doses and excess cancer risk from ingestion of reservoir fish and turtles. Also, previous investigations did not confirm that people are actually being exposed or that they have elevated levels of PCBs or mercury. In addition, a contractor for the Tennessee Department of Health (TDOH) recommended that an extensive region-wide evaluation be conducted of relevant exposures and health effects in counties surrounding the Watts Bar Reservoir. Prior to the initiation of such evaluations, ATSDR believed that it was important to determine whether mercury and PCBs were actually elevated in individuals who consumed large amounts of fish and turtles from the reservoir. Mercury was included in this exposure investigation because it was a historical contaminant of concern released from the Oak Ridge Reservation.

Study Design and Methods

This exposure investigation was cross-sectional in design as it evaluated exposures of the fish and turtle consumers at the same point in time. However, because serum PCB and mercury blood levels are indicators of chronic exposure, the results of this investigation provide information on both past and current exposure for each study participant.

Exposure investigations are one of the approaches that ATSDR uses to develop better characterization of past, present, or possible future human exposure to hazardous substances in the environment. These investigations only evaluate exposures and do not assess whether exposure levels resulted in adverse health effects. Furthermore, this investigation was not designed as a research study (for example, participants were not randomly selected for inclusion in the study and there was no comparison group), and the results of this investigation are only applicable to the participants in the study and cannot be extended to the general population.

Specific objectives of this investigation included measuring levels of serum PCBs and blood mercury in people consuming moderate to large amounts of fish or turtles, identifying appropriate health education activities and follow-up health actions, and providing new information to help evaluate the need for future region-wide assessments.

Study Group

The target population was persons who consumed moderate to high amounts of fish and turtles from the Watts Bar Reservoir. ATSDR recruited participants through a variety of means, including newspaper, radio, and television announcements, as well as posters and flyers placed in bait shops and marinas. ATSDR representatives also made an extensive, proactive attempt to reach potential participants by telephoning several hundred individuals who had purchased fishing licenses in the area.

ATSDR interviewed more than 550 volunteers. Of these, 116 had eaten enough fish to be included in the investigation. To be included in the investigation, volunteers had to report eating one or more of the following during the past year: 1 or more turtle meals; 6 or more meals of catfish and striped bass; 9 or more meals of white, hybrid, or smallmouth bass; or 18 or more meals of largemouth bass, sauger, or carp.

Exposures

Human exposures to PCBs and mercury from fish and turtle ingestion were evaluated.

Outcome Measure

Outcome measures included serum PCB and total blood mercury levels. ATSDR also collected demographic and exposure information from each participant (for example, length of residency near the reservoir; species eaten, where caught, and how prepared).

Results

The 116 participants resided in eight Tennessee counties and several other states. The mean age was 52.5 years and 58.6% of the participants were male and 41.4% were female. A high school education was completed by 65%. Eighty percent consumed Watts Bar Reservoir fish for 6 or more years, while 65.5% ate reservoir fish for more than 11 years. Twenty percent ate reservoir turtles in the last year. The average daily consumption rate for fish or turtles was 66.5 grams per day.

Serum PCB levels above 20 parts per billion (ppb) were considered elevated, and only five individuals had elevated serum PCB levels. Of the five participants with elevated PCB levels, four had levels between 20 and 30 ppb. One participant had a serum PCB level of 103.8 ppb, which is higher than levels found in the general population. None of the participants with elevated PCB levels had any known occupational or environmental exposures that might have contributed to the higher levels.

Only one participant had an elevated blood mercury level—higher than 10 ppb. The remaining participants had mercury levels up to 10 ppb, which is comparable to levels found in the general population.

Conclusions

Serum PCB levels and blood mercury levels in participants were similar to levels found in the general population.

Based on the screening questionnaire, most of the people who volunteered for the study (over 550) ate little or no fish or turtles from the Watts Bar Reservoir. Those who did eat fish or turtles from the reservoir indicated that they would continue to do so even though they were aware of the fish advisory.

Introduction

Fish are an important part of a healthy diet. They are a lean, low-calorie source of protein. Some sport fish caught in the nation's lakes, rivers, oceans, and estuaries, however, may contain chemicals that could pose health risks if these fish are eaten in large amounts.

The purpose of this brochure is not to discourage you from eating fish. It is intended as a guide to help you select and prepare fish that are low in chemical pollutants. By following these recommendations, you and your family can continue to enjoy the benefits of eating fish.

Fish taken from polluted waters might be hazardous to your health. Eating fish containing chemical pollutants may cause birth defects, liver damage, cancer, and other serious health problems.

Chemical pollutants in water come from many sources. They come from factories and sewage treatment plants that you can easily see. They also come from sources that you can't easily see, like chemical spills or runoff from city streets and farm fields. Pollutants are also carried long distances in the air.

Fish may be exposed to chemical pollutants in the water, and the food they eat. They may take up some of the pollutants into their bodies. The pollutants are found in the skin, fat, internal organs, and sometimes muscle tissue of the fish.

What can I do to reduce my health risks from eating fish containing chemical pollutants ?

Following these steps can reduce your health risks from eating fish containing chemical pollutants. The rest of the brochure explains these recommendations in more detail.

1. ***Call your local or state environmental health department.*** Contact them before you fish to see if any advisories are posted in areas where you want to fish.
2. ***Select certain kinds and sizes of fish for eating.*** Younger fish contain fewer pollutants than older, larger fish. Panfish feed on insects and are less likely to build up pollutants.
3. ***Clean and cook your fish properly.*** Proper cleaning and cooking techniques may reduce the levels of some chemical pollutants in the fish.

Health Note

Advisories are different from fishing restrictions or bans or limits. Advisories are issued to provide ***recommendations*** for limiting the amount of fish to be eaten due to levels of pollutants in the fish.

A Message from the Administrator

Christine Todd Whitman

I believe water is the biggest environmental issue we face in the 21st Century in terms of both quality and quantity. In the 30 years since its passage, the Clean Water Act has dramatically increased the number of waterways that are once again safe for fishing and swimming. Despite this great progress in reducing water pollution, many of the nation's waters still do not meet water quality goals. I challenge you to join with me to finish the business of restoring and protecting our nation's waters for present and future generations.

For More Information

For more information about reducing your health risks from eating fish that contain chemical pollutants, contact your local or state health or environmental protection department. You can find the telephone number in the blue section of your local telephone directory.

You may also contact:

U.S. Environmental Protection Agency
Office of Water
Fish and Wildlife Contamination Program (4305T)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

web address: www.epa.gov/ost/fish

United States Environmental Protection Agency
Office of Water (4101M)
EPA 823-F-02-005 • April 2002

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

In celebration of the 30th anniversary of the Clean Water Act, EPA presents

A Guide to Healthy Eating of the Fish You Catch

★ 2002 ★ THE YEAR OF CLEAN WATER
Celebration & Recommitment

ATSDR AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Developed in collaboration with the Agency for Toxic Substances and Disease Registry, U.S. Public Health Service

Catching Fish

How can I find out if the waters that I fish in are polluted?

It's almost impossible to tell if a water body is polluted simply by looking at it. However, there are ways to find out.

First, look to see if warning signs are posted along the water's edge. If there are signs, follow the advice printed on them.

Second, even if you don't see warning signs, call your local or state health or environmental protection department and ask for their advice. Ask them if there are any advisories on the kinds or sizes of fish that may be eaten from the waters where you plan to fish. You can also ask about fishing advisories at local sporting goods or bait shops where fishing licenses are sold.

If the water body has not been tested, follow these guidelines to reduce your health risks from eating fish that might contain small amounts of chemical pollutants.

Health Note

Some chemical pollutants, such as mercury and PCBs, can pose greater risks to women of childbearing age, pregnant women, nursing mothers, and young children. This group should be especially careful to greatly reduce or avoid eating fish caught from polluted waters.

Do some fish contain more pollutants than others?

Yes. You can't look at fish and tell if they contain chemical pollutants. The only way to tell if fish contain harmful levels of chemical pollutants is to have them tested in a laboratory. Follow these simple guidelines to lower the risk to your family:

- If you eat gamefish, such as lake trout, salmon, walleye, and bass, eat the smaller, younger fish (within legal limits). They are less likely to contain harmful levels of pollutants than larger, older fish.
- Eat panfish, such as bluegill, perch, stream trout, and smelt. They feed on insects and other aquatic life and are less likely to contain high levels of harmful pollutants.
- Eat fewer fatty fish, such as lake trout, or fish that feed on the bottoms of lakes and streams such as catfish and carp. These fish are more likely to contain higher levels of chemical pollutants.

Cleaning Fish

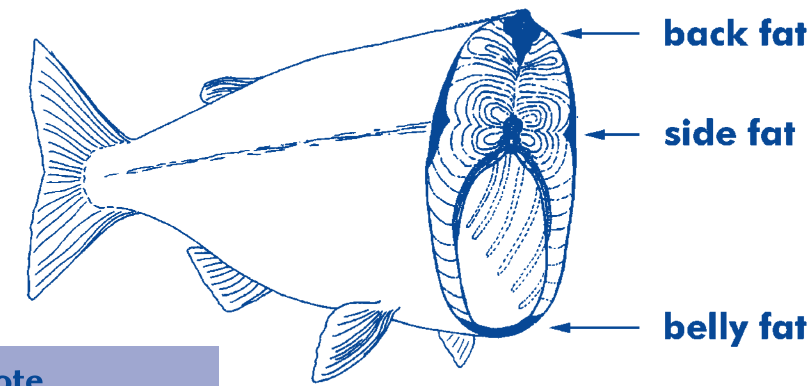
Can I clean my fish to reduce the amount of chemical pollutants that might be present?

Yes. It's always a good idea to remove the skin, fat, and internal organs (where harmful pollutants are most likely to accumulate) before you cook the fish.

As an added precaution:

- Remove and throw away the head, guts, kidneys, and the liver.

Trim away the skin and fatty tissue before cooking to reduce the level of some pollutants in the fish you eat.



Health Note

Mercury is found throughout the tissue in fish, so these cleaning and cooking techniques will not reduce the amount of mercury in a meal of fish.

- Fillet fish and cut away the fat and skin before you cook it.
- Clean and dress fish as soon as possible.

Remember that with any fresh meat, always follow proper food handling and storage techniques. To prevent the growth of bacteria or viruses, keep freshly caught fish on ice and out of direct sunlight.

Cooking Fish

Can I cook my fish to reduce my health risk from eating fish containing chemical pollutants?

Yes. The way you cook fish can make a difference in the kinds and amounts of chemical pollutants remaining in the fish. Fish should be properly prepared and grilled, baked, or broiled. By letting the fat drain away, you can remove pollutants stored in the fatty parts of the fish. Added precautions include:

- Avoid or reduce the amount of fish drippings or broth that you use to flavor the meal. These drippings may contain higher levels of pollutants.
- Eat less fried or deep fat-fried fish because frying seals any chemical pollutants that might be in the fish's fat into the portion that you will eat.
- If you like smoked fish, it is best to fillet the fish and remove the skin before the fish is smoked.

Posted Streams, Rivers, and Reservoirs

> *The Commissioner shall have the power, duty, and responsibility to…post or cause to be posted such signs as required to give notice to the public of the potential or actual dangers of specific uses of such waters.*
> Tennessee Water Quality Control Act

When streams or lakes are found to have significantly elevated bacteria levels or when fish tissue contaminant levels exceed risk-based criteria, it is the responsibility of the Department of Environment and Conservation to post warning signs so that the public will be aware of the threat to public health.

Consistent with EPA guidance, any stream or reservoir in Tennessee with an advisory is assessed as not meeting the recreational designated use. Clearly, if fishermen cannot safely eat the fish they catch, the waterbody is not supporting its goal to be fishable. Likewise, streams and lakes with high levels of bacteria are not suitable for recreational activities such as swimming or wading.

Bacteriological Contamination

The presence of pathogens, disease-causing organisms, affects the public's ability to safely swim, wade, and fish in streams and reservoirs. Pathogen sources include failing septic tanks, collection system failure, failing animal waste systems, or urban runoff. About 147 river miles are posted due to bacterial contamination.

Bacteriological Advisories in Tennessee
(August 2004. This list is subject to revision.)

East Tennessee

Stream	Portion	County	Comments
Beaver Creek (Bristol)	TN/VA line to Boone Lake (20.0 miles)	Sullivan	Nonpoint sources in Bristol and Virginia.
Cash Hollow Creek	Mile 0.0 to 1.4	Washington	Septic tank failures.
Coal Creek	STP to Clinch R. (4.7 miles)	Anderson	Lake City STP.
East Fork Poplar Creek	Mouth to Mile 15.0	Roane	Oak Ridge area.
First Creek	Mile 0.2 to 1.5	Knox	Knoxville urban runoff
Goose Creek	Entire Stream (4.0 miles)	Knox	Knoxville urban runoff.
Leadvale Creek	Douglas Lake to headwaters (1.5 miles)	Jefferson	White Pine STP.
Little Pigeon River	Mile 0.0 to 4.6	Sevier	Improper connections to storm sewers, leaking sewers, and failing septic tanks.
Pine Creek	Mile 0.0 to 10.1	Scott	Oneida STP and collection system
Litton Fork	Mile 0.0 to 1.0		
South Fork	Mile 0.0 to 0.7		
East Fork	Mile 0.0 to 0.8		
North Fork	Mile 0.0 to 2.0		
Second Creek	Mile 0.0 to 4.0	Knox	Knoxville urban runoff.
Sinking Creek	Mile 0.0 to 2.8	Washington	Agriculture & urban runoff
Sinking Creek Embayment of Fort Loudoun Reservoir	1.5 miles from head of embayment to cave	Knox	Knoxville Sinking Creek STP.
Third Creek	Mile 0.0 to 1.4, Mile 3.3	Knox	Knoxville urban runoff.
East Fork of Third Creek	Mile 0.0 to 0.8	Knox	Knoxville urban runoff.
Johns Creek	Downstream portion (5.0 miles)	Cocke	Failing septic tanks

East Tennessee Continued

Stream	Portion	County	Comments
Baker Creek	Entire stream (4.4 miles)	Cocke	Failing septic tanks
Turkey Creek	Mile 0.0 to 5.3	Hamblen	Morristown collection system.
West Prong of Little Pigeon River	Mile 0.0 to 17.3	Sevier	Improper connections to storm sewers, leaking sewers, and failing septic tanks.
Beech Branch	Entire stream (1.0 mile)		
King Branch	Entire stream (2.5 miles)		
Gnatty Branch	Entire stream (1.8 miles)		
Holy Branch	Entire stream (1.0 mile)		
Baskins Branch	Entire stream (1.3 miles)		
Roaring Creek	Entire stream (1.5 miles)		
Dudley Creek	Entire stream (5.7 miles)		

Southeast Tennessee

Stream	Portion	County	Comments
Chattanooga Creek	Mouth to GA line (7.7 mi.)	Hamilton	Chattanooga collection system.
Little Fiery Gizzard	Upstream natural area to Grundy Lake (3.7 miles).	Grundy	Failing septic tanks in Tracy City.
Clouse Hill Creek	Entire Stream (1.9 miles)		
Hedden Branch	Entire Stream (1.5 miles)		
Oostanaula Creek	Mile 28.4 -31.2 (2.8 miles)	McMinn	Athens STP and upstream dairies.
Stringers Branch	Mile 0.0 to 5.4	Hamilton	Red Bank collection system.
Citico Creek	Mouth to headwaters (7.3 miles)	Hamilton	Chattanooga urban runoff and collection system.

Middle Tennessee

Stream	Portion	County	Comments
Duck River	Old Stone Fort State Park (0.2 miles)	Coffee	Manchester collection system.
Little Duck River	Old Stone Fort State Park (0.2 miles)		
Mine Lick Creek	Mile 15.3 to 15.8 (0.5 mile)	Putnam	Baxter STP.
Nashville Area		Davidson	Metro Nashville collection system overflows and urban runoff.
Brown's Creek	Entirety (3.3 miles)		
Dry Creek	Mile 0.0 to 0.1		
Gibson Creek	Mile 0.0 to 0.2		
McCrory Creek	Mile 0.0 to 0.2		
Tributary to McCrory Creek	Mile 0.0 to 0.1		
Richland Creek	Mile 0.0 to 2.2		
Whites Creek	Mile 0.0 to 2.1		
Cumberland River	Bordeaux Bridge (Mile 185.7) to Woodland Street Bridge (Mile 190.6)		

Fish Tissue Contamination

Fish are an important part of a balanced diet and a good source of low fat protein. They also provide essential fatty acids that are crucial for the proper functioning of the nervous system and help prevent heart disease. The Department recommends that residents and visitors continue to eat fish from Tennessee rivers and reservoirs, but they should also follow the published advisories on consumption hazards in individual reservoirs.

Approximately 94,400 reservoir acres and 119 river miles are currently posted due to contaminated fish. The contaminants most frequently found at dangerous levels in fish tissue are PCBs, chlordane, and other organics. Mercury has also been found at dangerously high levels in fish tissue in two east Tennessee waterways, East Fork Poplar Creek and North Fork Holston River.

Organic substances tend to bind with the sediment, settle out of the water, and persist for a very long time. In the sediment, they become part of the aquatic food chain and, over time, concentrate in fish tissue. Contaminants can be found in fish tissue even if the substance has not been used or manufactured in decades.

Waterbodies where fish tissue has levels of contamination that pose a higher than acceptable risk to the public are posted and the public is advised of the danger. Signs are placed at main public access points and a press release is submitted to local newspapers. The list of advisories is also published in TWRA's annual fishing regulations. If needed, TWRA can enforce a fishing ban.

In March of 2004, the U.S. Department of Health and Human Services in conjunction with the U.S. Environment Protection Agency, issued a mercury advisory for the consumption of fish and shellfish by pregnant women, nursing mothers, young children, and women who might become pregnant. The advisory specifically warns this sensitive sub-population to avoid eating fish that have been found to have elevated mercury levels: Shark, Swordfish, King Mackerel, and Tilefish. For more information on this advisory please see EPA's website at:
http://www.epa.gov/waterscience/fishadvice/advice.html.

Reducing Risks from Contaminated Fish

The best way to protect yourself and your family from eating contaminated fish is by following the advice provided by the Department of Environment and Conservation. Cancer risk is accumulated over a lifetime of exposure to a carcinogen (cancer-causing agent). For that reason, eating an occasional fish, even from an area with a fishing advisory, will not measurably increase your cancer risk.

At greatest risk are people who eat contaminated fish for years, such as recreational or subsistence fishermen. Some groups of people like children or people with a previous occupational exposure to a contaminant are more sensitive to that pollutant. Studies have shown that contaminants can cross the placental barrier in pregnant women to enter the baby's body, thereby increasing the risk of developmental problems. These substances are also concentrated in breast milk.

The Division's goal in issuing fishing advisories is to provide the information necessary for people to make **informed choices** about their health. People concerned about their health will likely choose not to eat fish from contaminated sites.

If you choose to eat fish in areas with elevated contaminant levels, here is some advice on how to reduce this risk:

1. **Throw back the big ones.** Smaller fish generally have lower concentrations of contaminants.

2. **Avoid fatty fish.** Organic carcinogens such as DDT, PCBs, and dioxin accumulate in fatty tissue. In contrast, however, mercury tends to accumulate in muscle tissue. Large carp and catfish tend to have more fat than gamefish. Moreover, the feeding habits of carp, sucker, buffalo, and catfish tend to expose them to the sediments, where contaminants are concentrated.

3. **Wash fish before cleaning.** Some contaminants are concentrated in the mucus, so fish should be washed before they are skinned and filleted.

4. **Broil or grill your fish.** These cooking techniques allow the fat to drip away. Frying seals the fat and contaminants into the food.

5. **Throw away the fat if the pollutant is PCBs, dioxin, chlordane or other organic contaminants.** Organic pesticides tend to accumulate in fat tissue, so cleaning the fish so the fat is discarded will provide some protection from these contaminates.

Fish Tissue Advisories in Tennessee
(August 2004. This list is subject to revision.)

West Tennessee

Stream	County	Portion	HUC Code	Pollutant	Comments
Loosahatchie River	Shelby	Mile 0.0 - 20.9	08010209	Chlordane, Other Organics	Do not eat the fish.
McKellar Lake	Shelby	Entirety (13 miles)	08010100	Chlordane, Other Organics	Do not eat the fish.
Mississippi River	Shelby	Mississippi stateline to just downstream of Meeman-Shelby State Park (31 miles)	08010100	Chlordane, Other Organics	Do not eat the fish. Commercial fishing prohibited by TWRA.
Nonconnah Creek	Shelby	Mile 0.0 to 1.8	08010201	Chlordane, Other Organics	Do not eat the fish. Advisory ends at Horn Lake Road bridge.
Wolf River	Shelby	Mile 0.0 - 18.9	08010210	Chlordane, Other Organics	Do not eat the fish.

Middle Tennessee

Stream	County	Portion	HUC Code	Pollutant	Comments
Woods Reservoir	Franklin	Entirety (3,908 acres)	06030003	PCBs	Catfish should not be eaten.

East Tennessee

Stream	County	Portion	HUC Code	Pollutant	Comments
Boone Reservoir	Sullivan, Washington	Entirety (4,400 acres)	06010102	PCBs, chlordane	Precautionary advisory for carp and catfish. *
Chattanooga Creek	Hamilton	Mouth to Georgia Stateline (11.9 miles)	06020001	PCBs, chlordane	Fish should not be eaten. Also, avoid contact with water.
East Fork of Poplar Creek including Poplar Creek embayment	Anderson, Roane	Mile 0.0 - 15.0	06010207	Mercury, PCBs	Fish should not be eaten. Also, avoid contact with water.
Fort Loudoun Reservoir	Loudon, Knox, Blount	Entirety (14,600 acres)	06010201	PCBs	Commercial fishing for catfish prohibited by TWRA. No catfish or largemouth bass over two pounds should be eaten. Do not eat largemouth bass from the Little River embayment.
Melton Hill Reservoir	Knox, Anderson	Entirety (5,690 acres)	06010207	PCBs	Catfish should not be eaten.
Nickajack Reservoir	Hamilton, Marion	Entirety (10,370 acres)	06020001	PCBs	Precautionary advisory for catfish. *
North Fork Holston River	Sullivan, Hawkins	Mile 0.0 - 6.2 (6.2 miles)	06010101	Mercury	Do not eat the fish. Advisory goes to TN/VA line.

East Tennessee Continued

Stream	County	Portion	HUC Code	Pollutant	Comments
Tellico Reservoir	Loudon	Entirety (16,500 acres)	06010204	PCBs	Catfish should not be eaten.
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tennessee River portion (38,000 acres)	06010201	PCBs	Catfish, striped bass, & hybrid (striped bass-white bass) should not be eaten. Precautionary advisory* for white bass, sauger, carp, smallmouth buffalo and largemouth bass.
Watts Bar Reservoir	Roane, Anderson	Clinch River arm (1,000 acres)	06010201	PCBs	Striped bass should not be eaten. Precautionary advisory for catfish and sauger. *

*Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month.

Additional national fish tissue advisories have been issued for the most sensitive sub-populations: pregnant women, nursing mothers, children, and women who could become pregnant. See the attached joint EPA and FDA advisory.

U.S. Department of Health and Human Services
U.S. Environmental Protection Agency

EPA-823-R-04-005
March 2004

WHAT YOU NEED TO KNOW ABOUT MERCURY IN FISH AND SHELLFISH

2004 EPA and FDA ADVICE FOR:
WOMEN WHO MIGHT BECOME PREGNANT
WOMEN WHO ARE PREGNANT
NURSING MOTHERS
YOUNG CHILDREN

Fish and shellfish are an important part of a healthy diet. Fish and shellfish contain high-quality protein and other essential nutrients, are low in saturated fat, and contain omega-3 fatty acids. A well-balanced diet that includes a variety of fish and shellfish can contribute to heart health and children's proper growth and development. So, women and young children in particular should include fish or shellfish in their diets due to the many nutritional benefits.

However, nearly all fish and shellfish contain traces of mercury. For most people, the risk from mercury by eating fish and shellfish is not a health concern. Yet, some fish and shellfish contain higher levels of mercury that may harm an unborn baby or young child's developing nervous system. The risks from mercury in fish and shellfish depend on the amount of fish and shellfish eaten and the levels of mercury in the fish and shellfish. Therefore, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) are advising women who may become pregnant, pregnant women, nursing mothers, and young children to avoid some types of fish and eat fish and shellfish that are lower in mercury.

By following these 3 recommendations for selecting and eating fish or shellfish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury.

1. Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury.

2. Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.

    - Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.

    - Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So, when choosing your two meals of fish and shellfish, you may eat up to 6 ounces (one average meal) of albacore tuna per week.

3. Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters, but don't consume any other fish during that week.

Follow these same recommendations when feeding fish and shellfish to your young child, but serve smaller portions.

Frequently Asked Questions about Mercury in Fish and Shellfish:

1. "What is mercury and methylmercury?"
   Mercury occurs naturally in the environment and can also be released into the air through industrial pollution. Mercury falls from the air and can accumulate in streams and oceans and is turned into methylmercury in the water. It is this type of mercury that can be harmful to your unborn baby and young child. Fish absorb the methylmercury as they feed in these waters and so it builds up in them. It builds up more in some types of fish and shellfish than others, depending on what the fish eat, which is why the levels vary.

2. "I'm a woman who could have children but I'm not pregnant - so why should I be concerned about methylmercury?"
   If you regularly eat types of fish that are high in methylmercury, it can accumulate in your blood stream over time. Methylmercury is removed from the body naturally, but it may take over a year for the levels to drop significantly. Thus, it may be present in a woman even before she becomes pregnant. This is the reason why women who are trying to become pregnant should also avoid eating certain types of fish.

3. "Is there methylmercury in all fish and shellfish?"
   Nearly all fish and shellfish contain traces of methylmercury. However, larger fish that have lived longer have the highest levels of methylmercury because they've had more time to accumulate it. These large fish (swordfish, shark, king mackerel and tilefish) pose the greatest risk. Other types of fish and shellfish may be eaten in the amounts recommended by FDA and EPA.

4. "I don't see the fish I eat in the advisory. What should I do?"
   If you want more information about the levels in the various types of fish you eat, see the FDA food safety website, www.cfsan.fda.gov/~frf/sea-mehg.html or the EPA website at www.epa.gov/ost/fish.

5. "What about fish sticks and fast food sandwiches?"
   Fish sticks and "fast-food" sandwiches are commonly made from fish that are low in mercury.

6. "The advice about canned tuna is in the advisory, but what's the advice about tuna steaks?"
   Because tuna steak generally contains higher levels of mercury than canned light tuna, when choosing your two meals of fish and shellfish, you may eat up to 6 ounces (one average meal) of tuna steak per week.

7. "What if I eat more than the recommended amount of fish and shellfish in a week?"
   One week's consumption of fish does not change the level of methylmercury in the body much at all. If you eat a lot of fish one week, you can cut back for the next week or two. Just make sure you average the recommended amount per week.

8. "Where do I get information about the safety of fish caught recreationally by family or friends?"
   Before you go fishing, check your Fishing Regulations Booklet for information about recreationally caught fish. You can also contact your local health department for information about local advisories. You need to check local advisories because some kinds of fish and shellfish caught in your local waters may have higher or much lower than average levels of mercury. This depends on the levels of mercury in the water in which the fish are caught. Those fish with much lower levels may be eaten more frequently and in larger amounts.

For further information about the risks of mercury in fish and shellfish call the U.S. Food and Drug Administration's food information line toll-free at 1-888-SAFEFOOD or visit FDA's Food Safety website www.cfsan.fda.gov/seafood1.html

For further information about the safety of locally caught fish and shellfish, visit the Environmental Protection Agency's Fish Advisory website www.epa.gov/ost/fish or contact your State or Local Health Department. A list of state or local health department contacts is available at www.epa.gov/ost/fish. Click on Federal, State, and Tribal Contacts. For information on EPA's actions to control mercury, visit EPA's mercury website at www.epa.gov/mercury.

This document is available on the web at http://www.cfsan.fda.gov/~dms/admehg3.html.

U.S. Department of Health and Human Services
and
U.S. Environmental Protection Agency

Mercury Levels in Commercial Fish and Shellfish

Return to Advisory on Mercury in Seafood

See also Mercury in Fish: FDA Monitoring Program

Table 1. Fish and Shellfish With Highest Levels of Mercury

SPECIES	MERCURY CONCENTRATION (PPM)				NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	MIN	MAX		
MACKEREL KING	0.73	NA	0.23	1.67	213	GULF OF MEXICO REPORT 2000
SHARK	0.99	0.83	ND	4.54	351	FDA SURVEY 1990-02
SWORDFISH	0.97	0.86	0.10	3.22	605	FDA SURVEY 1990-02
TILEFISH (Gulf of Mexico)	1.45	NA	0.65	3.73	60	NMFS REPORT 1978

Table 2. Fish and Shellfish With Lower Levels of Mercury						
SPECIES	MERCURY CONCENTRATION (PPM)				NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	MIN	MAX		
ANCHOVIES	0.04	NA	ND	0.34	40	NMFS REPORT 1978
BUTTERFISH	0.06	NA	ND	0.36	89	NMFS REPORT 1978
CATFISH	0.05	ND	ND	0.31	22	FDA SURVEY 1990-02
CLAMS	ND	ND	ND	ND	6	FDA SURVEY 1990-02
COD	0.11	0.10	ND	0.42	20	FDA SURVEY 1990-03
CRAB [3]	0.06	ND	ND	0.61	59	FDA SURVEY 1990-02
CRAWFISH	0.03	0.03	ND	0.05	21	FDA SURVEY 2002-03
CROAKER (Atlantic)	0.05	0.05	0.01	0.10	21	FDA SURVEY 1990-03
FLATFISH [2]	0.05	0.04	ND	0.18	22	FDA SURVEY 1990-02
HADDOCK	0.03	0.04	ND	0.04	4	FDA SURVEY 1990-02
HAKE	0.01	ND	ND	0.05	9	FDA SURVEY 1990-02
HERRING	0.04	NA	ND	0.14	38	NMFS REPORT 1978

JACKSMELT	0.11	0.06	0.04	0.50	16	FDA SURVEY 1990-02
LOBSTER (Spiny)	0.09	0.14	ND	0.27	9	FDA SURVEY 1990-02
MACKEREL ATLANTIC (N. Atlantic)	0.05	NA	0.02	0.16	80	NMFS REPORT 1978
MACKEREL CHUB (Pacific)	0.09	NA	0.03	0.19	30	NMFS REPORT 1978
MULLET	0.05	NA	ND	0.13	191	NMFS REPORT 1978
OYSTERS	ND	ND	ND	0.25	34	FDA SURVEY 1990-02
PERCH OCEAN	ND	ND	ND	0.03	6	FDA SURVEY 1990-02
PICKEREL	ND	ND	ND	0.06	4	FDA SURVEY 1990-02
POLLOCK	0.06	ND	ND	0.78	37	FDA SURVEY 1990-02
SALMON (Canned)	ND	ND	ND	ND	23	FDA SURVEY 1990-02
SALMON (Fresh/Frozen)	0.01	ND	ND	0.19	34	FDA SURVEY 1990-02
SARDINE	0.02	0.01	ND	0.04	22	FDA SURVEY 2002-03
SCALLOPS	0.05	NA	ND	0.22	66	NMFS REPORT 1978
SHAD (American)	0.07	NA	ND	0.22	59	NMFS REPORT 1978
SHRIMP	ND	ND	ND	0.05	24	FDA SURVEY 1990-02

SQUID	0.07	NA	ND	0.40	200	NMFS REPORT 1978
TILAPIA	0.01	ND	ND	0.07	9	FDA SURVEY 1990-02
TROUT (Freshwater)	0.03	0.02	ND	0.13	17	FDA SURVEY 2002-03
TUNA (Canned, Light)	0.12	0.08	ND	0.85	131	FDA SURVEY 1990-03
WHITEFISH	0.07	0.05	ND	0.31	25	FDA SURVEY 1990-03
WHITING	ND	ND	ND	ND	2	FDA SURVEY 1990-02

Table 3. Mercury Levels of Other Fish and Shellfish

SPECIES	MERCURY CONCENTRATION (PPM)				NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	MIN	MAX		
BASS (Saltwater)[1]	0.27	0.15	0.06	0.96	35	FDA SURVEY 1990-03
BLUEFISH	0.31	0.30	0.14	0.63	22	FDA SURVEY 2002-03
BUFFALOFISH	0.19	0.14	0.05	0.43	4	FDA SURVEY 1990-02
CARP	0.14	0.14	0.01	0.27	2	FDA SURVEY 1990-02
CROAKER WHITE (Pacific)	0.29	0.28	0.18	0.41	15	FDA SURVEY 1990-03
GROUPER	0.55	0.44	0.07	1.21	22	FDA SURVEY 2002-03
HALIBUT	0.26	0.20	ND	1.52	32	FDA SURVEY 1990-02

LOBSTER (Northern/ American)	0.31	NA	0.05	1.31	88	NMFS REPORT 1978
MACKEREL SPANISH (Gulf of Mexico)	0.45	NA	0.07	1.56	66	NMFS REPORT 1978
MACKEREL SPANISH (S. Atlantic)	0.18	NA	0.05	0.73	43	NMFS REPORT 1978
MARLIN	0.49	0.39	0.10	0.92	16	FDA SURVEY 1990-02
MONKFISH	0.18	NA	0.02	1.02	81	NMFS REPORT 1978
ORANGE ROUGHY	0.54	0.56	0.30	0.80	26	FDA SURVEY 1990-03
PERCH (Freshwater)	0.14	0.15	ND	0.31	5	FDA SURVEY 1990-02
SABLEFISH	0.22	NA	ND	0.70	102	NMFS REPORT 1978
SCORPIONFISH	0.29	NA	0.02	1.35	78	NMFS REPORT 1978
SHEEPSHEAD	0.13	NA	0.02	0.63	59	NMFS REPORT 1978
SKATE	0.14	NA	0.04	0.36	56	NMFS REPORT 1978
SNAPPER	0.19	0.12	ND	1.37	25	FDA SURVEY 2002-03
TILEFISH (Atlantic)	0.15	0.10	0.06	0.53	17	FDA SURVEY 2002-03
TUNA (Canned, Albacore)	0.35	0.34	ND	0.85	179	FDA SURVEY 1990-03
TUNA (Fresh/Frozen)	0.38	0.30	ND	1.30	131	FDA SURVEY 1990-02
WEAKFISH (Sea Trout)	0.25	0.16	ND	0.74	27	FDA SURVEY 1990-03

Source of data: FDA Surveys 1990-2003

" National Marine Fisheries Service Survey of Trace Elements in the Fishery Resource" Report 1978

" The Occurrence of Mercury in the Fishery Resources of the Gulf of Mexico" Report 2000

Market share calculation based on 2001 National Marine Fisheries Service published landings data

* Mercury was measured as Total Mercury and/or Methylmercury

ND - mercury concentration below the Level of Detection (LOD=0.01ppm)

NA - data not available

[1] Includes: Sea bass/ Striped Bass/ Rockfish

[2] Includes: Flounder, Plaice, Sole

[3] Includes: Blue, King, Snow

Advisory on Mercury in Seafood

Mercury in Fish: FDA Monitoring Program

Pesticides and Chemical Contaminants

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Appendix G. Responses to Public Comments

ATSDR received the following comments from the public during the public comment period (November 30, 2006 to January 31, 2007) for the *Polychlorinated Biphenyl (PCB) Releases: Oak Ridge Reservation (USDOE)* public health assessment (November 2006). For comments that questioned the validity of statements made in the document, ATSDR verified or corrected the statements.

	Public Comment	ATSDR's Response
1	General: Nice work! This report is a step in the direction of improving the state of the art. Given globalization of the food supply, it may be prudent to participate in the World Health Organization (WHO) GEMS/Food activities linking Total Diet Studies with measures designed to improve health and food safety as well as reduce environmental contamination and body burden. Our involvement would be mutually beneficial (US with the world/equality with reciprocity). Improving our standing with the rest of the world in health science and human development is in our interest. (See who.int/foodsafety/chem.)	Thank you for the comment.
2	Page i, line 32: Pregnant women and nursing mothers should be included every time examples of "high-risk/sensitive/special populations" are listed. Given what we now know about PCBs, if I were to choose one food to monitor PCB levels and trends over time given control measures, that food would be mother's milk rather than fish. Of course, it is not an either/or since fish contributes so heavily to the exposure dose. However, monitoring fish alone does not tell us what is happening to pregnant women, nursing mothers or their offspring. It is the mother-baby dyad that is high-risk/sensitive/special. During pregnancy they are one organism, and the exclusively breastfed baby is entirely dependent upon mother for sustenance. They share fluids, energy, nutrients, and contaminants. To protect children in utero and in infancy while nursing, we protect/educate childbearing girls/women. There is no question in my mind that this is the right thing to do. The only question I have is whether we also need to add MEN during the childbearing years!	ATSDR recognizes that pregnant women and nursing mothers are a sensitive population and discusses the potential effects from PCB exposure to children in utero and to nursing infants in Section VII. Child Health Considerations (see page 114).
3	Page 5, line 17: Add nursing mothers. Also, p.97, line 10; p.112, line 36; p.113, lines 26-27; and Appendix A-11, definition of special populations.	Thank you for the comment. ATSDR added "nursing mothers" to the areas indicated.
4	Page 10, figure: The pink and lavender colors are too close…more contrast is needed.	A public comment on another Oak Ridge public health assessment noted that the figure was outdated; therefore, ATSDR removed it from this document as well.
5	Page 16, figure: Can you add Rockwood and Spring City to the figure?	Thank you for the comment. ATSDR added Rockwood and Spring City to the figure.

	Public Comment	ATSDR's Response
6	Page 17, box: Refer the reader to Appendix E for additional information on PCB congeners and Aroclors. Appendix E is a good primer that includes concepts that are helpful in reading.	Thank you for the comment. ATSDR added "Please see Appendix E for additional information" to the text box.
7	Page 36, lines 24-26: I am puzzled by the authors' meaning. Tennessee is divided into three parts—East, Middle, and West Tennessee. The largest population centers in East Tennessee are Knoxville (173,278), Chattanooga (154,887), Johnson City (57,394), and Oak Ridge (27,338). (US Census Bureau, QuickFacts, 2003).	ATSDR changed the sentence to read "…the city of Oak Ridge has been <u>one of</u> the largest population center<u>s</u> in eastern Tennessee."
8	Page 96, lines 13-14 and page 112, line 36: Current studies show mixed results on the relationship between fish consumption and IUGR, birth weight, and other pregnancy outcomes. This should be clearly acknowledged if you offer these results as a reason to promote fish consumption. There are obvious limitations to studying one food in relation to pregnancy outcomes. Studies that do not characterize local food choices/dietary patterns and estimate both energy/nutrient intake and contaminant exposure/body burden add to the confusion.	ATSDR deleted the sentence about intrauterine growth retardation.
9	Page 112, line 36: Replace the word <u>exposure</u> with the word <u>consumption</u>.	ATSDR replaced "exposure to" with "consumption of."

Appendix H. Responses to Peer Review Comments

ATSDR received the following comments from independent peer reviewers for the *Polychlorinated Biphenyl (PCB) Releases: Oak Ridge Reservation (USDOE)* public health assessment. For comments that questioned the validity of statements made in the document, ATSDR verified or corrected the statements.

	Peer Reviewer Comment	ATSDR's Response
Does the public health assessment adequately describe the nature and extent of contamination?		
1	Yes, very well.	Thank you for your comment.
2	Yes, in general the public health assessment does adequately describe the nature and extent of contamination. I have only two suggestions. First, what Aroclors were used at ORR? This information would be helpful in the interpretation of the congener-specific environmental data. Second, were analyses performed for polychlorinated dioxins and dibenzofurans? These compounds often coincide with PCBs, especially when the latter are heated or burned, and are of concern given their high toxicity.	A PCB-based mixture containing 60 percent Aroclor 1248 was used as a cutting fluid during the machining process for enriched uranium (ChemRisk 1999a). Many of the outdoor capacitors contained fluids containing 50-60 percent Aroclor 1242 (ChemRisk 1999a). Aroclors 1254 and 1260 were found in stream sediments in the Melton Valley area (ChemRisk 1999a). Yes, analyses were performed for polychlorinated dioxins and dibenzofurans. ATSDR evaluated their nature and extent in the Evaluation of Current (1990 to 2003) and Future Chemical Exposures in the Vicinity of the Oak Ridge Reservation Public Health Assessment. This public health assessment can be accessed at http://www.atsdr.cdc.gov/HAC/oakridge/phact/screening/index.html.
3	The public health assessment appears to adequately describe the nature and extent of the contamination.	Thank you for your comment.
Does the public health assessment adequately describe the existence of potential pathways of human exposure?		
4	Yes. Pathways discussion was handled very thoroughly. A lot of data gathered over the years were well summarized, and the graphics are well done. The screening evaluation on page 4 was a particularly helpful summary.	Thank you for your comment.

	Peer Reviewer Comment	ATSDR's Response
	Although the report is a very useful compendium of all past reports on the subject, the only concern is that so much historical data are presented that it somewhat impairs the ability to objectively look at the current data independent of past modeling efforts and conservative conclusions that have changed over time. This is particularly true with regard to lack of discussion of inherent uncertainty and assumptions underlying the calculations on page 91—either these need to be disclosed, or the sections on past assessments significantly abbreviated to avoid confusion. Lack of discussion of uncertainty is less of a problem for those with a strong background in health risk assessment, but may prove challenging to decipher for even the most motivated of lay readers, which may be your key audience.	ATSDR agrees that there is uncertainty in any exposure evaluation. To be protective of public health, ATSDR chose conservative (protective) assumptions to counter-balance the inherent uncertainty. To insure exposure was not underestimated, ATSDR used site-specific information to estimate exposure doses. When site-specific data were unavailable, ATSDR used several health-protective assumptions to estimate doses. The assumptions ATSDR used to estimate exposure doses are disclosed in Section IV.C.3. Dose Estimation (see page 91). The consumption rates used in the public health evaluation are based on information collected during the fish consumption study in ATSDR's Watts Bar Reservoir Exposure Investigation (ATSDR 1998), rather than default parameters (e.g., EPA's intake recommendations for freshwater anglers are 0.005–0.017 kg/day; U.S. EPA 2000). More than 550 local fish consumers provided consumption information during the survey. ATSDR added this reference to the assumptions provided on page 92 to allow for a better understanding of the consumption rates selected.
5	Yes, in general the public health assessment does adequately describe potential pathways of human exposure. I agree that the greatest potential for exposure is from the consumption of contaminated fish, and that it is unlikely that sediment or surface water would pose a significant threat. The authors also argue that air is unlikely to pose a major risk, but it would be helpful if air PCB levels were presented to help substantiate this conclusion. Even if there is no air current release of PCBs from ORR, it is possible that PCBs are volatilizing from the sediment and surface water. In fact, some studies indicate that levels of PCBs in ambient air near hazardous waste sites may range from 25 to 50 ng/cm^3. Given the possibility of daily exposure through inhalation, this pathway should be more thoroughly evaluated.	No air monitoring data exist for ORR-related PCB releases. However, volatilization of PCBs from the sediment and surface water is not likely to be a substantive pathway of exposure. First, the concentrations detected in the sediment and surface water do not present a public health hazard for direct exposure (i.e., dermal contact, incidental ingestion) to these media; therefore, volatilization to the air is also highly unlikely to result in significant exposure. Second, the exposure duration and frequency are low for this potential pathway (i.e., people are not often in a situation where they would be inhaling volatilized PCBs from sediment or surface water).
6	The public health assessment adequately describes the potential pathways of human exposure.	Thank you for your comment.

	Peer Reviewer Comment	ATSDR's Response
Are all relevant environmental and toxicological data (i.e., hazard identification, exposure assessment) being appropriately used?		
7	In my opinion, no. The report in the case of frequently eating certain fish species seems to subordinate a significant amount of actual measured data of good quality to estimated exposures ("comparison values") that have a high degree of inherent uncertainty. Such comparisons with vastly different inherent uncertainty (which is not discussed in detail on pages 55 or 91 and should be in the interest of full disclosure) render these comparisons almost apples-and-oranges, and one wonders why modeled estimates would take precedence over actual data given its quality and quantity.	As stated on page i, exposure investigations are one of the tools ATSDR uses to develop a better characterization of past, present, or possible future human exposure to hazardous substances in the environment. These investigations evaluate only exposure—they do not assess whether exposure levels result in adverse health effects. Because of the lack of health-based standards to compare them to, the serum data cannot be used to make health determinations. ATSDR uses the data to evaluate relative exposures. On the basis of the results of the Watts Bar Reservoir Exposure Investigation (ATSDR 1998), ATSDR concluded that the PCB body burdens of Watts Bar Reservoir moderate to high fish consumers are below people exposed occupationally, above non-fish consumers, and within the range for people who consume sport fish (see Figure 28). Further, as stated in the summary brief included in Appendix F, the exposure investigation was not designed as a research study (for example, participants were not randomly selected for inclusion in the study and there was no comparison group), and the results of this investigation are applicable only to the participants in the study and cannot be extended to the general population. ATSDR's health assessments are conducted to evaluate whether exposure levels are expected to result in adverse health effects. The goal of the health effects evaluation is to decide whether or not harmful effects might be possible in the exposed population by weighing the scientific evidence and by keeping site-specific doses in perspective. Health assessors estimate a level of exposure to a substance (i.e., they calculate a dose) using conservative (protective) assumptions. The doses are then compared to health-based comparison values and/or health effects levels to determine whether people could be harmed from contact with the substance. The output is a qualitative description of whether site exposure doses are of sufficient nature and magnitude to trigger a public health action to limit, eliminate, or further study any potential harmful exposures. Figure 29 and Figure 30 show the comparison of exposure doses to the health effects levels found in the scientific literature. Section III. Evaluation of Environmental Contamination and Potential Exposure Pathways (see page 50) discusses ATSDR's health evaluation process in more detail.

	Peer Reviewer Comment	ATSDR's Response
	The problem is compounded when the advisories and recommendations are issued based on comparison with these estimates without adequate discussion of inherent uncertainty, rather than relying on the more compelling actual monitoring data presented. A thorough discussion of the uncertainty inherent in the comparison values is needed to make this more clear and understandable to the lay public. As a consumer, I would want these data presented with a range of comparison values that reflect different exposure assumptions so that I can decide for myself what is a relevant basis of comparison.	ATSDR agrees that there is uncertainty in any exposure evaluation. Whenever possible, ATSDR uses site-specific information to estimate exposures. When these site-specific data are unavailable, however, ATSDR uses health-protective assumptions to estimate doses to ensure that exposures are not underestimated. ATSDR chose conservative assumptions to counter-balance the inherent uncertainty. In this case, the consumption rates were chosen based on information collected during the fish consumption study in ATSDR's Watts Bar Reservoir Exposure Investigation (ATSDR 1998), rather than default parameters. ATSDR added this reference to the assumptions provided on page 92 to allow for a better understanding of the consumption rates selected. In addition, ATSDR calculated exposure from five levels of fish consumption, so that people can decide for themselves whether their own level of exposure is a potential health hazard.
	Piecing together data from various parts of the report, it seems that the current values reflect uncertainly factors of perhaps 7,000, and that very little modification to the assumptions would be needed to render all these "potentially hazardous" levels of exposure all well within acceptable limits. "Robust conservatism" (page 60) is fine, but the assumptions need to be fully disclosed in a PHA as detailed as this, as the report's conclusions rely heavily on these assumptions. Simply saying "comparison values are set much lower than the lowest amount shown to affect health" (page 61) is not sufficient to fully inform. An informed public deserves to know and understand how these conclusions were reached, and there is no complete discussion of uncertainly or inherent assumptions included in the report despite a few assumptions being mentioned throughout the text. This clear explanation of uncertainty and underlying assumptions, and why conclusions were based on these values more heavily than measured data, is the only major shortcoming of the report.	ATSDR agrees that the "potentially hazardous" levels could very well not be harmful. As stated in Section IV.C.5. Conclusions (see page 98), all of the estimated exposure doses that ATSDR calculated are below the lowest health effects level reported in the scientific literature (LOAEL of 0.005 mg/kg/day). However, the doses approach the LOAEL, which is the level at which health effects have been observed. Given the uncertainties involved in the toxicity studies, it would be prudent public health practice to limit consumption of certain species of fish to minimize exposures to PCBs, especially for sensitive populations. ATSDR adjusted the language on page 99 to mention the inherent uncertainties. The assumptions are fully disclosed in Section IV.C.3. Dose Estimation (see page 91). As stated above, ATSDR conducts exposure investigations to evaluate exposure and conducts health assessments to assess whether exposure levels are expected to result in adverse health effects.
8	In general, the environmental data are appropriately used. I have some concerns, however, about the detection limit of 10 ppb for the congener-specific fish PCB data presented in Appendix E. In my experience, this is a relatively high LOD, and renders the interpretation of the fish data difficult. For example, only four of the 16 congeners presented have a median concentration greater than the LOD.	ATSDR agrees that the LOD of 10 ppb is rather high. Therefore, instead of assuming the undetected values were zero, ATSDR substituted 2.5 ppb, or one half of the lowest concentration (5 ppb), as an estimate of the undetected congeners. Further, concentrations less than the declared LOD were sometimes estimated for congeners.

	Peer Reviewer Comment	ATSDR's Response
	More serious concerns arise regarding the use of human sera data from Task 3. Comparisons with other studies must be cautiously made, given differences in analytical methodologies.	ATSDR agrees that comparisons with other studies must be made cautiously. Because the NHANES data did not allow for a direct comparison with exposure investigation participants, ATSDR plotted the sum of the serum concentrations of nine congeners (measured in the serum samples of the participants and included in the NHANES data) against serum PCB concentrations. ATSDR did this for each participant for which both congener and serum PCB information was available, with the exception of the one outlier. Figure 27 shows the plot, the linear regression, and the equation describing the straight line. Using this equation, ATSDR assigned an equivalent, ORR-specific level to each serum sample in the NHANES data. This technique allowed ATSDR to compute measures of central tendency such as the median, mode, and arithmetic and geometric means for the NHANES data in the same way as the data for the Watts Bar Reservoir exposure investigation participants.
	However, a cut-point of 20 ppb for defining "elevated" appears to be too high when contrasted with other studies conducted in the 1990s and 2000s—a value of 10 ppb would be more appropriate.	In summarizing the results of the exposure investigation in the public health assessment, ATSDR did not mean to imply that serum samples above 20 ppb are elevated. ATSDR clarified the discussion on page 81.
	The maximum observed concentration of 103.8 ppb is extraordinarily high, and is more consistent with occupational exposures than fish consumption. In my opinion, statements such as "the serum PCB levels of participants … are slightly below national norms for total PCBs "(pg 80) are not supported by the data, and contradict other statements such as "body burdens of Watts Bar Reservoir fish consumers are below people exposed occupationally, above non-fish consumers, and within the range for people who consume sport fish (italics added)" (pg 86).	The maximum serum PCB concentration of 103.8 ppb is an outlier. This level differed from the mean of the others by more than 17 times their standard deviation. This serum belonged to a person who fished in Miami, Florida, 10 months per year. Because this person's serum was so high, ATSDR provided follow-up counseling and recommended that this person undergo a medical evaluation.
	It would also be helpful for comparison purposes if some non-consumers were tested for serum PCB levels and to determine whether a gradient existed between amount of fish consumption and PCB body burden. For purposes of the health assessment, it would be important to examine differences in fish consumption and PCB levels by gender and whether male anglers shared their catch with their wives.	The purpose of ATSDR's Watts Bar Reservoir Exposure Investigation (ATSDR 1998) was to determine whether people consuming *moderate to large amounts* of fish and turtles from the Watts Bar Reservoir were being exposed to elevated levels of PCBs. ATSDR interviewed more than 550 volunteers. Of these, 116 people consumed moderate to high amounts of fish and turtles from the Watts Bar Reservoir and were included in the investigation. Figure 28 compares PCB serum concentrations of Watts Bar Reservoir moderate to high fish consumers to people who do not eat any fish. People who infrequently eat fish were evaluated in the public health assessment also.

	Peer Reviewer Comment	ATSDR's Response
	The authors should also discuss the possibility of self-selection bias, given the nature of the recruitment.	The target population of ATSDR's Watts Bar Reservoir Exposure Investigation (ATSDR 1998) was persons who consumed moderate to high amounts of fish and turtles from the Watts Bar Reservoir. ATSDR representatives made an extensive, proactive attempt to reach potential participants by telephoning over 550 individuals who had purchased fishing licenses in the area. And to a lesser extent, ATSDR recruited participants through newspaper, radio, and television announcements, as well as posters and flyers placed in bait shops and marinas. As stated in the summary brief included in Appendix F, the exposure investigation was not designed as a research study (for example, participants were not randomly selected for inclusion in the study and there was no comparison group), and the results of this investigation are applicable only to the participants in the study and cannot be extended to the general population.
9	There are some inadequacies in the ways environmental & toxicologic data are used. 1) PCBs are a family of different but structurally related chemicals, known individually as congeners. Congeners have different toxicities: some are non-toxic, others highly toxic. This assessment has only used the measurements of individual congeners to compare in the aggregate, with the total PCB concentration (expressed as Aroclors). More correctly, a separate assessment of potential toxicity should be made using the congener data. For this assessment the concentration of each congener should be multiplied by a factor representing its toxicologic potency & the results summed to assess the toxicity of the mixture.	PCBs in samples of fish taken before 1996 were sometimes reported as Aroclors, sometimes as individual congeners, and sometimes as both. Samples of fish taken during and after 1996 were generally reported only as Aroclors. ATSDR acknowledges in Appendix E that adding the congeners present in a sample provides a more accurate total of PCBs than adding the Aroclors. However, laboratories did not measure all 209 congeners—only the most common 40—and so contamination could be understated if rare congeners are present. To provide an overview of the distribution of the different congeners in Watts Bar Reservoir fish, ATSDR used data for congeners in all 370 samples for which congener data were reported. Please see Appendix E for a discussion of how ATSDR evaluated PCBs measured as total congeners vs. total Aroclors.
	When considering consumption of turtles the assessment should always carefully distinguish consumption of turtle meat, turtle fat, and mixed consumption of turtle parts. This distinction is lost, for example, on page 83 (IVA Introduction) where turtles are eliminated from further in-depth evaluation <u>despite</u> the finding that the highest levels of PCBs were in turtle fat.	ATSDR agrees that because of much higher PCB concentration in turtle fat, there should always be a distinction between consuming turtle meat and consuming turtle fat. ATSDR added clarifying footnotes to the places where this distinction was missing (e.g., Table 8, page 84, and page 89).
	There is overreliance on the single study by Gladen when assessing the potential toxicity to children of PCBs in breast milk. The conclusions should reflect the entire extent of scientific information on the topic, taking into account both human and animal studies.	ATSDR revised the Child Health Considerations section (see page 114) to be more inclusive of the entire extent of scientific information about prenatal and postnatal exposures of PCBs to fetuses, infants, and young children.

	Peer Reviewer Comment	ATSDR's Response
Does the public health assessment accurately and clearly communicate the health threat posed by the site?		
10	The risks of frequently eating certain species of fish are not adequately communicated because the actual biomonitoring data presented in this report differ quite significantly from the modeled estimates, and it is not clear why lesser quality data are relied upon more heavily than the extensive amount of monitoring data that are so well presented here. The statement on page 53 is misleading in that it states "this PHA used PCB serum levels from people who ate moderate to large amounts of fish…"—the Agency did, but then ultimately deferred to modeled comparison values to derive its conclusions. The fact that serum PCB levels of residents with historically moderate to high consumption of local fish in the area of greatest contamination are lower than national norms comes as a pleasant surprise and should indicate not only assurance of past low risks but also confidence in current and future exposures based on the trends in sampling and biomonitoring data presented throughout the report (which would be very helpful to graph). This seems to be reinforced by the LWBR baseline risk data presented on page 26. Similarly, conclusions such as "median PCB concentrations exceeded the PCB comparison values for children in the low fish consumption group" etc. (page 68) may be true based on incompletely disclosed and rather conservative assumptions, but it is not clear this is a conclusion based on modeling data rather than actual data. In sum, the public health implications outlined on page 5 do not seem supported by the data, and fish advisories are not warranted based on these and other actual data presented in the report.	ATSDR's exposure investigations evaluate only exposure—they do not assess whether exposure levels result in adverse health effects. Because of the lack of health-based standards to compare them to, the serum data cannot be used to make health determinations. Further, the results of exposure investigations are applicable only to the participants in the study and cannot be extended to the general population. Please see the response to comment 7 for additional clarification between exposure investigations and health assessments. ATSDR's health assessments are conducted to evaluate whether exposure levels are expected to result in adverse health effects. The results of the health assessment suggest that, as a conservative measure, it would be prudent public health practice to limit consumption of certain species of fish, because some of the doses approached (but did not exceed) the health effects level. It would be prudent for sensitive populations especially to minimize their exposures to PCBs. Further, TDEC has issued fish consumption advisories for Poplar Creek, the Clinch River, the Tennessee River, and the Lower Watts Bar Reservoir. The advisory is available at the following Web site: http://www.state.tn.us/environment/wpc/publications/advisories.pdf.
	The conclusion that PCBs from LWBR "if they accumulated in the body in large amounts could present a risk of illness" (page 39) seems at odds with the actual biomonitoring data presented earlier and thus perhaps not as relevant to the current discussion, or at least it should be emphasized in the first sentence of the third full paragraph that these are conclusions based on conservative risk modeling rather than actual data.	ATSDR clarified the conclusions of the summary of the February 1996 Health Consultation on the Lower Watts Bar Reservoir on page 39.
	The discussions of the health benefits of eating fish, breastfeeding, and how to prepare fish and turtle so as to minimize risk are very well done and are entirely appropriate. It greatly helps local residents make informed decisions when the public health agency can put exposures in overall context such as this. It is rare to see the data presented this way. Well done.	Thank you for your comment.

	Peer Reviewer Comment	ATSDR's Response
	(And if everyone followed these recommendations, would advisories be needed? In other words, shouldn't these overall recommendations, which apply to all fish, be the Agency guidance instead of trying to have residents keep track of how many of what type of fish it's OK to eat for what age group per week? Which guidance would result in lower overall exposure and better public health benefits?)	ATSDR developed the conclusions to correspond with the advisory issued by TDEC. ATSDR identified the fish that would result in the highest exposure. For additional perspective, ATSDR also provided general guidance/recommendations to help people minimize their exposures to PCBs from consuming fish.
11	Yes, in general the health assessment does accurately and clearly communicate the health threat posed by the site. For example, it presents a balanced view weighing the risks posed by chemical contamination with the dietary benefits of fish consumption.	Thank you for your comment.
	It would be useful to calculate the risks for pregnant women separately from other adults, given the greater sensitivity of the fetus (pg 97).	ATSDR does not calculate risks; rather, ATSDR reviews site-related environmental data and general information about toxic substances at the site. The health assessor derives an estimated dose of the substance to which people in the community might be exposed, and then compares this dose to public health standards. The estimated dose for a pregnant woman would be the same as for other adults; however, the fetus' susceptibility to the exposure is greater, thus leading to the additional guidance for sensitive populations, such as pregnant and nursing women.
	In addition, the possibility of additive or synergistic effects should be considered, given the presence of mercury, arsenic, radionuclides and other contaminants from ORR in addition to PCBs.	This public health assessment focuses on exposures to PCBs. ATSDR conducted an evaluation of current and future chemical exposures and concluded that current and future exposures to ORR site-related chemicals (individually or in combination) in soil, sediment, surface water, biota (other than fish), and air do not pose a public health hazard. The full report is available online at http://www.atsdr.cdc.gov/HAC/oakridge/phact/screening/index.html. ATSDR agrees that synergistic effects from different chemicals are very important to consider; however, there are too many unknowns and too much uncertainty to evaluate additive or synergistic effects from past exposure.
	Finally, more details should be given about the cancer incidence investigation that was conducted in the area. For example, what cancer sites were elevated, and are they consistent with the findings of other studies of similar exposures?	The full report, *Assessment of Cancer Incidence in Counties Adjacent to Oak Ridge Reservation*, is available online at http://www.atsdr.cdc.gov/HAC/oakridge/phact/cancer_oakridge/index.html. ATSDR added the following on page 103: "No consistent pattern of cancer occurrence was, however, identified. Given the large number of statistical analyses conducted in this assessment, it is not unusual to find some increases and some decreases in cancer occurrence. The increases could simply be the result of heightened awareness and screening in particular areas."
12	The final conclusions as stated on pages 6 & 98 do not match exactly. They should.	The conclusions in the text box on page 6 are meant to be a concise summary of the conclusions on page 98.

	Peer Reviewer Comment	ATSDR's Response
	Some confusion or imprecision is introduced through reference to low, moderate, and high consumption—e.g., of fish. The terms low, moderate, and high only have relative subjective meaning in this context. If and whenever they are used, the authors should specify the exact amounts of fish consumption they mean. For example: not more than 2 6-ounce servings of catfish, a week.	ATSDR agrees and therefore added a text box on page 5 to define a fish meal for a child and adult and defined the terms *low*, *moderate*, and *high* in the text box on page 6.
Are the conclusions and recommendations appropriate in view of the site's condition as described in the public health assessment?		
13	Yes, with the exception of frequently eating certain species of fish. The monitoring data presented here would strongly suggest no advisory is needed, particularly for current and future exposure, which is stated to be the focus of the report (per page 38).	ATSDR's exposure investigations evaluate only exposure—they do not assess whether exposure levels result in adverse health effects. Because of the lack of health-based standards to compare them to, the serum data cannot be used to make health determinations. Further, the results of exposure investigations are applicable only to the participants in the study and cannot be extended to the general population. ATSDR's health assessments are conducted to evaluate whether exposure levels are expected to result in adverse health effects. The results of the health assessment suggest that, as a conservative measure, prudent public health practice would limit consumption of certain species of fish, because some of the doses approached (but did not exceed) the health effects level. Further, TDEC has issued fish consumption advisories for Poplar Creek, the Clinch River, the Tennessee River, and the Lower Watts Bar Reservoir. The advisory is available at the following Web site: http://www.state.tn.us/environment/wpc/publications/advisories.pdf. Please see the response to comment 7 for additional clarification between exposure investigations and health assessments.
14	Yes, I believe that the conclusions and recommendations noted on pp 96–98 are indeed appropriate in view of the site's condition. It would be useful to explain in the text the message presented in the highlighted box—that is, why is cancer not expected from eating contaminated fish near the ORR? Species-specific recommendations for pregnant and nursing women should be added as a bulleted item on pg 97. It may also be advisable to recommend that children and pregnant and nursing women avoid eating any amount of the highly contaminated fish species to provide the maximum protection to these sensitive subgroups.	ATSDR added the following sentence to the text box: "The highest estimated exposure doses are hundreds of times below the levels proven to cause cancer." ATSDR added a bulleted item for pregnant women and nursing mothers to the conclusion.

	Peer Reviewer Comment	ATSDR's Response
15	The conclusions & recommendations generally appear sound. However, (1) they must be stated clearly and consistently and (2) additional assessments should be made using the PCB congener data.	(1) ATSDR clarified the conclusions. (2) The PCB congener data are limited. PCBs in samples of fish taken before 1996 were sometimes reported as Aroclors, sometimes as individual congeners, and sometimes as both. Samples of fish taken during and after 1996 were generally reported only as Aroclors. Further, laboratories did not measure all 209 congeners, only the most common 40. To provide an overview of the distribution of the different congeners in Watts Bar Reservoir fish, ATSDR used data for congeners in all 370 samples for which congener data were reported. Please see Appendix E for a discussion of how ATSDR evaluated PCBs measured as total congeners vs. total Aroclors.
Are there any other comments about the public health assessment that you would like to make?		
16	Overall, I believe that the public health assessment is well done. It is thorough, comprehensive, and balanced in its description of the problem, the health risks of the site, and its conclusions and recommendations. In general, it is well written, although in some cases the language could be improved—e.g., "it is unclear whether the reported *effects* would actually cause adverse health *effects* "(italics added, pg 97). The concerns noted above about the human PCB serum data should be addressed. The possibility of inhalation exposure through volatilization should be more completely evaluated, as should the health risks of fish consumption among pregnant and nursing women. Given the mixture of contaminants present at the site, additive and synergistic effects should also be considered.	This PHA underwent several rounds of editorial review and was again reviewed prior to its final release. Minor changes were made to the text to clarify unclear language, including the phrase noted. Please see the response to comment 7. Please see the responses to comments 5 and 11. Please see the response to comment 11.
17	The format & terminology of the assessment is highly stylized. The process and communication have taken on a technical language, which appears stilted and acronym-laden. Although much of the process is sound and, in fact, inherently sensible, the documents are difficult to read & to follow. It would be useful to have one or more physicians skilled in risk communication to individuals and/or groups, review the way the documents are put together, with a view to making the presentation of methods, results, and conclusions simpler and more transparent, so that they were more understandable & therefore more meaningful to lay audiences.	The authors of the public health assessment followed the guidelines provided in ATSDR's Public Health Assessment Guidance Manual (available at www.atsdr.cdc.gov/HAC/phamanual/). While the body of the health assessment contains technical language, the Executive Summary is written in a more understandable language for the lay reader. Further, ATSDR's editors review every document and are familiar with preparing documents released to the public.
18	Page 2: "…some people who ate fish or geese from these waterways [MAY HAVE] received higher doses…"	ATSDR made the noted editorial change.

	Peer Reviewer Comment	ATSDR's Response
19	Page 3: …"exceeded the comparison values for some consumption groups [UNDER CERTAIN EXPOSURE CONDITIONS]."	ATSDR made the noted editorial change.
20	Page 3: Re: geese, it is not clear that it was ever confirmed who actually eats geese and in what quantity. Without this knowledge it is hard to come to the conclusion that "adults and children who eat moderate to high levels of Canada geese" are at health risk (page 71). The assumptions on which this conclusion is based must be more clearly spelled out.	The exposure scenario of adults and children eating moderate to high amounts of Canada geese was retained for further evaluation. In Section IV, Public Health Implications, ATSDR determined that Canada geese are safe to eat in any amount. The assumptions ATSDR used to determine that eating Canada geese required further evaluation are detailed on page 56. The assumptions used to determine that it is safe to eat Canada geese are described on page 92.
21	Page 4: "…concern over eating fish was eliminated for some consumption groups [WHICH?} but not for all [WHICH?]	This paragraph summarizes the screening evaluation of the health assessment. Additional details are provided in Section III.B. Exposure Evaluation of PCBs. The important point is that the fish consumption pathway was retained for further evaluation.
22	Page 6: Yellow box: "Eating moderate to high amounts…[DEFINE}" "…is not recommended [BECAUSE OF..]	ATSDR made the noted editorial change.
23	Page 25: "Surveys to gauge the usefulness of fish advisories." It would be useful to have the results presented in the report somewhere. The ORRHES Brief of March 5, 1998, states that "those who did eat fish or turtles from the reservoir indicated that they would continue to do so even through they were aware of the fish advisory." That finding would indicate the Agency advice regarding the benefits of fish consumption and how to best prepare fish might be a more useful advisory with a higher degree of compliance than the limits on consumption recommended in this report.	ATSDR presented the conclusions and recommendations in a format similar to the advisories issued by TDEC. For additional perspective, ATSDR also provided general guidance/recommendations to help people minimize their exposures to PCBs from consuming fish. By being presented with both the specific fish consumption advisories and general fish preparation information, the individual fish consumer can make his/her own decisions regarding the consumption of fish from the Watts Bar Reservoir.
24	Page 52, A-4, and elsewhere: "…exposure (i.e., dose)." These are not interchangeable terms and should be corrected. See http://www.epa.gov/iris/gloss8.htm.	The term *dose* is meant to be defined as "an estimate of the amount of chemical exposure." ATSDR clarified this term by moving (i.e., *dose*) to after the word *site*.
25	Page 56: Table 3. In addition to presentation of inherent uncertainty in these values, the important information missing on this page is to correlate these values with the PCB values that might be predicted from consuming fish in the past and the measured biomonitoring results. Otherwise it is very difficult for a lay reader to put the modeled numbers in context with the actual biomonitoring data collected from actual past exposures. The footnote is a good start, but in combination with the data from page 88, it appears that there is a 7,000-fold uncertainly factor, which should be more clearly discussed if readers are to be genuinely informed about these levels.	The comparison values presented in Table 3 were developed to screen the PCB concentrations detected in fish. It is not appropriate to compare these values with the serum PCB levels. ATSDR clarified the screening process in Section III.A.4. Deriving Comparison Values (see page 55).

	Peer Reviewer Comment	ATSDR's Response
26	Page 56: "…hunters might consume 22 pounds of goose muscle per year." On what basis? "If similar consumption ratios held for geese…" On what basis would this assumption be made?	The goose consumption rate was chosen to estimate a worst-case scenario for the screening assessment and was based on professional judgment. It is reasonable to assume that people who eat geese might have similar high, medium, and low consumption ratios as people who eat fish.
27	Page 71: "…ATSDR compared distribution of [ACTUAL] PCB contamination with [ESTIMATED] protective PCB comparison values…"	ATSDR made the noted editorial change.
28	Page 75: "Because total Aroclors provide more conservative estimates of fish contamination…" Here is another example of where both approaches should be provided to show the effects of making such assumptions.	Please see the response to comment 9.
29	Page 79: "ATSDR conducted the exposure investigation primarily because of the uncertainties involved in the QRA …." It is not clear why the Agency then diluted the value of the exposure investigation by comparing measured results to conservative estimates with all the inherent problems of the original QRA, without clearly explaining these uncertainties.	ATSDR deleted the quoted sentence. ATSDR's exposure investigations only evaluate exposure—they do not assess whether exposure levels result in adverse health effects. Because of the lack of health-based standards to compare them to, the serum data cannot be used to make health determinations. Further, results of exposure investigations are applicable only to the participants in the study and cannot be extended to the general population. ATSDR's health assessments are conducted to evaluate whether exposure levels are expected to result in adverse health effects. Please see the response to comment 7 for additional clarification between exposure investigations and health assessments.
30	Page 81: The median PCB concentrations exceeded the ATSDR comparison values for both adults and children in the moderate and high consumption groups." It is difficult to support this statement without a clear presentation of the assumptions underlying the comparison values. When that happens, it would seem revisions to the table on page 82 would be expected.	The assumptions underlying the comparison values are presented in Section III.A.4. Deriving Comparison Values (see page 55).
31	Page 83: "ATSDR compared estimated exposure doses to standard toxicity values." It would be misleading to call these "standard" values. They should be described as conservatively protective exposure values specifically developed for this site, with assumptions clearly defined.	ATSDR clarified the language on page 84 to explain that the exposure doses were compared to toxicity values at which health effects have been observed (e.g., LOAELs).
32	Page 85: Footnote a, add citation and/or year.	ATSDR made the noted editorial change.

	Peer Reviewer Comment	ATSDR's Response
33	Page 86, 100, 105, 113, and elsewhere: "body burdens…are above non-fish consumers…" Again, this conclusion, which is stated several times, needs to emphasize it is based on estimated comparison values and is not necessarily supported by actual biomonitoring data. It is really not clear why these conclusions are presented with more emphasis that the fact that measured PCB serum levels of high-frequency consumers eating the most concentrated fish over many years are below national norms. This is the information I would want to know as a local resident in order to make an informed decision, particularly given documented exposure trends.	ATSDR's exposure investigations evaluate only exposure—they do not assess whether exposure levels result in adverse health effects. Because of the lack of health-based standards to compare them to, the serum data cannot be used to make health determinations. Further, the results of exposure investigations are applicable only to the participants in the study and cannot be extended to the general population. ATSDR's health assessments are conducted to evaluate whether exposure levels are expected to result in adverse health effects. Please see the response to comment 7 for additional clarification between exposure investigations and health assessments.
34	Page 87: Add values with confidence intervals to the legend.	The purpose of the figure is to graphically show the comparison of Watts Bar Reservoir moderate to high fish consumers to people occupationally exposed to PCBs, fish consumers not exposed occupationally, and non-fish consumers not exposed occupationally. The arithmetic mean, geographic mean, and median are already provided. ATSDR does not think it is necessary to also include confidence intervals, which would most likely be too much information for the lay reader.
35	Page 88: "An exposure dose…" This is the definition of a dose, not an exposure dose.	ATSDR made the noted editorial change.
36	Page 90: "…making cross-species predictions highly uncertain…" Another reason the uncertainty in the comparison values needs to be clearly presented.	The assumptions ATSDR used to calculate comparison values are presented in Section III.A.4. Deriving Comparison Values (see page 55). ATSDR uses comparison values to screen chemicals and identify those requiring additional evaluation. For those chemicals evaluated further, ATSDR calculates estimated exposure doses and compares them to health effects levels (e.g., LOAELs and NOAELs) from the scientific literature to form health conclusions. To counter-balance the uncertainty, whenever possible ATSDR uses site-specific information to estimate exposures. When these site-specific data are unavailable, however, ATSDR uses health-protective assumptions to estimate doses to ensure the exposures are not underestimated.
37	Page 90: Table 11: As a local resident, I would want to know what body burden would be expected from these measured concentrations, using Agency modeling relative to the body burdens that were actually measured. Some verification of the modeling is possible with all these data and is not presented here. The Agency takes an important first step in pages 91–92 where estimated doses are presented based on the measured PCB concentrations in fish, but stops short of comparing these values to earlier estimates on which advisories are based. As these would seem to be very conservative conclusions of estimated dose, yet based on more accurate data, it is very unclear why the advisories are not based on these data.	Thank you for the comment; however, this is beyond the scope of the health assessment process.

	Peer Reviewer Comment	ATSDR's Response
38	Page 96: "Eating moderate to high amounts…less than an order of magnitude below the LOAEL." This and the following sentence should be deleted. Per the definition of RfD and LOAEL, it does not matter whether the value is 1 or 10 or 100-fold below the NOAEL—it only matters that it is below the LOAEL.	An RfD is an EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans. ATSDR uses an RfD to screen exposures that require further evaluation. A NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals in a study. A LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals in a study. ATSDR uses NOAELs and LOAELs on which to base health conclusions. Because the estimated doses associated with eating moderate to high amounts of certain species of fish are less than an order of magnitude below the LOAEL, which involves uncertainties, ATSDR believes it would be prudent public health practice to limit consumption of certain species of fish to minimize exposures to PCBs, especially for sensitive populations.
39	Page 97: "Estimated exposure doses within an order of magnitude of the LOAEL are of health concern and warrant further consideration." This is not consistent with any definition of LOAEL of which I am aware. A citation to support this statement should be provided. If one cannot be provided, this sentence should be deleted.	ATSDR revised the sentence to state: "Estimated exposure doses within an order of magnitude of the LOAEL are of potential health concern and warrant further consideration because of the uncertainties in the toxicity studies."
40	Page 97, 101, 113: "Prudent health practice…" As indicated above, this paragraph and the following three bullets would not appear to be supported by the data presented—only by modeled estimates for which the supporting assumptions have not been completely disclosed.	ATSDR's exposure investigations evaluate only exposure—they do not assess whether exposure levels result in adverse health effects. Because of the lack of health-based standards to compare them to, the serum data cannot be used to make health determinations. Further, the results of exposure investigations are applicable only to the participants in the study and cannot be extended to the general population. ATSDR's health assessments are conducted to evaluate whether exposure levels are expected to result in adverse health effects. Please see the response to comment 7 for additional clarification between exposure investigations and health assessments. The assumptions ATSDR used to calculate exposure doses are fully disclosed in Section IV.C.3. Dose Estimation (see page 91).
41	Page 97: "…children and adults would be well advised to limit their consumption…" Again, this statement is not supported by the sampling data presented in the report, particularly when the benefits of eating fish are considered, as appropriately discussed in the subsequent discussion on pages 97–98.	ATSDR recognizes the nutritional benefits of eating fish in the public health assessment and specifically points out what species of fish are safe to eat and from where those species may safely be taken. ATSDR also provides guidance about how to prepare and cook fish to reduce exposures to PCBs without forfeiting the health benefits from eating fish. Please also see the response to comment 7 for additional clarification between exposure investigations and health assessments.
42	Page 99: The data in the report would not suggest limiting consumption of any of these fish.	Please see the responses to comments 7 and 38.

	Peer Reviewer Comment	ATSDR's Response
43	Page 101: "Because the estimated doses are not expected to cause heath effects, no further analysis of health outcome data is appropriate." Exactly. Then why limit fish consumption? And on what basis?	ATSDR revised this discussion to emphasize that "observable" health effects are unlikely to be found during a health study because the estimated exposure doses are below the LOAEL. However, as a conservative measure, ATSDR determined that prudent public health practice would limit consumption of certain species of fish to minimize exposures to PCBs, especially for sensitive populations.
44	Page 101: …"cancer was mentioned as a health problem more than twice as much as any other health problem…" Is that statistic unique to this population? This seems to be the standard degree of concern in the US population. If so, is it worth mentioning?	ATSDR thinks this statement is worth mentioning because it provides justification for conducting the assessment of cancer incidence.
45	Page 112: "…the highest doses would have come from fish consumption—still, these doses are not expected to have caused them harm." If past frequent exposures to high concentrations did not cause harm, and current exposures are less and continuing to decline, on what basis can a recommendation be issued to limit current and future fish consumption in light of the known health benefits of eating fish?	Because the estimated doses associated with eating moderate to high amounts of certain species of fish are less than an order of magnitude below the LOAEL, ATSDR believes it would be prudent public health practice to limit consumption of certain species of fish to minimize exposures to PCBs, especially for sensitive populations.
46	Page 113: "[Per the yellow box, PAST, PRESENT AND FUTURE] exposure to PCBs in the sediment…	ATSDR made the noted editorial change.
47	Page 113: "Frequent eating of…" delete this paragraph for reasons detailed above.	Please see the responses to comments 7 and 38.
48	Page 113: …"exposed to doses…" not the correct use of the term. Try "exposed to amounts" or "ingesting."	ATSDR made the noted editorial change.
49	Page 113: "Children can safely eat…" and the following sentence should be deleted as being inconsistent with the conclusions presented on page 101 and 112, and elsewhere.	These conclusions for children are not inconsistent with the conclusions stated elsewhere. Table 13 shows the recommended number of fish and geese meals that can safely be eaten, as well as the recommended consumption limits.
50	Page 113: "If community members wish to reduce their exposure to PCBs…" to the end of page 114 is excellent public health guidance and is the appropriate conclusion to this report.	Thank you for your comment.

	Peer Reviewer Comment	ATSDR's Response
Are there any other comments?		
51	As our ability to measure and interpret actual monitoring data increases, it would seem appropriate for the Agency to place more emphasis on making recommendations using real-world data and move away from the modeled estimates that are rife with uncertainty, the estimates that we all formerly had to rely on heavily—sometimes almost exclusively—to make public health recommendations. The advantage of looking at data from these sites for the first time, rather than as an evolution over three decades, is that it seems evident that if these data were made available and interpreted for the first time today that no advisories would be issued other than the very helpful guidance on the health benefits of fish and the best way to prepare them to ensure maximum health benefit. Instead of devolving from past reliance on models and established advisories incrementally over time, the challenge is to issue advisories consistent with today's methodologies and monitoring data. If no advisory would be issued today based on available information, then there is no reason to keep modifying older advisories now that more definitive information is available upon which we can all rely.	ATSDR agrees that as the ability to measure and interpret actual monitoring data increases, there should be more emphasis on using "real-world data" over modeled estimates.