

## **Indicator: Contaminants in Lake Fish Tissue (335)**

Lakes and reservoirs throughout the United States provide important sport fisheries and other recreational opportunities. Lake ecosystems also provide critical habitat for aquatic species and support wildlife populations that depend on aquatic species for food. Lakes and reservoirs occur in a variety of landscapes (e.g., urban, agricultural, and wilderness), and they can receive contaminants from several sources, including direct discharges into the water, air deposition, and agricultural or urban runoff. A group of contaminants of particular concern are the persistent, bioaccumulative, and toxic (PBT) chemicals. These contaminants are highly toxic, long-lasting chemicals that enter lakes and reservoirs and accumulate in the fish. They can reach levels that affect the health of people and wildlife that eat fish from these environments.

This indicator is derived from fish samples collected and analyzed for EPA's National Study of Chemical Residues in Lake Fish Tissue. The data generated from this probabilistic survey (Olsen et al. 1998; EPA 1999; Stevens et al. 2003 and 2004) are designed to estimate the national distribution of the mean levels of selected persistent, bioaccumulative, and toxic chemical residues in fish tissue from lakes and reservoirs of the contiguous United States (lower 48 states). Fish samples were collected from 500 lakes and reservoirs over a four-year period (2000-2003). The sampling locations were statistically selected from the estimated 147,000 target lakes and reservoirs in the lower 48 states based on an unequal probability survey design. The lakes are divided into six size categories, with varying probabilities assigned to each category to achieve a similar number of lakes in each category. Lake sizes range from 1 hectare (about 2.5 surface acres) to over 5,000 hectares (including lakes up to 900,000 surface acres), were at least 1 meter (3 feet) deep, and had permanent fish populations.

Sampling teams applied consistent materials and methods nationwide to collect composites of one predator species (e.g., bass or trout) and one bottom-dwelling species (e.g., carp or catfish) at each lake or reservoir. EPA's Field Sampling Plan for the National Study of Chemical Residues in Lake Fish Tissue (EPA 2000a) describes the procedures for fish sample collection, handling, and shipping. Composites consisted of five adult fish of similar size. A single laboratory prepared fish tissue samples for analysis in a strictly controlled environment. Fillets were analyzed for predator composites, and whole bodies were analyzed for bottom dweller composites. Predator composites provide data on edible tissue relevant to human health, and bottom dweller composites provide whole body data relevant to wildlife consumption. Analyses of the fish tissue for each chemical group (e.g., PCBs or organochlorine pesticides) were conducted by the same laboratory using the same standard analytical method for the duration of the study. Quality assurance and quality control procedures for collecting and analyzing samples for this indicator are described in quality assurance project plans (QAPPs) prepared for the study (EPA 2000b and 2000c).

The indicator consists of statistical results from analysis of predator and bottom dweller tissue concentrations for 15 chemicals or chemical groups. Fourteen of these chemicals or chemical groups also appear in the Coastal Fish Tissue indicator (285). They include mercury, arsenic (total inorganic), dioxins/furans, total PCBs, and 11 organochlorine pesticides. Statistics for the 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, and 95<sup>th</sup> percentiles of the concentrations of each chemical in fish tissue are presented for predator fillets and for whole bottom-dwelling fish.

Mercury in fish can originate from a variety of sources, with the primary source being from atmospheric deposition. EPA estimates that on average over three quarters of the mercury deposited in the U.S. comes from international sources with the remaining coming from U.S. and Canadian sources (EPA 2005), although the scientific understanding of mercury atmospheric chemistry is still evolving, and there is considerable uncertainty associated with the estimates of global source impacts. In

addition, production of PCBs for use ceased in 1977; chlordane was banned in 1988; DDT was banned in 1972; and known and quantifiable industrial emissions of dioxin in the United States are estimated to have been reduced by approximately 90% from 1987 levels (EPA, 2004).

### **What the Data Show**

Mercury, polychlorinated biphenyls (PCBs), dioxins and furans, and DDT are widely distributed in lakes and reservoirs in the contiguous 48 states (Figures 335-1, 335-2). Mercury and PCBs were detected in 100% of both the predator and bottom dweller composite samples. Dioxins and furans were detected in 81% of the predator composite samples and in 99% of the bottom dweller composite samples, and DDT was detected in 78% of the predator composites and 98% of the bottom dweller composites. Median concentrations in predator filets (i.e., half of the fish tissue samples had higher values) were as follows: mercury, 0.285 ppm; total PCBs, 2.161 ppb; dioxins and furans, 0.006 ppt [TEQ]; and total DDT, 1.473 ppb (Figure 1). Median concentrations in whole bottom-dwelling fish were lower for mercury (0.069 ppm), but higher for total PCBs (13.88 ppb), dioxins and furans (0.406 ppt [TEQ]), and total DDT (12.681 ppb) (Figure 335-2).

A number of chemicals analyzed for this study were not detected in any of the fish tissue samples. This includes 10 of the 46 pesticides (one organochlorine and all nine organophosphate pesticides) and 32 of the 40 semivolatile organic chemicals (e.g., polycyclic aromatic hydrocarbons (PAHs) and chlorobenzenes) (EPA National Lake Fish Tissue Study report in progress).

### **Indicator Limitations**

- Survey data are only available for the contiguous 48 states.
- The Great Lakes, the Great Salt Lake, and lakes without permanent fish populations were not part of the target population.
- Due to the inaccessibility (e.g., landowner denial of access) of some target lakes, the results are representative of the sampled population of lakes (approximately 80,000) rather than the target population of lakes (approximately 147,000) in the lower 48 states.

### **Data Sources**

The data source for this indicator is the National Study of Chemical Residues in Lake Fish Tissue, U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology. <http://www.epa.gov/waterscience/fishstudy/>. The report on this study is in progress.

### **References**

Olsen, A.R., D.L. Stevens, Jr., and D. White. 1998. Application of global grids in environmental sampling. *Computing Science and Statistics* 30:279-284.

Stevens, D. L., Jr. and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. *Environmetrics* 14: 593-610.

Stevens, D. L., Jr. and A. R. Olsen. 2004. Spatially-balanced sampling of natural resources. *Journal of American Statistical Association* 99(465): 262-278.

EPA. 1999. National Study of Chemical Residues in Lake Fish Tissue: Study Design. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C.

EPA. 2000a. Field Sampling Plan for the National Study of Chemical Residues in Lake Fish Tissue. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-R-02-004.

EPA. 2000b. Quality Assurance Project Plan for Sample Collection Activity in the National Study of Chemical Residues in Lake Fish Tissue. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-R-02-005.

EPA. 2000c. Quality Assurance Project Plan for Analytical Control and Assessment Activities in the National Study of Chemical Residues in Lake Fish Tissue. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-R-02-006.

EPA. 2004. National Listing of Fish Advisories. Fact Sheet. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-F-04-016.

EPA, 2005. Technical Support Document. Revision of December 2000 Regulatory Finding on the Emissions of Hazardous Air Pollutants From Electric Utility Steam Generating Units and the Removal of Coal- and Oil-Fired Electric Utility Steam Generating Units from the Section 112(c) List: Reconsideration. Office of Air and Radiation, Washington, D.C.

## Graphics

**Figure 335-1. Tissue Concentration Estimates for Predators**

Chemical	Number of Samples	Number of Samples above MDL*	Percentiles for Fillet Tissue Concentrations (ppm)						
			5th	10th	25th	50th	75th	90th	95th
Mercury	486	486	0.059	0.089	0.177	0.285	0.432	0.562	0.833
Total PCBs	486	486	0.000351	0.000494	0.001000	0.002161	0.008129	0.018159	0.033161
TEQ Dioxins/Furans only	486	395	0	0	0	0.000000006	0.000000046	0.000000109	0.000000318
Total Inorganic Arsenic	486	2	0	0	0	0	0	0	0
Total Chlordane	486	96	0	0	0	0	0	0.003617	0.008266
Total DDT	486	378	0	0	0	0.001473	0.006938	0.019661	0.030568
Dicofol	486	15	0	0	0	0	0	0	0
Dieldrin	486	24	0	0	0	0	0	0	0.001193
Total Endosulfan	486	18	0	0	0	0	0	0	0
Endrin	486	3	0	0	0	0	0	0	0
Heptachlor epoxide	486	6	0	0	0	0	0	0	0
Hexachlorobenzene	485	0	0	0	0	0	0	0	0
Lindane (gamma BHC)	486	28	0	0	0	0	0	0	0.000994
Mirex	486	10	0	0	0	0	0	0	0
Toxaphene	486	0	0	0	0	0	0	0	0

\* MDL = Method Detection Limit

**Figure 335-2. Tissue Concentration Estimates for Bottom Dwellers**

Chemical	Number of Samples	Number of Samples above MDL*	Percentiles for Fillet Tissue Concentrations (ppm)						
			5th	10th	25th	50th	75th	90th	95th
Mercury	395	395	0.019	0.020	0.039	0.069	0.124	0.220	0.247
Total PCBs	395	395	0.001579	0.002308	0.005146	0.013876	0.070050	0.130787	0.198324
TEQ Dioxins/Furans only	395	393	0.000000019	0.000000059	0.000000165	0.000000406	0.000001067	0.000001770	0.000002006
Total Inorganic Arsenic	395	36	0	0	0	0	0	0	0.037
Total Chlordane	395	197	0	0	0	0.001653	0.009313	0.025964	0.030931
Total DDT	395	388	0.001080	0.001821	0.004226	0.012681	0.035345	0.153923	0.218625
Dicofol	395	8	0	0	0	0	0	0	0
Dieldrin	395	73	0	0	0	0	0	0.003436	0.024613
Total Endosulfan	395	23	0	0	0	0	0	0	0
Endrin	395	14	0	0	0	0	0	0	0
Heptachlor epoxide	395	25	0	0	0	0	0	0	0.000676
Hexachlorobenzene	395	0	0	0	0	0	0	0	0
Lindane (gamma BHC)	395	31	0	0	0	0	0	0.000729	0.001541
Mirex	395	19	0	0	0	0	0	0	0.001866
Toxaphene	395	1	0	0	0	0	0	0	0

\* MDL = Method Detection Limit

## R.O.E. Indicator QA/QC

**Data Set Name:** CONTAMINANTS IN LAKE FISH TISSUE

**Indicator Number:** 335 (89141)

**Data Set Source:**

**Data Collection Date:** UNKNOWN

**Data Collection Frequency:**

**Data Set Description:** Contaminants in Lake Fish Tissue

**Primary ROE Question:** What are the trends in the contamination/quality/safety of consumable fish and shellfish?

### Question/Response

**T1Q1** Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

The chemical measurements upon which the indicator for the National Study of Chemical Residues in Lake Fish Tissue (or National Lake Fish Tissue Study) is based are widely accepted as scientifically and technically valid. Fish tissue samples for this study were analyzed for 268 target chemicals using a number of standard EPA analytical methods, including Method 1613B (dioxins/furans), Method 1625 (semi-volatile organics), Method 1631B (mercury), Method 1632A (arsenic), Method 1656A (organochlorine pesticides), Method 1657A (organophosphate pesticides), and Method 1668 (PCBs). A list of the target chemicals (analytes) and summary descriptions for each of the methods are posted under AFish Tissue Sampling@ on the National Lake Fish Tissue Study website at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/). The units for chemical concentration vary, depending on the method. The units for the chemical concentrations for each chemical group are specified in the method and reported as follows: ng/kg (ppt) for dioxins/furans, ug/kg (ppb) for semi-volatile organics, ng/g (ppb) for mercury, ug/g (ppm) for arsenic, ug/kg (ppb) for pesticides, and ng/kg (ppt) for PCBs. A discussion of the uncertainty associated with the reporting thresholds is included in Section 4.2.2 of the Quality Assurance Report for the National Study of Chemical Residues in Lake Fish Tissue: Year 1 and Year 2 Analytical Data (January 2003), which is available on the National Lake Fish Tissue Study website.

**T1Q2** Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

The sampling design and field sampling plan used to collect the data over time and space for the National Lake Fish Tissue Study are based on sound scientific principles. The objective of the National Lake Fish Tissue Study is to estimate the national distribution of the mean levels of selected persistent, bioaccumulative, and toxic chemical residues in fish tissue from lakes and reservoirs of the contiguous United States. An unequal probability sample design was applied to address the study objective. Probability sampling provides the basis for estimating resource extent and condition, for characterizing trends in extent or condition, and for representing spatial pattern, all with

known certainty. It is an essential requirement for a program such as the National Lake Fish Tissue Study that aims to describe the condition of national resources. A total of 500 locations were sampled over a period of four years to collect fish for the National Lake Fish Tissue Study. The target population for the study is all lakes and reservoirs within the contiguous United States, excluding the Laurentian Great Lakes and the Great Salt Lake. This study defines a lake as a permanent body of water of at least one hectare (2.47 acres) in surface area with a minimum of 1,000 m<sup>2</sup> of open (unvegetated) water and a minimum depth of one meter. The lakes in this study must also have a permanent fish population. Olsen, Stevens, and White described the procedures used to select the unequal probability sample of lakes in the following reference: Olsen, A.R., D.L. Stevens, Jr., and D. White. 1998. Application of global grids in environmental sampling. *Computing Science and Statistics* 30:279-284. The sampling design and lake selection process are also summarized in Section 7 of the Quality Assurance Project Plan (QAPP) for Sample Collection Activities for a National Study of Chemical Residues in Lake Fish Tissue. The final list of 500 lakes appears in Appendix A of the Sample Collection QAPP, which is available under AFish Sampling@ on the National Lake Fish Tissue website at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/). Sampling methods and monitoring requirements are described in detail in the Field Sampling Plan for the National Study of Chemical Residues in Lake Fish Tissue, which is available under AFish Sampling@ on the National Lake Fish Tissue Study website at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/). The study procedures for collection and preparation of fish composite samples for chemical analysis are based on recommended procedures in EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis, Third Edition (2000), which is available under ANational Guidance@ on the Fish Advisory website at [www.epa.gov/waterscience/fish/](http://www.epa.gov/waterscience/fish/).

**T1Q3** Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Not applicable.

**T2Q1** To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

The National Lake Fish Tissue Study is a comprehensive, representative survey of chemical contaminants in fish tissue from lakes and reservoirs in the contiguous United States. The fish study indicator provides data to describe national distributions of mean concentrations of 15 chemicals in freshwater fish tissue and assess the safety of consuming recreational fish species from lakes and reservoirs in the lower 48 states. Fish were collected for this study from 500 lakes and reservoirs in the lower 48 states over a period of four years. Each location was sampled once, and replicate fish composite samples were collected about 10% of the lakes and reservoirs. The 500 sampling locations are listed in Appendix A of the QAPP for Sample Collection Activities for a National Study of Chemical Residues in Lake Fish Tissue, which is available online at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/). Sampling for the study began in October 1999 and ended in November 2003.

**T2Q2** To what extent does the sampling design represent sensitive populations or ecosystems?

Since it is a probabilistic design, the sampling design represents sensitive populations or ecosystems in proportion to their occurrence in the natural environment.

**T2Q3** Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

The proposed National Lake Fish Tissue Study indicator reports statistical summary information only; various human health screening values and consumption thresholds exist that can be applied to interpret these data (e.g., Table 5-3 in EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis, Third Edition (2000) and Tables 4-1 through 4-25 in EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2: Risk Assessment and Fish Consumption Limits, Third Edition (2000); both fish advisory guidance documents are available online at [www.epa.gov/waterscience/fish/](http://www.epa.gov/waterscience/fish/)).

**T3Q1** What documentation clearly and completely describes the underlying sampling and analytical procedures used?

The following documents describe the sampling procedures used for the National Lake Fish Tissue Study; the first two documents are online at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/) and the third document is online at [www.epa.gov/waterscience/fish/](http://www.epa.gov/waterscience/fish/)

Sample Collection Activities QAPP:

U.S. Environmental Protection Agency (USEPA). 2000. Quality Assurance Project Plan for Sample Collection Activity in the National Study of Chemical Residues in Lake Fish Tissue. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-R-02-005.

Field Sampling Plan:

U.S. Environmental Protection Agency (USEPA). 2002. Field Sampling Plan for the National Study of Chemical Residues in Lake Fish Tissue, First Revision. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-R-02-004.

Fish Advisory Guidance for Fish Sampling and Analysis:

U.S. Environmental Protection Agency (USEPA). 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis, Third Edition. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA-823-B-00-007.

The following documents describe the analytical procedures used for the National Lake Fish Tissue Study; both documents are online at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/)



Analytical Activities QAPP:

U.S. Environmental Protection Agency (USEPA). 2000. Quality Assurance Project Plan for Analytical Control and Assessment Activities in the National Study of Chemical Residues in Lake Fish Tissue. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-R-02-006.

Analytical QA Report (Years 1 and 2):

U.S. Environmental Protection Agency (USEPA). 2003. Quality Assurance Report for the National Study of Chemical Residues in Lake Fish Tissue: Year 1 and Year 2 Analytical Data. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C. EPA-823-C-04-003.

**T3Q2** Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

The complete National Lake Fish Tissue Study data set covering the full four years of the study is will be made publicly available as part of the peer review of the indicator, currently available for internal EPA uses only. Prior to the peer review, The Office of Science and Technology (within the Office of Water) has been providing the data in Excel files on CDs in response to requests from EPA programs. These files include metadata and data dictionaries for each of the worksheets in a file. Copies of the National Lake Fish Tissue Study data CD can be obtained from the following contact: Leanne Stahl National Lake Fish Tissue Study Manager OW/OST (4305T) U.S. EPA 1200 Pennsylvania Avenue, NW Washington, DC 20460 202-566-0404 (phone) 202-566-0409 (fax) [stahl.leanne@epa.gov](mailto:stahl.leanne@epa.gov) The first two years of the fish study data have been released to the public. The National Lake Fish Tissue Study website ([www.epa.gov/waterscience/fishstudy](http://www.epa.gov/waterscience/fishstudy)) contains an announcement advertising the availability of the data and identifying how to obtain it. CDs are mailed to those who call or send an e-mail message to request the data.

**T3Q3** Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Sufficient information is available to reproduce all components of the National Lake Fish Tissue Study, including lake selection, sample collection, tissue analysis and data analysis. The summaries below describe existing information that could be used to repeat each component of the study.

**Lake Selection**

The National Lake Fish Tissue Study sampling design is described in detail in the Sample Collection QAPP (*Quality Assurance Project Plan for Sample Collection Activity in the*

*National Study of Chemical Residues in Lake Fish Tissue*, EPA-823-R-02-005 ) and summarized in the Field Sampling Plan (*Field Sampling Plan for the National Study of Chemical Residues in Lake Fish Tissue*, EPA-823-R-02-004). Both documents are posted on the fish study website ([www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/)). A key component of the sampling design is the lake selection process. The Sample Collection QAPP provides general information about this process, including discussions of the type of survey design applied to this process (unequal probability survey design), the sample frame for the survey (River Reach File Version 3, which was the best national GIS coverage available for lakes in 1999), and the procedures used to select the unequal probability sample of lakes. A detailed explanation of the statistical site selection methodology appears in the following series of references:

Stevens, D.L., Jr. (1997) Variable density grid-based sampling designs for continuous spatial populations. *Environmetrics* 8: 167-95.

Stevens, D.L., Jr. and A.R. Olsen. (1999) Spatially restricted surveys over time for aquatic resources. *Journal of Agricultural, Biological, and Environmental Statistics* 4: 415-28.

Stevens, D.L., Jr. and A.R. Olsen. (2003) Variance estimation for spatially balanced samples of environmental resources. *Environmetrics* 14: 593-610.

Stevens, D.L., Jr. and A.R. Olsen. (2004) Spatially-balanced sampling of natural resources. *Journal of American Statistical Association* 99 (465): 262-278.

Information from these references can be combined with information from the electronic files used to generate the original and reserve fish study lake lists to re-create the lake selection process. These electronic files are archived on the Office of Research and Development's (ORD's) computer system at their Corvallis, OR facility. Determining the status of each lake selected for the study and documenting this information in an electronic spreadsheet was the final step in establishing the list of target lakes sampled for the study. The Sample Collection QAPP and the Field Sampling Plan list the criteria that a lake must meet to be included in the study. They also discuss documentation of lakes that qualify as lakes for the study, but are inaccessible due to physical barriers or landowner permission not being granted to sample lakes on private property. Electronic records of lake status are being maintained in OST by the fish study manager and in ORD by the fish study team statistician.

### **Sample Collection**

All the critical information for fish sample collection, handling, and shipping is specified in the Standard Operating Procedure (SOP) entitled "Fish Tissue Sample Collection Procedures for a National Study of Chemical Residues in Lake Fish Tissue." This SOP is appended to both the Sample Collection QAPP and the Field Sampling Plan, and both of these documents are available on the fish study website ([www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/)). The SOP lists the equipment and materials needed for sample collection, provides step-by-step procedures for collecting the fish

samples that include the criteria and target species lists for the two composite types (predators and bottom dwellers) being collected from each lake, and specifies detailed instructions for completing field forms, wrapping and labeling the fish, and packing the fish in coolers for shipment to the sample processing laboratory. Examples of the field forms are included in the SOP, and they could easily be reproduced from electronic files (in WordPerfect format) being maintained for the study.

### **Tissue Analysis**

All fish tissue samples are being processed and analyzed in accordance with procedures that are documented in EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume I: Fish Sampling and Analysis, Third Edition* (EPA-823-B-00-007), in the *Quality Assurance Project Plan for Analytical Control and Assessment Activities in the National Study of Chemical Residues in Lake Fish Tissue* (EPA-823-R-02-006), and in the *Quality Assurance Report for the National Study of Chemical Residues in Lake Fish Tissue: Year 1 and Year 2 Analytical Data* (EPA-823-C-04-003). All three documents are available online at [www.epa.gov/waterscience/fish/](http://www.epa.gov/waterscience/fish/) (fish advisory guidance) and at [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/) (fish study Analytical Activities QAPP and Analytical Data QA report for Years 1 and 2). The Analytical Data QA report summarizes the fish composite processing procedures, refers to the fish advisory guidance (Volume I) for a detailed description of the procedures, and notes two exceptions to the procedures in the fish advisory guidance. The QA report also lists and describes all the analytical methods employed for tissue analysis.

### **Data Analysis**

Statistical procedures for analysis of the National Lake Fish Tissue Study data are described in the Data Analysis QAPP, which is currently in draft form.

**T3Q4** To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

Two quality assurance project plans (QAPPs) have been developed for the National Lake Fish Tissue Study that describe quality assurance and quality control (QA/QC) procedures for sample collection activities and for analytical activities: (1) Quality Assurance Project Plan for Sample Collection Activities for a National Study of Chemical Residues in Lake Fish Tissue and (2) Quality Assurance Project Plan for Analytical Control and Assessment Activities in the National Study of Chemical Residues in Lake Fish Tissue. Both QAPPs are available on EPA's fish study website at the following Internet address: [www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/). A third QAPP describing QA/QC procedures for statistical analyses of the study data has been drafted and is undergoing revision before submission for final approval. This QAPP is entitled Data Analysis Activities for the National Study of Chemical Residues in Lake Fish Tissue, and it will be posted on the fish study website once it is approved.

**T4Q1** Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

The statistical survey method used to generalize National Lake Fish Tissue Study results to all lakes and reservoirs in the contiguous 48 states that met the study criteria is described in Section 4.2 of the Quality Assurance Project Plan for Data Analysis Activities for the National Study of Chemical Residues in Lake Fish Tissue. The Data Analysis QAPP is currently in draft form, but should be ready to submit for final approval by the end of June 2005. For this study, there is no generalization over time.

**T4Q2** Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Section 7.7 of the Quality Assurance Project Plan for Data Analysis Activities for the National Study of Chemical Residues in Lake Fish Tissue discusses estimates of uncertainty related to sample size. These estimates can be readily developed for the number of samples of each composite type (predator and bottom dweller) collected for the study. During the study, replicate fish composite samples were collected at about 10% of the sampling sites. Estimates of sampling variability will be generated from the replicate sample results.

**T4Q3** Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

Section 4.0 of the Sample Collection QAPP (Quality Assurance Project Plan for Sample Collection Activity in the National Study of Chemical Residues in Lake Fish Tissue, EPA-823-R-02-005) identifies and discusses potential sources and effects of error and bias in the sampling design. Sections 5.0 (training), 7.1 (sample type), and 8.1 (target species) provide additional information about reducing sampling variability in the study. The QAPP is available on the fish study website ([www.epa.gov/waterscience/fishstudy/](http://www.epa.gov/waterscience/fishstudy/)). Results of the statistical analysis of fish tissue data from the National Lake Fish Tissue Study will include some uncertainty, but the confidence intervals will be small enough that the uncertainty will not impact conclusions for the 2006 Report on the Environment (ROE) indicator.

**T4Q4** Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

Data for the National Lake Fish Tissue Study are limited to the 48 contiguous United States. Alaska and Hawaii were not included in the study due to resource constraints and study design considerations. Also, in selecting lakes for the study, the Great Lakes and the Great Salt Lake were excluded from the target population. A significant number of target lakes could not be sampled due to physical inaccessibility (e.g., remote locations) or to landowner denial of access to private lakes. This created a gap between the target population and the sampled population of lakes. Therefore, conclusions from statistical

analysis of the study data will be applied to the sampled population of approximately 80,000 lakes rather than the target population of approximately 150,000 lakes.

## 500 Sampling Sites

