Appendix F. Summary Briefs and Fact Sheets

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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 This involved interviewing both active and retired DOE staff members about past operations, as well as reviewing historical documents (such as purchase orders, laboratory records, and published operational reports).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

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

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.

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ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

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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ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

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.

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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

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

A Guide to Healthy Eating of the Fish You Catch

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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

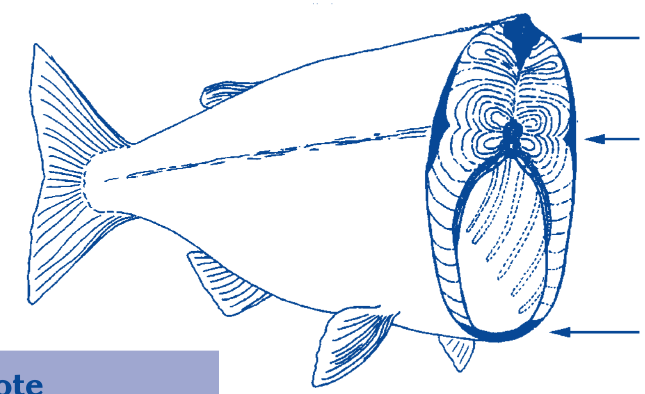
Can I clean my fish to reduce the amount of chemical pollutants that might be present?

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.