Back to Table of Contents

**U.S. Army
Corps of Engineers**

New England District
Concord, Massachusetts

**U.S. Environmental
Protection Agency**

New England Region
Boston, Massachusetts

HUMAN HEALTH RISK ASSESSMENT
GE/HOUSATONIC RIVER SITE
REST OF RIVER

VOLUME IV
APPENDIX C
CONSUMPTION OF FISH AND WATERFOWL RISK ASSESSMENT

DCN: GE-021105-ACMT

February 2005

**Environmental Remediation Contract
GE/Housatonic River Project
Pittsfield, Massachusetts**

Contract No. DACW33-00-D-0006

Task Order 0003

WESTON SOLUTIONS

HUMAN HEALTH RISK ASSESSMENT
GE/HOUSATONIC RIVER SITE
REST OF RIVER

VOLUME IV
APPENDIX C
FISH AND WATERFOWL CONSUMPTION RISK ASSESSMENT

ENVIRONMENTAL REMEDIATION CONTRACT
GENERAL ELECTRIC (GE)/HOUSATONIC RIVER PROJECT
PITTSFIELD, MASSACHUSETTS

Contract No. DACW33-00-D-0006
Task Order No. 0003
DCN: GE-021105-ACMT

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

and

U.S. Environmental Protection Agency
New England Region
Boston, Massachusetts

Prepared by

Weston Solutions, Inc.
West Chester, Pennsylvania

February 2005

W.O. No. 20123.001.096.0728

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

ATTACHMENTS

LIST OF TABLES

Title **Page**

LIST OF TABLES
(Continued)

Title **Page**

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

Title **Page**

LIST OF TABLES
(Continued)

Title **Page**

LIST OF TABLES
(Continued)

Title **Page**

LIST OF TABLES
(Continued)

Title **Page**

LIST OF TABLES
(Continued)

Title **Page**

LIST OF FIGURES

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES (Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES (Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF FIGURES
(Continued)

Title **Page**

LIST OF ACRONYMS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ADD	average daily dose
AhR	aryl hydrocarbon receptor
ANS	Academy of Natural Sciences of Philadelphia
CDDs	chlorodibenzo-p-dioxins
COPC	contaminant of potential concern
CSF	cancer slope factor
CSM	conceptual site model
CTDEP	Connecticut Department of Environmental Protection
CTDHS	Connecticut Department of Health Services
CTE	central tendency exposure
DOC	dissolved organic carbon
DOJ	Department of Justice
DQO	data quality objective
ED	exposure duration
EF	exposure frequency
EPA	U.S. Environmental Protection Agency
FI	fraction ingested
GC/ECD	gas chromatography/electron capture detection
GC/MS	gas chromatography/mass spectrometry
GE	General Electric Company
GERG	Geochemical and Environmental Research Group
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HHRA	human health risk assessment
HQ	hazard quotient
HRA	Housatonic River Area
IR	consumption rate
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LOAEL	lowest observed adverse effect level
MassWildlife	Massachusetts Division of Fisheries and Wildlife
MCA	Monte Carlo Analysis
MDEP	Massachusetts Department of Environmental Protection

LIST OF ACRONYMS
(Continued)

MDPH	Massachusetts Department of Public Health
mg/kg-d	milligrams per kilogram of body weight per day
NAPL	nonaqueous phase liquid
NAS	National Academy of Sciences
PCB	polychlorinated biphenyl
PCDDs/PCDFs	polychlorinated dioxins and furans
ppm	parts per million
PRA	probabilistic risk assessment
PSA	Primary Study Area
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RfD	reference dose
RFI	RCRA Facility Investigation
RME	reasonable maximum exposure
SAB	Science Advisory Board
SI	Supplemental Investigation
SIM	selected ion monitoring
SIWP	Supplemental Investigation Work Plan
TCDD	tetrachlorodibenzo-p-dioxin
TEF	toxic equivalency factor
TEQ	toxic equivalence
TMA	trout management area
tPCB	total PCB
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
VOCs	volatile organic compounds
WESTON®	Weston Solutions, Inc.
WHO	World Health Organization

CONSUMPTION OF FISH AND WATERFOWL RISK ASSESSMENT – EXECUTIVE SUMMARY

INTRODUCTION

The Housatonic River, its sediment, and associated floodplain have been contaminated with polychlorinated biphenyls (PCBs) and other hazardous substances released from the General Electric Company (GE) facility located in Pittsfield, MA. The entire site, known as the General Electric/Housatonic River Site, consists of the 254-acre (103-hectare) GE manufacturing facility; the Housatonic River and its floodplain from Pittsfield, MA, to Long Island Sound; former river oxbows that have been filled with material originating at the facility; neighboring commercial properties; Allendale School; Silver Lake; and other properties or areas that have become contaminated as a result of GE's facility operations.

In September 1998, after years of scientific investigations and regulatory actions, a comprehensive agreement was reached between GE and various governmental entities, including the U.S. Environmental Protection Agency (EPA), the Massachusetts Department of Environmental Protection (MDEP), the U.S. Department of Justice (DOJ), the Connecticut Department of Environmental Protection (CTDEP), and the City of Pittsfield. The agreement provides for the investigation and cleanup of the Housatonic River and associated areas. The agreement has been documented in a Consent Decree between all parties that was entered by the Federal court in October 2000. Under the terms of the Consent Decree, EPA conducted the human health and ecological risk assessments, and is conducting a modeling study of PCB transport and fate for the Housatonic River below the confluence of the East and West Branches ("Rest of River").

The Rest of River, which is the subject of this risk assessment, is the portion of the river that extends from the confluence of the East and West Branches of the Housatonic River (the confluence) in Pittsfield, to the Massachusetts border with Connecticut, a distance of approximately 54 miles (87 km), and beyond into Connecticut to Long Island Sound. The total distance from the confluence to Long Island Sound is approximately 139 miles (224 km). In addition to the river proper, the Rest of River includes the associated riverbank and floodplain, extending laterally to the 1-ppm PCB isopleth. Between the confluence and the Woods Pond Dam, the 1-ppm tPCB isopleth is approximately equivalent to the 10-year floodplain (BBL, 1996).

Risk Assessment Overview

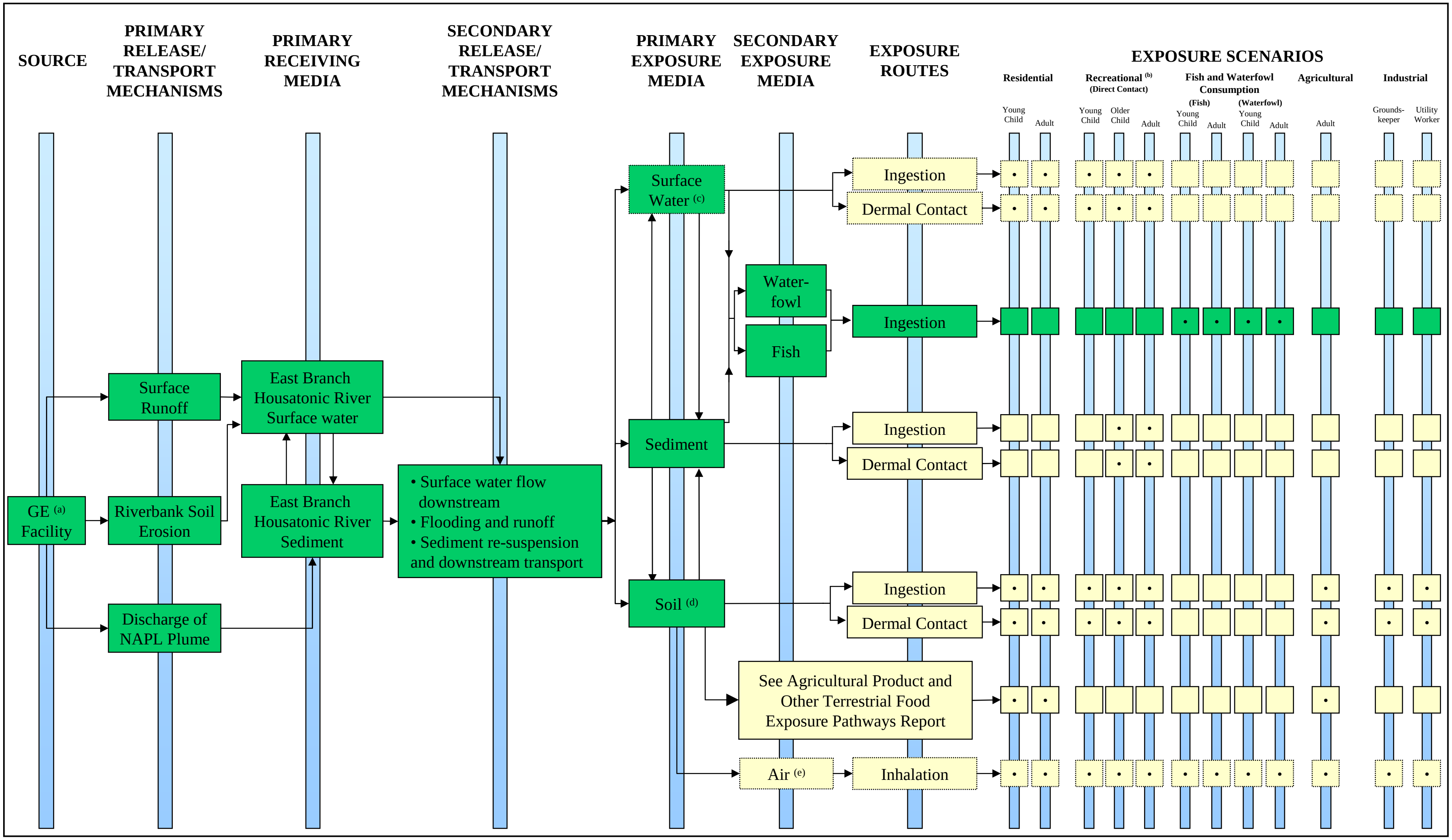
The Human Health Risk Assessment (HHRA) represents an important component of EPA's Supplemental Investigation of the Rest of River, along with the Ecological Risk Assessment and Modeling Study. The HHRA provides a comprehensive evaluation of health risks associated with uses of the river, its banks and floodplain under baseline conditions (i.e., no action) for current and future uses. This evaluation will be considered in:

- Determining the need for remedial actions.
- Setting media protection goals for contaminants of concern.

This volume, Consumption of Fish and Waterfowl Risk Assessment (Appendix C), is a technical appendix of the HHRA for the Rest of River portion of the GE/Housatonic River Site. The report and technical appendices provide a comprehensive examination of health risks associated with identified current recreational, residential, agricultural, and commercial/industrial uses of the site; and uses that might reasonably be expected in the future. Figure ES-1 presents the conceptual site model (CSM) for the entire HHRA, with the fish and waterfowl consumption pathways highlighted. The CSM depicts the pathways from the source of contamination through the various environmental media to exposure to individuals categorized by activity and age group.

Overview of Fish and Waterfowl Risk Assessment

This appendix provides quantitative risk estimates for the consumption of fish and waterfowl from the Rest of River using both point estimate and probabilistic methodologies. Both approaches evaluate potential cancer risks and noncancer health hazards to children and adults from fish consumption from locations in Massachusetts and Connecticut and from waterfowl consumption in Massachusetts. Potential risks from consumption of waterfowl in Connecticut are evaluated semiquantitatively, and risks from the consumption of frogs and turtles are



	Residential		Recreational (b) (Direct Contact)			Fish and Waterfowl Consumption				Agricultural	Industrial	
						(Fish)		(Waterfowl)				
	Young Child	Adult	Young Child	Older Child	Adult	Young Child	Adult	Young Child	Adult	Adult	Grounds-keeper	Utility Worker
Surface Water (c) – Ingestion	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚	⬚	⬚	⬚	⬚	⬚	⬚
Surface Water (c) – Dermal Contact	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚	⬚	⬚	⬚	⬚	⬚	⬚
Water-fowl / Fish – Ingestion	🟩	🟩	🟩	🟩	🟩	🟩 •	🟩 •	🟩 •	🟩 •	🟩	🟩	🟩
Sediment – Ingestion	☐	☐	☐	•	•	☐	☐	☐	☐	☐	☐	☐
Sediment – Dermal Contact	☐	☐	☐	•	•	☐	☐	☐	☐	☐	☐	☐
Soil (d) – Ingestion	•	•	•	•	•	☐	☐	☐	☐	•	•	•
Soil (d) – Dermal Contact	•	•	•	•	•	☐	☐	☐	☐	•	•	•
See Agricultural Product and Other Terrestrial Food Exposure Pathways Report	•	•	☐	☐	☐	☐	☐	☐	☐	•	☐	☐
Air (e) – Inhalation	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •	⬚ •

• = Complete exposure pathway

☐ = Incomplete exposure pathway

⬚ = Not evaluated quantitatively.

🟩 = Pathways of concern.

NAPL = nonaqueous phase liquid.

(a) = Includes all facility-related sources such as site soils, Unkamet Brook, Silver Lake, former oxbows, fill areas, etc.

(b) = There are seven variations of the recreational scenario, including: general recreation, ATV/dirt and mountain biker, marathon canoeist, recreational canoeist, angler, waterfowl hunter, and sediment exposure. The scenario selected will depend on the medium and exposure area of concern being evaluated.

(c) = Chemical concentrations in surface water were compared to conservative, site-specific screening risk based concentrations (SRBCs) as an initial screening step. Results of the screening process indicated chemical concentrations in surface water below levels of human health concern. Thus, direct contact to surface water was not evaluated quantitatively.

(d) = Includes floodplain and riverbank soil.

(e) = Air sampling conducted at various points along the Lower River resulted in low concentrations of PCBs. An additional sampling and screening level risk assessment was performed. Results of the screening process indicated chemical concentrations in air below levels of human health concern. Thus, inhalation of air was not evaluated quantitatively.

Figure ES-1
Conceptual Site Model

Fish and Waterfowl
Consumption Risk Assessment
General Electric Housatonic River Site
Rest of River

discussed qualitatively. PCBs, toxic equivalence (TEQ) associated with dioxins, furans, and dioxin-like PCBs, and mercury are included as contaminants of potential concern (COPCs). The consumption of fish and waterfowl such as ducks and geese is a particular concern because of the ability of contaminants such as PCBs and other persistent organic pollutants to bioaccumulate and biomagnify in animals.

The State of Connecticut posted a fish consumption advisory for most of the Connecticut section of the river in 1977 as a result of the PCB contamination in the river sediment and fish tissue. In 1982, the Massachusetts Department of Public Health (MDPH) issued a consumption advisory for fish, frogs, and turtles for the Housatonic River. In addition, in 1999, MDPH issued a waterfowl consumption advisory from Pittsfield to Great Barrington due to PCB concentrations in wood ducks and mallards collected from the river by EPA and Massachusetts Division of Fisheries and Wildlife (MassWildlife).

Public awareness of the PCB contamination, in addition to the fish and duck consumption advisories, has resulted in less recreational activity than if there were no consumption advisories. Estimates of consumption rates in this risk assessment were based on rates expected to occur if the river and the biota were not contaminated and in the absence of consumption advisories. This approach is consistent with EPA policy (EPA, 1990).

For the fish consumption portion of the risk assessment, four areas were evaluated in the Rest of River:

- The Primary Study Area (PSA) – from the confluence of the East and West Branches of the Housatonic River to Woods Pond Dam (Reaches 5 and 6).
- Rising Pond in Great Barrington, MA (Reach 8).
- West Cornwall, CT, to Bulls Bridge, CT (Reaches 11 and 12).
- Lake Lillinonah and Lake Zoar, CT (Reaches 14 and 15).

PCB contamination was found in mallards and wood ducks collected by the EPA in 1998 from the PSA (Woods Pond and its backwaters) (MDPH, 1999). The waterfowl portion of the risk assessment was based on these data.

HAZARD IDENTIFICATION

The purpose of the hazard identification is to identify the data available to assess risks, to summarize the data relevant to human health, and to identify COPCs for the fish and waterfowl consumption exposure pathways.

Fish have been sampled for PCBs in many locations throughout the Rest of River since the 1970s. The fish samples have included various fish species and tissue types (e.g., fillet, offal, whole fish). Some sampling programs have included dioxins, furans, organochlorine pesticides, and metals as analytes in addition to PCBs.

The majority of the data used for the risk assessment in the Massachusetts reaches of the river were obtained during the investigation conducted by the EPA. Implementation of the major elements of the investigation was completed in 2001. The data are summarized as part of the Rest of River RCRA Facility Investigation (RFI) (BBL and QEA, 2003).

In the EPA investigation, total PCBs (tPCBs) in fish tissue were reported as the sum of congeners; and congener concentrations for PCBs, dioxins, and furans were also reported. Fish tissue data in Connecticut were obtained from a biennial monitoring program of PCB concentrations in selected fish species and benthic insects conducted by the Academy of Natural Sciences of Philadelphia (ANS) on behalf of GE (ANS, 2001). PCB congener analysis has been conducted on these fish tissue samples since 1992, and the results reported both as sum of congeners and as Aroclors. Individual congener concentrations, however, are not reported.

Fish data from all sampling programs were evaluated to determine whether they met data quality criteria. Fish data that met these criteria were then screened for relevance to the human health risk assessment based on the following criteria:

- Species preferred for consumption.
- Tissues relevant to human consumption.
- Legal size limits for species.

Mallards and wood ducks were captured in the PSA and a reference area in August and September 1998, prior to the fall migration, during sampling programs conducted by

MassWildlife during its annual banding effort and by EPA. Breast (skin on) and liver tissue were analyzed for PCB congeners, dioxins/furans, and pesticides (BBL and QEA, 2003).

COPC Selection

Data that met data quality criteria and were relevant to human health risk assessment were evaluated to select COPCs for full risk analysis. The COPC selection process was similar for fish and waterfowl.

Because of the known releases from the GE facility and high measured concentrations in site media, PCBs were included as COPCs. Aroclors, the commercial form of PCBs released from the GE facility, are known to contain small amounts (µg/g concentrations) of chlorinated furans (PCDFs) as a consequence of the manufacturing process (ATSDR, 2000; Erickson, 2001). Dioxins and furans were detected in samples of nonaqueous phase liquid (NAPL) from the GE facility and in sediment samples collected adjacent to the GE facility (BBL and QEA, 2003). Because of their relationship with releases from the GE facility, dioxins and furans were retained as COPCs in fish in Massachusetts reaches of the river, and in waterfowl. Dioxin/furan data were not reported for fish in Connecticut reaches of the river.

Organochlorine pesticides and metals were screened based on the following criteria:

- Frequency of detection.
- Frequency of exceeding the EPA Region 3 contaminant-specific risk-based concentrations (RBCs; EPA, 2004a).
- Magnitude by which the RBC was exceeded.

All metals and chlorinated pesticides were eliminated based on these selection criteria with the exception of mercury. Mercury was retained as a COPC for fish (data for Reaches 5 and 6 only).

DOSE-RESPONSE ASSESSMENT

The purpose of the dose-response assessment is to identify the toxicity values for assessing potential human cancer risks and noncancer health effects. These toxicity values include cancer slope factors (CSFs) for estimating excess lifetime cancer risk and chronic reference doses

(RfDs) for estimating noncancer hazard. In the risk characterization step, estimated COPC doses from consumption of fish or waterfowl are combined with dose-response values to calculate potential cancer risk and noncancer hazard.

Toxicity values for tPCBs were obtained from the *Integrated Risk Information System* (IRIS) (EPA, 2004b). For mixtures like the highly chlorinated tPCB mixture at the site, EPA recommends using an upper-bound CSF of 2.0 $(mg/kg\text{-}d)^{-1}$ and a central estimate CSF of 1.0 $(mg/kg\text{-}d)^{-1}$. The IRIS database provides oral RfDs for Aroclor 1016 and Aroclor 1254. The mixture at the site most closely resembles Aroclor 1260 with minor contributions from Aroclor 1254 (WESTON, 2002; BBL and QEA, 2003), but no RfD is available for Aroclor 1260. With respect to chlorine content and environmental persistence, the PCB mixture at this site more closely resembles Aroclor 1254 than Aroclor 1016. Therefore, the RfD for Aroclor 1254 (0.00002, or 2E-05 mg/kg-d) was used.

The risks associated with 2,3,7,8-TCDD and other dioxin-like PCDD, PCDF, and PCB congeners were evaluated using a toxic equivalence approach (Van den Berg at al., 1998). Each dioxin-like congener was assigned a toxic equivalency factor (TEF) that is used to transform concentrations of individual dioxin-like PCDD, PCDF, and PCB congeners into equivalent concentrations of 2,3,7,8-TCDD known as TEQ. Toxicity values for 2,3,7,8-TCDD TEQ are not published in IRIS. The provisional CSF value of 1.5E+05 $(mg/kg\text{-}d)^{-1}$ was obtained from the *Health Effects Assessment Summary Tables* (HEAST) (EPA, 1997). No noncancer toxicity values are available for PCDD/PCDFs, and noncancer health effects from these compounds were not quantitatively evaluated.

Cancer risks from tPCBs and TEQ are presented separately, and represent two toxicological evaluations of cancer risks from the environmental mixture. The cancer risks from these separate evaluations are not summed, and the potential underestimate of tPCB cancer risk as a result of the potential enrichment of persistent congeners, including dioxin-like PCB congeners, is discussed in the uncertainty analysis (Section 7).

EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to estimate the nature, extent, and magnitude of potential exposure of adults and children to COPCs by consumption of fish and waterfowl. To provide a range of exposure estimates from the point estimate approach, both the reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios are presented. The RME, an estimate of the upper range of exposure in a population, is based on a combination of the upper and central estimates of exposure parameters representing the 90th percentile or greater of actual expected exposure. The CTE is the central tendency (i.e., average) exposure, which uses average exposure parameters to calculate an average exposure to an individual. Both the RME and CTE analyses are presented for each exposure scenario.

EPA guidance outlines a sequential “tiered” approach to the application of probabilistic models in a risk assessment. Each tier is evaluated and the results are used to influence the succeeding tiers. In the application of this approach, increasingly complex models and data are used to further quantify the effects of uncertainty regarding risk model input variables on the risk assessment result.

The fish and waterfowl risk assessment is composed of three tiers. The point estimate risk models represent the first tier of the risk assessment. One-dimensional Monte Carlo simulations and probability bounds analyses comprise the second tier. The resulting second-tier risk analysis consists of a probability distribution of risk, and plausible extreme uncertainty bounds on that risk distribution, for fish ingestion and waterfowl ingestion scenarios at each location evaluated. The third tier is a microexposure event (MEE) Monte Carlo simulation and a corresponding MEE probability bounds analysis. The MEE Monte Carlo simulation is intended to account for the day-to-day and year-to-year variation in an individual’s habits (e.g., hunting, fishing, cooking), and for the meal-to-meal and year-to-year variability in the fish and waterfowl that the individual brings home.

Potentially Exposed Populations

Recreational anglers, waterfowl hunters, and their families have been identified as having the highest potential exposure to contaminants from the consumption of fish and waterfowl, respectively. EPA has attempted to identify populations that engage in subsistence fishing in both the Massachusetts and Connecticut reaches of the Housatonic River, and has found no evidence that any exist at this time. EPA held discussions on April 29, 2004, with representatives of the Schaghticoke Tribal Nation, which obtained federal recognition in January 2004, pending appeal. Tribal members currently practice catch-and-release fishing because of the warnings on fish consumption. In the absence of such warnings, consumption would resume. Risks associated with the resumption of traditional cooking methods are evaluated in the uncertainty section.

Three populations that may be particularly sensitive to adverse effects of PCBs were considered in this risk assessment in addition to adults: fetuses (in utero exposure), nursing infants (via breast milk of exposed mothers), and young children (ages 1 to 6 years). The risks to young children are quantified with adult exposures throughout this report. Exposure to nursing infants is evaluated and discussed in HHRA Volume I, Section 10. The risks associated with in utero exposure are discussed in the uncertainty section.

Exposure Areas

Risks from consumption of fish were evaluated for four different exposure areas that were based on locations where anglers are known to fish. In Connecticut, data from separate locations were combined because there was no statistically significant difference between the PCB concentrations in fish sampled from the different areas. The exposure areas are sufficiently large that all angling and harvesting necessary to achieve the consumption rate used in the risk assessment may reasonably take place in a single exposure area.

Risks from the consumption of waterfowl were evaluated in one exposure area, the lower portion of the PSA. This area was popular with waterfowl hunters prior to the advisory and supports a resident waterfowl population of sufficient size to accommodate the consumption rates used in the risk assessment. Although no usable waterfowl data were available for areas farther downstream, in the uncertainty section, consumption of waterfowl in Connecticut was evaluated based on a comparison of sediment tPCB concentrations in Connecticut to those in the PSA, and contaminant concentrations in ducks harvested from reference locations in Massachusetts.

Exposure Models and Parameters

Exposure was calculated as average daily dose (ADD), expressed as administered dose in milligrams of contaminant per kilogram of body weight per day (mg/kg-d). ADDs were calculated for each receptor based on two different averaging times. ADDs averaged over the exposure duration were used to evaluate noncancer health effects. Lifetime average daily doses (LADDs), in which the doses are averaged over a 70-year lifetime, were used to evaluate potential cancer risk. To the extent possible, site-specific data were used to derive exposure parameters, including exposure duration and ingestion rates.

The probabilistic assessment of human health risks from fish and waterfowl ingestion includes both Monte Carlo simulations and probability bounds analyses. The Monte Carlo simulations use the same exposure model as the point estimate assessment. However, in the Monte Carlo simulations, distributions, rather than single values (point estimates), were used to incorporate variability for many of the exposure variables.

Exposure Point Concentrations (EPCs)

EPCs were calculated from fish or waterfowl tissue concentrations for each exposure area.

The fish species and parts of fish included in the sample for each exposure area were as follows:

- Primary Study Area (Reaches 5 and 6) – Brown bullhead, largemouth bass, sunfish, and yellow perch, skinned and trimmed fillet.
- Rising Pond (Reach 8) – Brown bullhead, largemouth bass, pumpkinseed (sunfish), and yellow perch, skinned and trimmed fillet.
- West Cornwall and Bulls Bridge (Reaches 11 and 12) – Smallmouth bass, skin-on fillet.
- West Cornwall – (Reach 11) Brown trout, skin and scales-on fillet.
- Lake Lillinonah and Lake Zoar, CT (Reaches 14 and 15) – Smallmouth bass, skin-on fillet.

The waterfowl consumption risk assessment was based on samples of mallard and wood duck skin-on breasts from the PSA.

Because data for various fish species were available for the PSA and Rising Pond, information related to the species consumption preferences of local residents was used to obtain a single EPC representative of fish consumption from this area. Risks from consumption of a single species and/or parts of the fish other than skin-off fillet were evaluated as part of the uncertainty analysis. Data from mallards and wood ducks were combined to obtain the waterfowl EPC.

EPCs were calculated for each data set for each exposure area as the 95% upper confidence limit (UCL) of the mean of the concentration data. The equations that were used for the calculation were selected based upon the shape of the underlying distribution of the concentration data.

Consumption Rate (IR)

Fish consumption rates were based on data from a survey of freshwater anglers in Maine (ChemRisk, 1992; Ebert et al., 1993). This survey was selected because it was a large, well-conducted survey of a population with characteristics similar to those of the Housatonic River Area (HRA). In addition, the underlying data were available and provided to EPA by the study authors. Unlike data available for the Housatonic River, fish consumption advisories were in effect for less than 1% of Maine's waters at the time the survey was conducted, thus there is no potential decrease in consumption rates because of fish consumption advisories.

EPA derived a RME consumption rate of 31 g/d, equivalent to fifty 8-oz meals/year, and a CTE consumption rate of 8.7 g/d, equivalent to fourteen 8-oz meals/year for all locations and fish species other than trout. Lower consumption rates were derived for trout (RME, 12 g/d; CTE, 4 g/d) because in this river system they are typically caught in flowing waters, while the other species evaluated may be caught in both flowing and standing waters (all waters). Consumption rates for flowing and standing waters were reported separately in the Maine Angler Survey. The fish consumption rates for species caught in all waters are consistent with surveys of Housatonic River residents and anglers conducted in Massachusetts and Connecticut (MDPH, 1997; Ebert et al., 1996).

Waterfowl consumption rates were calculated indirectly using data on frequency of consumption of waterfowl and expected portion sizes. Data regarding frequency of waterfowl meals were obtained from a survey of HRA residents conducted by MDPH in 1996 and from an ongoing volunteer study (MDPH, 1997). The survey was conducted prior to the issuance of the waterfowl consumption advisory. Portion sizes were based on national surveys of poultry consumption. The portion size is consistent with the amount of meat in the breast of duck species resident in the PSA, and the number of meals per year (11 and 5.4 for the RME and CTE, respectively) is consistent with hunting regulations, practices, and available resident waterfowl. For adults, consumption rates of 5 g/d and 2.4 g/d were used for the RME and CTE, respectively.

For both fish and waterfowl, child consumption rates were assumed to be half the adult rates based on the ratio of child to adult consumption rates of fish or poultry in national surveys.

Exposure Frequency (EF)

The exposure frequency used in the ADD calculation depends on the presentation of the consumption rate. For the point estimate risk assessment, annualized fish and waterfowl consumption rates were used; therefore, the EF was 365 days. For the MEE Monte Carlo simulation, consumption rate was based on meal size and the EF was expressed as meals/year.

Exposure Duration (ED)

Site-specific values for exposure duration were obtained from the results of the MDPH survey of the HRA. The survey included questions asking participants to provide estimates of the number of years they consumed freshwater fish. MDPH provided EPA with statistical summaries of this information (MDPH, 1997, 2001). For the 705 individuals who reported having ever consumed freshwater fish (of which approximately 75% was recreationally caught), the mean duration of consumption was 22.5 years, the 90th percentile was 50 years, and the 95th percentile was 60 years. For the point estimate risk assessment, the mean and 90th percentile values were selected as the ED for the CTE and RME, respectively. Although the 95th percentile is normally used for an RME value, the 90th percentile was selected in this case because of the lack of specificity of the data regarding the length of time consuming fish from the Housatonic River and the potential bias for overestimating exposure duration that it imposes. The full distribution of values was used in the probabilistic risk assessments. The MDPH survey did not ask a similar question regarding waterfowl consumption; therefore, the ED for fish consumption was also used for waterfowl consumption.

Cooking Loss (LOSS)

Lipophilic compounds such as PCBs, dioxins, and furans accumulate in the fatty tissue of fish or waterfowl. Some loss of these compounds may occur during cooking. For fish, the range of values for the percent of PCB lost during cooking was evaluated based on literature data for each cooking method typically used by HRA residents. A central tendency cooking loss was calculated by weighting (multiplying) the cooking method loss for each cooking method by the relative frequency of each cooking method by consumers of Housatonic River fish. The CTE cooking loss, 25%, was applicable to both skin-on and skin-off fillets. The conservative cooking loss was zero, based on the results of several studies. However, the CTE cooking loss was used for the both RME and CTE ADD calculations to maintain a mixture of upper and central tendency exposure estimates. For waterfowl, the cooking loss was assumed to be zero for both the RME and CTE because of the cooking practice of using the pan drippings in the preparation of gravies and sauces.

Fraction Ingested from the Site (FI)

Fraction ingested (FI) refers to the fraction of the sport-caught fish or waterfowl consumed by anglers that is from the Housatonic River. The values for fraction ingested are those that would be applicable in the absence of consumption advisories.

For fish, several site-specific surveys indicate that some anglers fished the Housatonic River exclusively, or nearly so, whereas more typical anglers fished the Housatonic River between 30% and 50% of the time. Based on these findings, the FIs for the RME and CTE anglers were 0.97 and 0.5, respectively. For waterfowl, both the RME and CTE FI were 1 because the time and effort necessary to locate a suitable area for waterfowl hunting and the additional effort often expended by hunters in establishing blinds and similar improvements suggest that the same areas are visited consistently by an individual.

RISK CHARACTERIZATION

The purpose of the risk characterization is to integrate the information developed in the exposure assessment and the dose-response assessment into an evaluation of the potential health risks associated with consumption of fish and waterfowl. Cancer risks and noncancer hazards were evaluated for both the RME and CTE point estimate and the probabilistic assessments.

Cancer risk is calculated by multiplying the lifetime average daily exposure to a COPC by the cancer slope factor for the COPC. The calculated cancer risk, which has no units, represents the excess cancer risk (above the background cancer risk) over a lifetime of exposure.

EPA's cancer risk range represents the increased risk of developing cancer, based on a plausible upper bound exposure, of approximately 1 in 1,000,000 (1E-06, equivalent to 1 x 10^{-6}) to 1 in 10,000 (1E-04, equivalent to 1 x 10^{-4}) over a 70-year (assumed) lifetime (EPA, 1990). Where the cumulative site risk to an individual based on the RME exceeds the 1E-04 excess lifetime cancer risk end of the risk range, action is generally warranted at a site. For sites where the cumulative site risk to an individual based on the RME is less than 1E-04, action generally is not warranted, but may be warranted if a chemical-specific standard that defines acceptable risk is violated or if there are noncancer effects or an adverse environmental impact that warrants action. EPA may also decide that a lower level of risk is unacceptable and that action is warranted where, for example, there are uncertainties in the risk assessment results. Once EPA has decided to take an action, EPA has expressed a preference for cleanups achieving the more protective end of the range (i.e., 1E-06), although strategies achieving reductions in site risks anywhere in the risk range may be deemed acceptable by EPA (EPA, 1991).

Noncancer hazards are described using the hazard index (HI), which is calculated by summing the hazard quotients (HQs) for all COPCs. An HQ is the ratio of the exposure duration-averaged estimated daily dose (ADD) to the contaminant-specific RfD.

HIs of less than 1 indicate that adverse noncancer hazards associated with the exposure scenario are unlikely to occur. EPA considers action when the HI exceeds 1.

RfDs are available for two of the three COPCs: tPCB and mercury (evaluated as methylmercury). The noncancer effects of the third COPC, TEQ, were evaluated qualitatively, but not quantitatively. Mercury was evaluated only in fish in the PSA, and the HQ was less than 1% the PCB HQ. Thus, for the purposes of this assessment, HQs and HIs are essentially equivalent.

Point Estimate and Monte Carlo Simulation Results

A combination of upper and average values for exposure parameters was used in the point estimate approach to calculate the RME risk, and average values were used to calculate the CTE risk. In the probabilistic assessments, the RME risk and CTE risk were obtained from the risk distribution. EPA defines the RME range as generally between the 90th and 99.9th percentiles, whereas the CTE risk is generally the 50th percentile (EPA, 2001).

The results of the point estimate cancer risk characterization are summarized in Table ES-1, along with the results of the 95th percentile (representative of an RME) and 50th percentile (median, representative of a CTE) of the two Monte Carlo simulations (one-dimensional and MEE). The 95th percentile of the Monte Carlo simulations is presented in these tables because it approximates the midpoint of the RME range and is the recommended starting point for risk management decisions (EPA, 2001).

For fish consumption, point estimate RME cancer risks for tPCBs range from 4E-04 to 8E-03, and CTE cancer risks for tPCBs range from 2E-05 to 3E-04. The point estimate cancer risks for TEQ are somewhat higher than for tPCBs. For example, in the PSA, the RME cancer risk for TEQ is 1E-02 compared to the tPCB cancer risk of 8E-03. The CTE cancer risk (PSA) for TEQ is 9E-04 compared to the tPCB cancer risk of 3E-04.

For waterfowl consumption, the point estimate RME risk is 1E-03 and the CTE risk is 1E-04 for tPCBs. In contrast to fish consumption, RME cancer risk due to TEQ is 20 times higher than risk from tPCBs and the CTE cancer risk is 40 times higher.

Table ES-1
Cancer Risk from Fish and Waterfowl Consumption: Point Estimate, One-Dimensional Monte Carlo, and Microexposure Event Analyses

	RME Range			Central Tendency Range		
	RME Point Estimate	95th Percentile 1-D Monte Carlo	95th Percentile MEE	CTE Point Estimate	50th Percentile 1-D Monte Carlo	50th Percentile MEE
tPCB Risk						
Fish Consumption, Primary Study Area (Reaches 5 & 6)	8E-03	2E-03	1E-03	3E-04	3E-04	5E-04
Fish Consumption, Rising Pond (Reach 8)	5E-03	2E-03	8E-04	2E-04	2E-04	3E-04
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	6E-04	2E-04	1E-04	2E-05	2E-05	4E-05
Trout Consumption, West Cornwall Area (Reach 11)	6E-04	2E-04	1E-04	3E-05	3E-05	5E-05
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	4E-04	1E-04	7E-05	2E-05	2E-05	3E-05
Waterfowl Consumption	1E-03	1E-03	9E-04	1E-04	2E-04	3E-04
TEQ Risk						
Fish Consumption, Primary Study Area (Reaches 5 & 6)	1E-02	3E-03	2E-03	9E-04	4E-04	7E-04
Fish Consumption, Rising Pond (Reach 8)	6E-03	2E-03	9E-04	4E-04	2E-04	4E-04
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	NA	NA	NA	NA	NA	NA
Trout Consumption, West Cornwall Area (Reach 11)	NA	NA	NA	NA	NA	NA
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	NA	NA	NA	NA	NA	NA
Waterfowl Consumption	2E-02	2E-02	1E-02	4E-03	2E-03	5E-03

Table ES-1 can be used to compare the risk of consuming fish caught at various locations on the Housatonic River. For example, the RME point estimate cancer risk from tPCBs decreases steadily with increasing distance downstream from Reaches 5 and 6 (which includes Woods Pond and its backwaters), to Rising Pond, to West Cornwall/Bulls Bridge, and finally to Lake Lillinonah/Lake Zoar (Reaches 14 and 15). Similar cancer risks are associated with the consumption of bass and trout in the West Cornwall area. Risks in the central tendency range show similar patterns.

Table ES-1 can also be used to compare the cancer risks from tPCBs associated with waterfowl and fish consumption in the PSA. For the RME point estimate, fish consumption is associated with tPCB cancer risks 8 times higher than waterfowl consumption. However, a comparison of the 95th percentiles of the Monte Carlo simulations (Table ES-1) indicates the cancer risk due to tPCBs is similar for fish and waterfowl consumption. The central tendency estimates of cancer risks indicate 1.5 to 3 times higher tPCB cancer risk from fish consumption than waterfowl consumption for both the point estimate and the Monte Carlo simulations.

A different pattern is observed when comparing the cancer risk associated with TEQ. RME and CTE point estimates and upper and central tendency Monte Carlo simulations indicate a higher cancer risk associated with consumption of waterfowl than with fish; the difference is approximately 2 times higher for the point estimate and 2 to 5 times higher for the Monte Carlo simulations.

Table ES-1 can be used to place the results of the point estimate in the context of the risk distributions generated by the Monte Carlo risk simulations. The point estimate RME cancer risks from tPCB and TEQ for fish consumption (all locations) are generally 2 to 4 times higher than the 95th percentile of the risk calculated using the one-dimensional simulations. In general, the point estimate RME risks are between the 99th and 99.5th percentile. The point estimate CTE cancer risks for fish consumption are at or very near the 50th percentile risk of the one-dimensional Monte Carlo simulation. The 50th percentile of the MEE simulation generally yields somewhat higher risks than the one-dimensional simulation. For waterfowl consumption, the tPCB RME point estimate risk is close to the 95th percentile risk of both the one-dimensional Monte Carlo simulation and the MEE simulation.

The TEQ RME point estimate risk is very close to the 95th percentile and 99th percentile of the one-dimensional Monte Carlo simulation and MEE simulation, respectively. The waterfowl tPCB CTE point estimate risk is one-half the 50th percentile risk of the one-dimensional Monte Carlo simulation (between the 25th and 50th percentile) and below the 25th percentile for the MEE simulation. The TEQ CTE point estimate risk is between the one-dimensional and MEE simulation 50th percentile estimates.

Table ES-2 presents the results of the point estimate noncancer evaluation for adults and children. For adult fish consumers, the HI for the RME ranges from 13 to 230. HIs are higher for child fish consumers, ranging from 31 to 550. As observed with the cancer risk, the noncancer hazard decreases proceeding downstream from the GE facility. For waterfowl consumption, the RME HI is 35 and the CTE HI is 17 for adults. The values are approximately 2 times higher in children.

Table ES-2 can be used to compare the point estimate and Monte Carlo simulations for noncancer hazards to both adults and children. For the upper range, the fish consumption RME point estimate is approximately twice as high as the 95th percentile of both Monte Carlo simulations, placing it between the 95th and 99th percentiles. The CTE point estimate HI is about 3 times higher than the 50th percentile of the risk distribution identified in the Monte Carlo simulations, placing it in approximately the 75th percentile. In contrast, for waterfowl consumption, the point estimate HI for the RME adult is approximately the 75th percentile of the one-dimensional Monte Carlo simulation and approximately the 90th percentile of the MEE simulation. For the central tendency, the waterfowl consumption CTE tPCB HI point estimates are approximately the 75th percentile.

Relationship Between Risk Estimates and the EPA Risk Range

The results of the point and probabilistic risk assessments were compared to the EPA acceptable risk range. The EPA cancer risk range identified in the National Contingency Plan (NCP) (EPA, 1990) is approximately 1E-06 to 1E-04, or an increased probability of developing cancer of 1 in 1,000,000 to 1 in 10,000 over the course of a 70-year lifetime. Exposure that results in no appreciable risk of significant adverse effect to individuals is the goal for COPCs with noncancer effects. An HI of 1 or less indicates no appreciable significant risk.

Table ES-2

Total PCB Noncancer Hazards from Fish and Waterfowl Consumption: Point Estimate, One-Dimensional Monte Carlo, and Microexposure Event Analyses

	RME Range			Central Tendency Range		
	RME Point Estimate	**95th Percentile 1-D Monte Carlo**	**95th Percentile MEE**	**CTE Point Estimate**	**50th Percentile 1-D Monte Carlo**	**50th Percentile MEE**
Hazard Index - Adult						
Fish Consumption, Primary Study Area (Reaches 5 & 6)	230	120	130	33	10	13
Fish Consumption, Rising Pond (Reach 8)	150	83	83	22	7.1	8.4
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	18	10	10	2.6	0.85	1.0
Trout Consumption, West Cornwall Area (Reach 11)	18	12	13	3.1	1.0	1.3
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	13	7.0	7.2	1.9	0.60	0.73
Waterfowl Consumption	35	76	57	17	7.2	8.7
Hazard Index - Child						
Fish Consumption, Primary Study Area (Reaches 5 & 6)	550	260	270	76	23	26
Fish Consumption, Rising Pond (Reach 8)	360	180	180	51	15	18
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 & 12)	43	21	22	5.9	1.9	2.2
Trout Consumption, West Cornwall Area (Reach 11)	42	24	29	7.3	2.2	2.9
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	31	15	15	4.3	1.3	1.6
Waterfowl Consumption	81	140	120	39	15	17

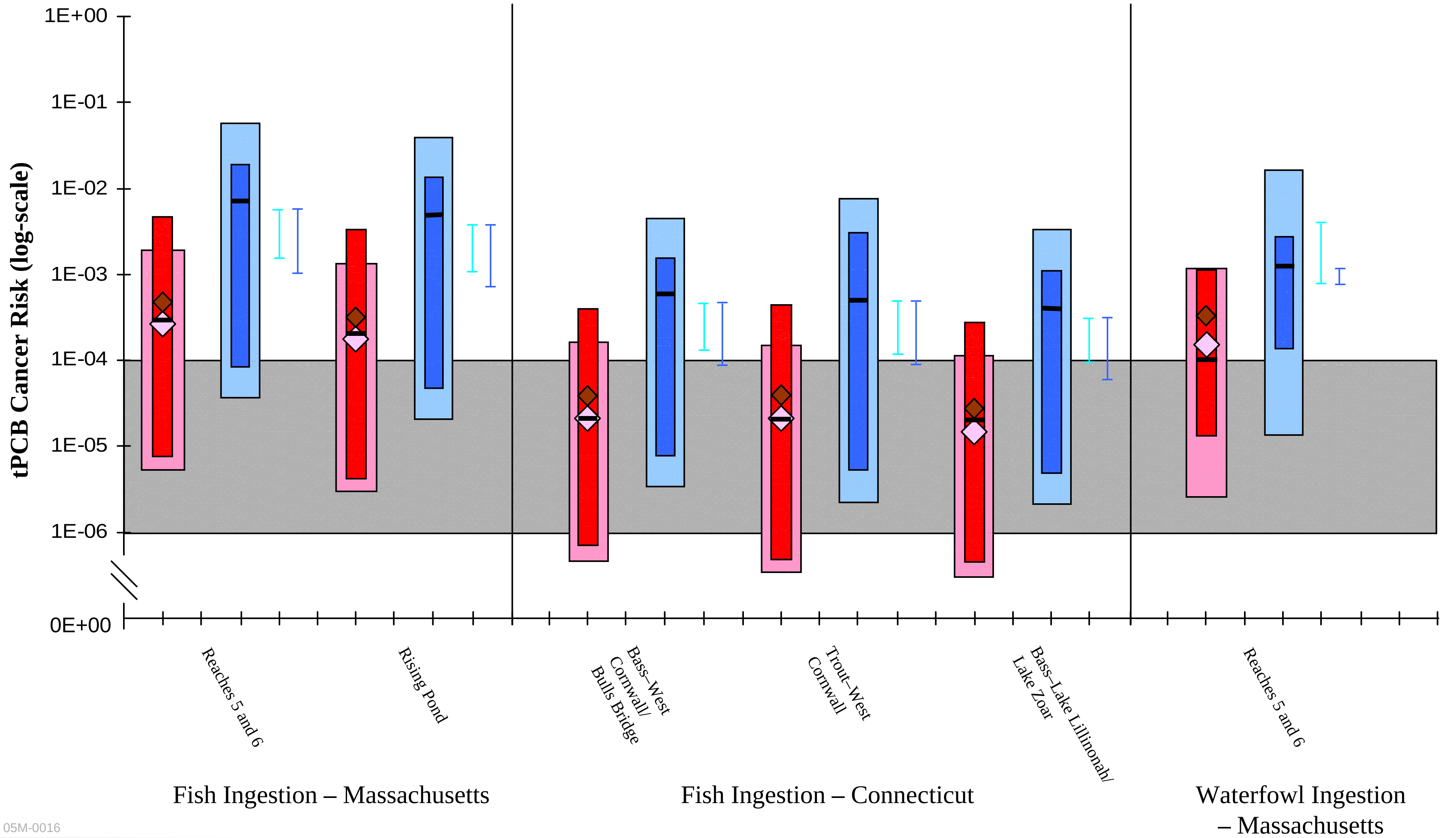
Figures ES-2 and ES-3 provide summaries of the tPCB and TEQ cancer risks calculated using the point estimate, Monte Carlo simulation, and probability bounds approaches and a comparison of these cancer risks and hazard quotients to the EPA risk range.

The red bars summarize the results for the central tendency exposures for each of the fish and waterfowl exposure locations, and the blue bars summarize the results for the RME exposures. EPA guidelines for cancer risks and noncancer hazards are noted by a gray shaded area and a gray line, respectively.

Using Figure ES-2 as an example, the red diamonds represent the median (50th percentile) cancer risk calculated using the one-dimensional Monte Carlo simulation (light red) and the MEE simulation (dark red). The black horizontal lines (on the red bars) represent the point estimate results for the CTE. For example, the central tendency cancer risk from tPCB due to consumption of fish caught in Reaches 5 and 6 is 3E-04 for both the point estimate CTE and the median of the one-dimensional Monte Carlo simulation. The median of the MEE simulation indicates a higher cancer risk. The light and dark bands of red correspond to the uncertainty around the median of the one-dimensional and MEE Monte Carlo simulations, respectively, that was calculated in the probability bounds analysis.

EPA guidance (EPA, 2001) suggests risk managers select the RME from the upper (i.e., 90th to 99.9th) percentiles of risk when using a probabilistic assessment. The blue vertical lines represent the RME risk range calculated using the one-dimensional Monte Carlo simulation (light blue) and the MEE simulation (dark blue). The black horizontal lines (on the blue bars) represent the point estimate results for the RME. The light and dark bands of blue correspond to the uncertainty surrounding the high-end percentiles of the one-dimensional and MEE Monte Carlo simulations, respectively, calculated with probability bounds analysis.

Excess lifetime cancer risks and noncancer hazards associated with the consumption of fish and waterfowl are considerably higher than the acceptable risk range.

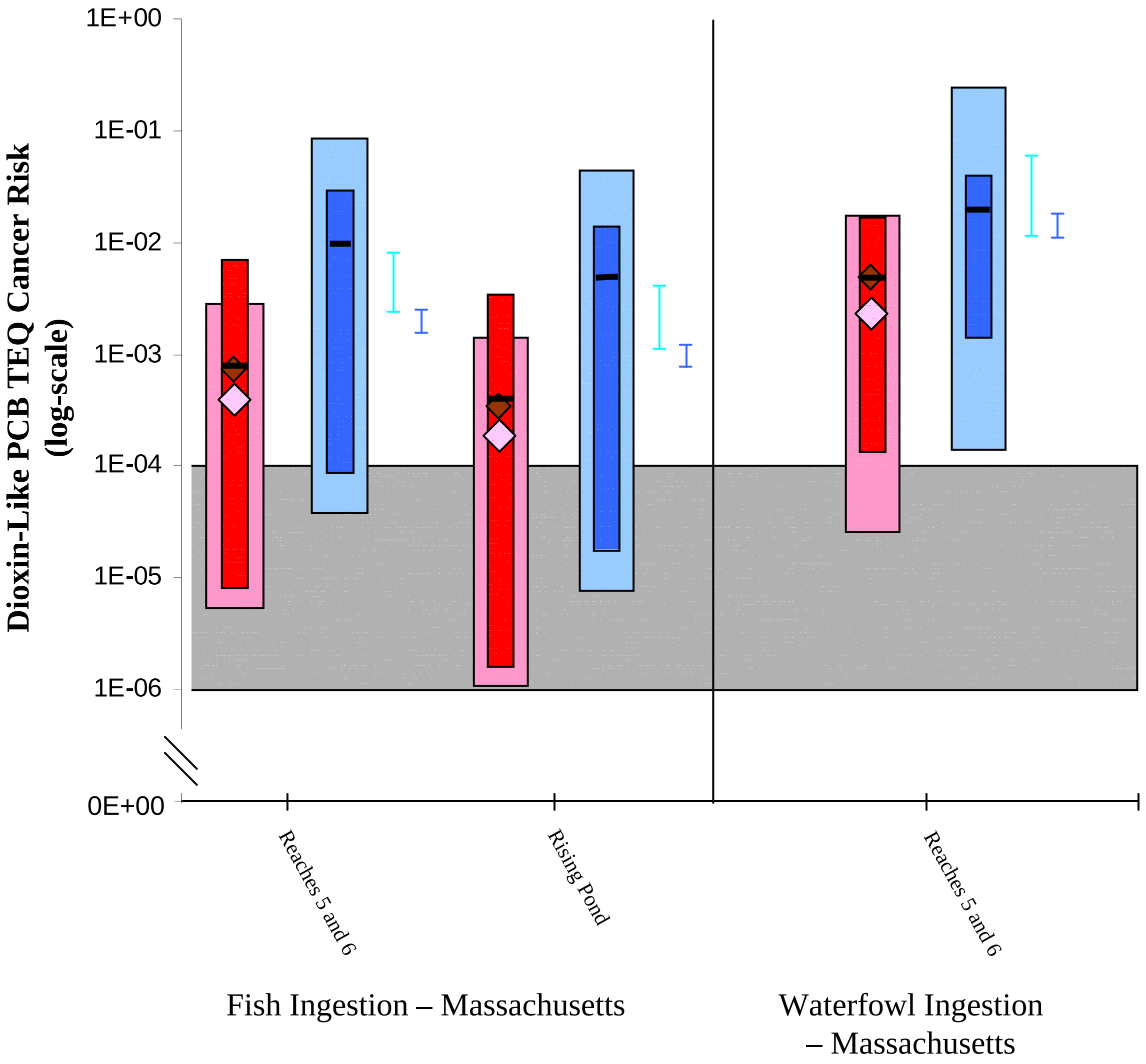


▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
▭ = Median calculated with one-dimensional probability bounds analysis.
▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
▭ = RME range calculated with one-dimensional probability bounds analysis.
▨ = EPA risk range (1E-06 to 1E-04).

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure ES-2
Relationship Between Point Estimate, Monte Carlo, and Probability Bounds Analyses for tPCB Cancer Risk from Fish and Waterfowl Consumption

MK01\O:\20123001.096\HHRA_FNL_FW\FW_FNL es-2 to es-5.ppt



05M-0016

▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
🟪 = Median calculated with one-dimensional probability bounds analysis.

▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
🟦 = RME range calculated with one-dimensional probability bounds analysis.
⬜ = EPA risk range (1E-06 to 1E-04).

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure ES-3
Relationship between Point Estimate, Monte Carlo, and Probability Bounds Analyses for Dioxin-Like PCB TEQ Cancer Risk from Fish and Waterfowl Consumption

MK01\O:\20123001.096\HHRA_FNL_FW\FW_FNL es-2 to es-5.ppt

Total PCB Cancer Risks—Fish consumption tPCB cancer risks calculated with the point estimate RME and in the RME range (the 90th to 99th percentile) of both the one-dimensional and MEE Monte Carlo simulations are above the upper end of the EPA risk range for all locations. The Monte Carlo simulations represent best estimates of the risk at the specified percentile, given that the assumptions about the parameter values and specified models are reasonable. In Massachusetts reaches, the cancer risks from tPCB RME risks generally exceed the upper end of the EPA risk range (1E-04), even if all the uncertainty associated with the data and models is taken into account. However, if all the uncertainty in the input values or parameterizations that produced the least risk were combined simultaneously and were "true," a combination that has a low probability, the uncertainty associated with the one-dimensional Monte Carlo model indicates that the risks could be between 1E-04 and 1E-05. In the similarly unlikely event that the input values and parameterizations that produced the highest risk were simultaneously correct, the cancer risk could be as high as 6E-02 at the 99th percentile.

A comparison of the tPCB cancer risks calculated with the point estimate CTE and the 50th percentile of the Monte Carlo simulations indicate that the "best estimate" central tendency risks for tPCB in Reaches 5 and 6 and in Rising Pond are above the EPA risk range, whereas the "best estimate" central tendency risks for tPCB in West Cornwall, Bulls Bridge, and Lakes Lillinonah and Zoar are in the risk range. The probability bounds analyses indicate that when all of the uncertainty around the median is included, the tPCB cancer risks in the Massachusetts reaches may be substantially above (between 1E-03 and 1E-02) to within the EPA risk range (between 1E-05 and 1E-06). The uncertainty bounds associated with the central tendency risks in West Cornwall and the lower reaches straddle the risk range.

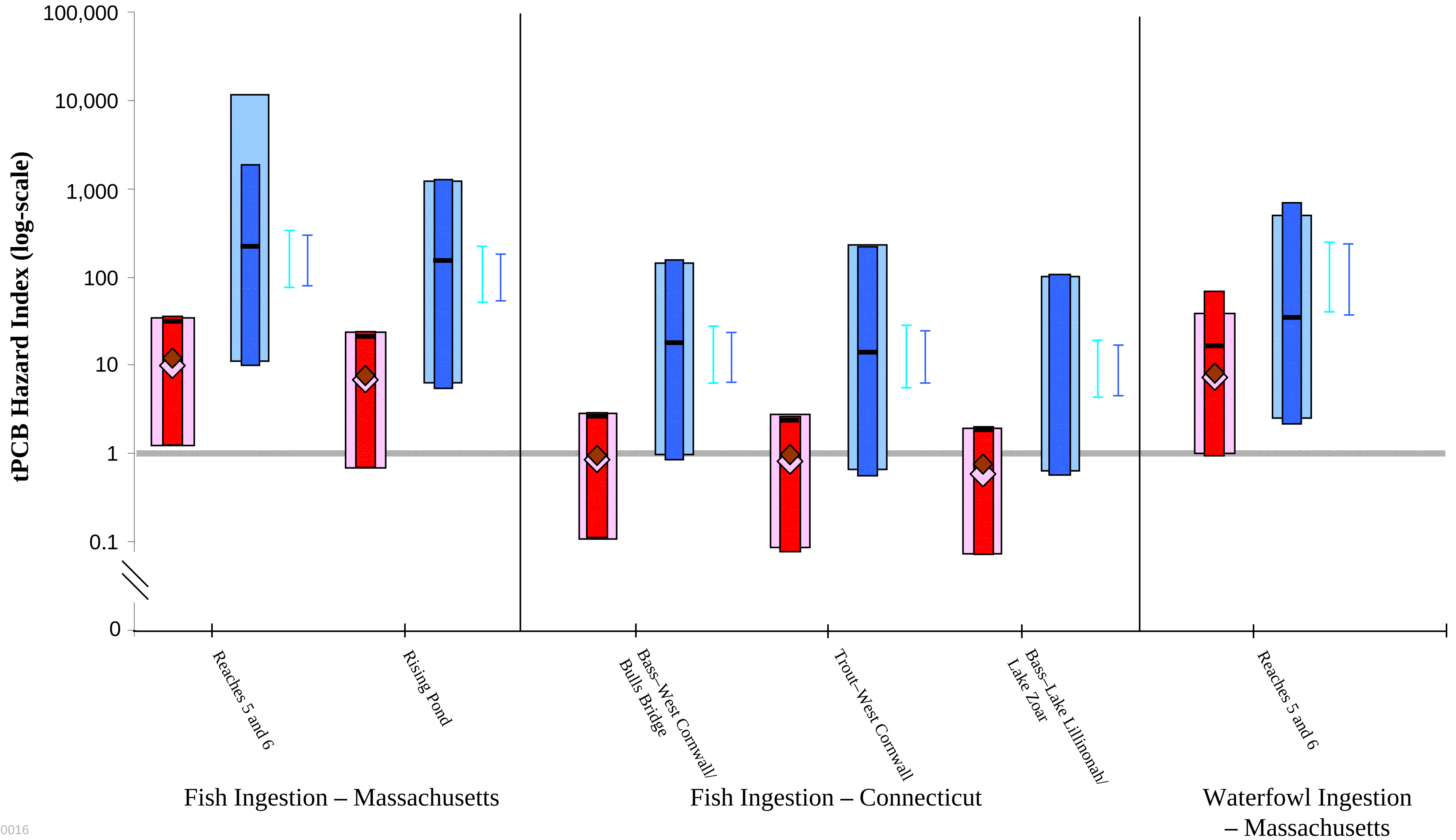
The final two bars on Figure ES-2 summarize the range of tPCB cancer risks due to waterfowl ingestion. As with fish ingestion, the RME tPCB cancer risk estimates are above the EPA risk range in the point estimate and both Monte Carlo simulations. The uncertainty around the RME range for the one-dimensional Monte Carlo simulation ranges from a high of 2E-02 at the 99th percentile to a low of 1E-05 for the 90th percentile. In the MEE model, even the low end of the uncertainty at the 90th percentile is 1E-04, the upper bound of the EPA risk range. The central tendency tPCB cancer risks based on the CTE and Monte Carlo simulations are 1E-04 or higher.

Accounting for all of the uncertainty, the results indicate that the central tendency risk could be greater than 1E-03 or less than 1E-05.

TEQ Cancer Risks—Figure ES-3 shows the cancer risk results for TEQ. The dioxin-like PCB TEQ cancer risks based on the fish consumption point estimate RME and the 90th to 99th percentiles of both Monte Carlo simulations are above the upper end of the EPA risk range. If all the uncertainty in the input values or parameterizations that produced the least risk were combined simultaneously and were "true," a combination that has a low probability, the uncertainty associated with the one-dimensional Monte Carlo model indicates that the risks could be between 1E-04 and 1E-05. In the similarly unlikely event that the input values and parameterizations that produced the highest risk were simultaneously correct, the cancer risk could be as high as 3E-02 at the 99th percentile. The dioxin-like PCB TEQ cancer risks calculated with the point estimate CTE and the 50th percentile of the Monte Carlo simulations indicate that the central tendency risks are also greater than the upper end of the EPA risk range. The probability bounds analyses indicate that when all of the uncertainty in input values, parameterizations, and models around the median is included, the TEQ cancer risk estimate could be as high as 7E-03 to as low as 5E-06 for Reaches 5 and 6.

The final two bars in Figure ES-3 summarize the range of dioxin-like PCB TEQ cancer risks due to waterfowl ingestion. As with fish ingestion, the RME TEQ cancer risk estimates are above the EPA risk range in the point estimate and both Monte Carlo simulations. The central tendency risk estimates are also above the upper end of the cancer risk range; however, the lower bound of the uncertainty around the central tendency risks for the one-dimensional Monte Carlo simulation may be within above the EPA cancer risk range.

Hazard Indices—Figures ES-4 and ES-5 summarize the noncancer hazard results for adults and children, respectively. The tPCB HIs based on both the adult and child fish consumption point estimate and Monte Carlo simulations for high-end receptors are above the EPA benchmark of 1 for all locations. For children at all locations, the uncertainty analyses for both Monte Carlo simulations indicate that the EPA benchmark is exceeded even at the 90th percentile of the distribution, and in the unlikely event that the input values and parameterizations that produced the lowest risk are simultaneously correct. In the Massachusetts



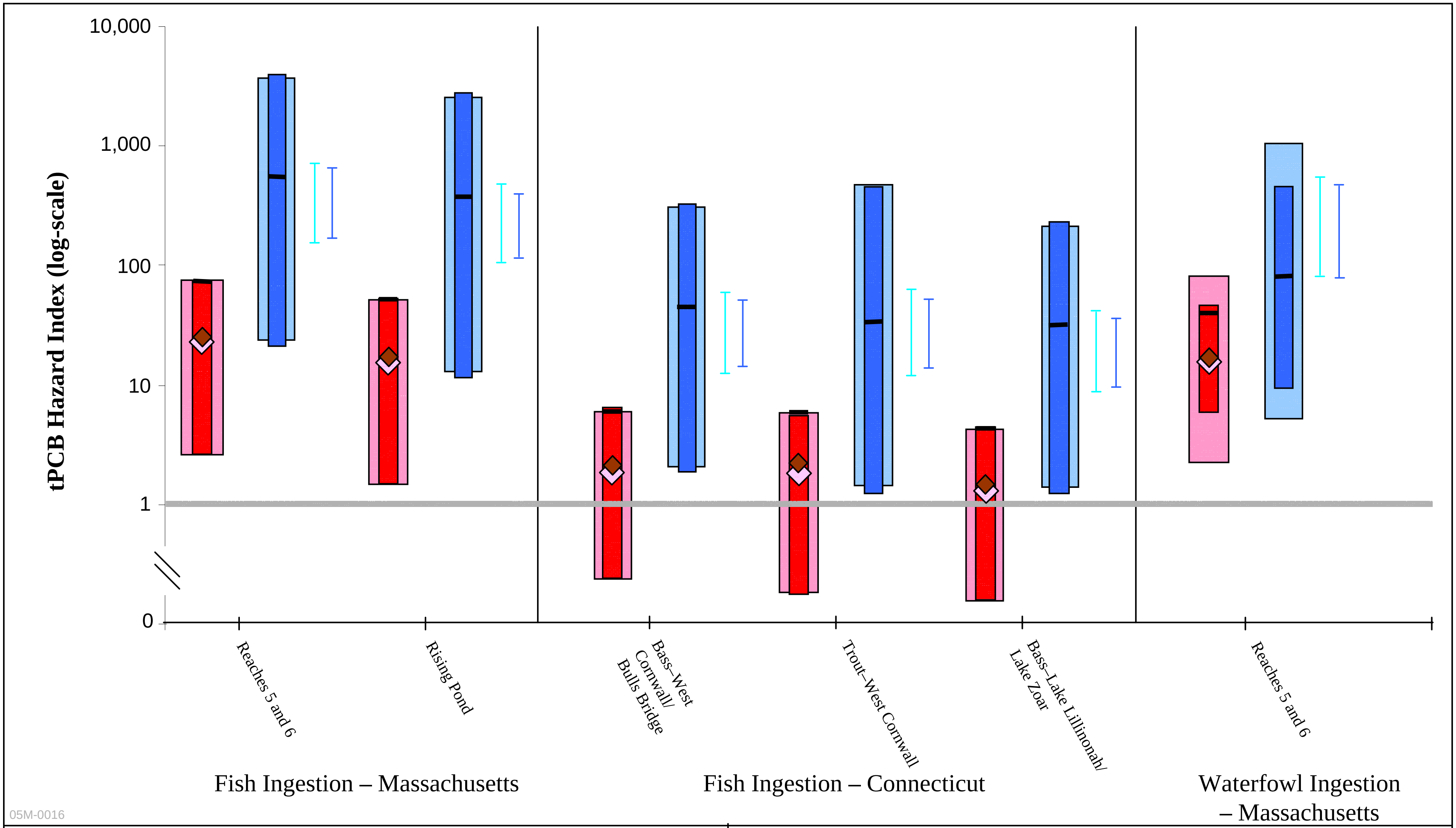
▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
▭ = Median calculated with one-dimensional probability bounds analysis.

▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
▭ = RME range calculated with one-dimensional probability bounds analysis.
▬ = EPA hazard benchmark

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure ES-4
Relationship Between Point Estimate, Monte Carlo, and Probability Bounds Analyses for tPCB Hazard Indices from Fish and Waterfowl Consumption by Adults

MK01\O:\20123001.096\HHRA_FNL_FW\FW_FNL es-2 to es-5.ppt



▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
▭ = Median calculated with one-dimensional probability bounds analysis.
▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
▭ = RME range calculated with one-dimensional probability bounds analysis.
▬ = EPA hazard benchmark

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure ES-5
Relationship Between Point Estimate, Monte Carlo, and Probability Bounds Analyses for tPCB Hazard Indices from Fish and Waterfowl Consumption by Children

reaches, HIs for central tendency child receptors (50th percentile of the Monte Carlo distributions) exceed the benchmark of 1, even when all the uncertainty is considered. In Connecticut reaches, Monte Carlo simulations indicate that the adult central tendency receptors have HIs near 1, whereas the child central tendency receptors have HIs of 1 to 3, above the EPA risk range. Including the uncertainty in all the input values, parameterization and models, the HI for central tendency receptors in Connecticut may be above or below the EPA benchmark of 1.

The final two bars on Figures ES-4 and ES-5 summarize the noncancer hazards due to waterfowl ingestion. Both the high-end and central tendency HIs for children and adults are above the EPA benchmark of 1, even if all the uncertainty in the input values or parameterizations that produced the least risk were combined simultaneously.

UNCERTAINTY ANALYSIS

EPA policy and guidance (EPA, 1995) recommend that a thorough discussion of the variability and uncertainty surrounding the calculation of risk be provided to inform decisionmakers when considering risk management alternatives. This risk assessment used multiple approaches to characterize the variability and uncertainty:

- Point estimate calculations of both reasonable maximum exposure (RME) and central tendency exposure (CTE).
- Monte Carlo simulations to characterize variability in risks, providing estimates of both a CTE and an RME range (i.e., 90th to 99.9th percentiles).
- Probability bounds analysis to quantify uncertainty in the risk assessment modeling assumptions, including the derivation of point estimates and probability distributions.
- Sensitivity analyses to identify the contribution of individual exposure parameters to variability and uncertainty.
- Qualitative discussion describing sources of uncertainty in the underlying data, the selection of parameter values, and modeling assumptions.
- Bounding analyses based on the point estimate approach to characterize higher risk behaviors that are not occurring at this time.

MAJOR FINDINGS

The major findings of the Fish and Waterfowl Consumption Risk Assessment include the following:

- For the fish and waterfowl consumption scenarios, the cancer risks from tPCBs exceed EPA's risk range in all of the exposure areas. The cancer risks from TEQ exceed EPA's risk range in all exposure areas for which TEQ is evaluated.
- Cancer risks from tPCB and TEQ for high end (RME) receptors are similar (within a factor of two) to each other for the fish consumption scenarios in which both COPCs were evaluated (Primary Study Area [Reaches 5 and 6]) and Rising Pond (Reach 8).
- Cancer risk from TEQ exceeds risk from tPCBs for the waterfowl consumption scenario.
- For the fish consumption scenarios, the noncancer hazard benchmark for adults and children was exceeded at all locations, by factors between 22 and 550 in Massachusetts, and by factors between 2 and 43 in Connecticut.
- For the waterfowl consumption scenarios, the noncancer hazard benchmark for adults and children was exceeded by factors between 7 and 80.
- Consumption of fish and waterfowl from the vicinity of Woods Pond contributes significant risk for individuals who both hunt and fish.
- A sensitivity analysis shows the consumption rates for fish and waterfowl have a greater influence on the risk than any other exposure variable. These consumption rates are considered reasonable and conservative estimates of future activity.

1. INTRODUCTION

1.1 OVERVIEW

The Housatonic River flows from north of Pittsfield, MA, to Long Island Sound and drains an area of approximately 1,950 square miles (500,000 hectares) in Massachusetts, New York, and Connecticut. The Housatonic River, its sediment, and associated floodplain have been contaminated with polychlorinated biphenyls (PCBs) and other hazardous substances released from the General Electric Company (GE) facility located in Pittsfield, MA. The entire site, known as the General Electric/Housatonic River Site, consists of the 254-acre (103-hectare) GE manufacturing facility; the Housatonic River and associated riverbanks and floodplains from Pittsfield, MA, to Long Island Sound; former river oxbows that have been filled; neighboring commercial properties; Allendale School; Silver Lake; and other properties or areas that have become contaminated as a result of GE's facility operations.

Because of its size and complexity, the GE/Housatonic River Site has been divided into several areas for investigation and cleanup. This report provides a comprehensive Human Health Risk Assessment (HHRA) for the portion of the site known as the Rest of River. The Rest of River extends from the confluence of the East and West Branches of the Housatonic River (the confluence) to the Massachusetts border with Connecticut, a distance of approximately 54 miles (87 km), and beyond into Connecticut to Long Island Sound. The total distance from the confluence to Long Island Sound is approximately 139 miles (224 km). In addition to the river proper, the Rest of River includes the associated riverbank and floodplain.

In September 1998, a comprehensive agreement was reached between GE and various governmental entities, including the U.S. Environmental Protection Agency (EPA), the Massachusetts Department of Environmental Protection (MDEP), the U.S. Department of Justice (DOJ), the Connecticut Department of Environmental Protection (CTDEP), and the City of Pittsfield. The agreement provides for the investigation and cleanup of the Housatonic River and associated areas. The agreement has been documented in a Consent Decree between all parties that was entered by the court in October 2000. Under the terms of the Consent Decree, EPA conducted the human health and ecological risk assessments, and is conducting a modeling study of PCB transport and fate for the Housatonic River below the confluence of the East and West Branches (Rest of River) and the surrounding watershed.

The Rest of River is defined in the Consent Decree as follows:

- "Between the confluence of the East and West Branches of the River and Woods Pond Dam, the Rest of the River generally includes the Housatonic River and its sediment, as well as its floodplain (except for Actual/Potential Lawns) extending laterally to the approximate 1 ppm PCB isopleth."
- "Downstream of Woods Pond Dam, the Rest of the River shall include those areas of the River and its sediment and floodplain (except for Actual/Potential Lawns) at which Waste Materials originating at the GE Plant Area have come to be located and which are being investigated and/or remediated pursuant to this Consent Decree."

Between the confluence and Woods Pond Dam, the 1-ppm tPCB isopleth is approximately equivalent to the 10-year floodplain, based on information in the RCRA Facility Investigation (RFI) (BBL, 1996; BBL and QEA, 2003). Downstream of Woods Pond Dam, the Rest of River is approximated by the 100-year floodplain. The 10-year floodplain and 1-ppm tPCB isopleth have not been delineated downstream of Woods Pond Dam.

The Consent Decree also includes specific language that requires the risk assessments and components of the modeling studies to be submitted for formal Peer Review. The Human Health Risk Assessment (HHRA) was submitted for Peer Review in June 2003. The Peer Review was conducted in November 2003, and EPA issued a Responsiveness Summary in March 2004. This final HHRA reflects the comments from the Peer Review Panel.

The HHRA consists of seven volumes. The first volume provides a comprehensive summary of the potential risks to human health associated with contamination in the Rest of River portion of the GE/Housatonic River Site for all exposure pathways, including direct contact with soil and sediment, consumption of fish and waterfowl from the river, and consumption of agricultural products (both plant and animal) grown on the floodplain. The six remaining volumes are appendices that provide the details of the assessment conducted for each exposure pathway.

1.2 SITE HISTORY

The Housatonic River is located in a predominantly rural area of western Massachusetts and Connecticut, where farming was the main occupation from colonial settlement through the late 1800s. As with most rivers, the onset of the industrial revolution in the late 1800s brought manufacturing to the banks of the Housatonic River in Pittsfield, MA. GE began its operations in its present location in 1903. Three manufacturing divisions have operated at the GE facility (Transformer, Ordnance, and Plastics).

The 254-acre GE facility in Pittsfield has historically been the major handler of PCBs in western Massachusetts, and is the only known source of PCBs found in the Housatonic River sediment and floodplain soil in Massachusetts. Although GE performed many functions at the Pittsfield facility throughout the years, the activities of the Transformer Division, including the construction and repair of electrical transformers using dielectric fluids, some of which contained PCBs (primarily Aroclors 1260, and to a lesser extent, 1254), were one likely significant source of PCB contamination. According to GE's reports, from 1932 through 1977, releases of PCBs reached the wastewater and stormwater systems associated with the facility and were subsequently conveyed to the East Branch of the Housatonic River and to Silver Lake, a 25-acre lake adjacent to the GE facility.

During the 1940s, efforts to straighten the Pittsfield reach of the Housatonic River by the City of Pittsfield and the U.S. Army Corps of Engineers (USACE) resulted in 11 former oxbows being isolated from the river channel. The oxbows were filled with material, some of which was later discovered to contain PCBs and other hazardous substances.

The State of Connecticut posted a fish consumption advisory for most of the Connecticut section of the river in 1977 as a result of the PCB contamination in the river sediment and fish tissue. In 1982, the Massachusetts Department of Public Health (MDPH) issued a consumption advisory for fish, frogs, and turtles for the Housatonic River. In addition, in 1999, MDPH issued a waterfowl consumption advisory from Pittsfield to Great Barrington due to PCB concentrations in wood ducks and mallards collected from the river by EPA.

Although a portion of the first 2 miles downstream from the facility was historically channelized, the river's course is relatively unaffected (with the exception of the several dams downstream) in areas south of Pittsfield. The river, from the confluence of the East and West Branches of the Housatonic to Woods Pond Dam in Lenox, is 10.7 miles long. The channel in this area is commonly 60 to 90 ft wide (and is occasionally as narrow as 40 ft or as wide as 125 ft), is bordered by extensive floodplain (up to 3,600 ft wide), and has a meandering pattern with numerous oxbows and backwaters. Woods Pond, the first impoundment downstream of the GE facility, is a shallow 54-acre impoundment that was formed by the construction of a dam in the late 1800s.

The land uses of the floodplain properties in Massachusetts include residential, commercial/industrial, agricultural, recreational (such as canoeing, fishing, and hunting), wildlife management, and parks and a golf course. The Housatonic River floodplain is an attractive area for recreation, including fishing and waterfowl hunting.

Numerous studies conducted since 1988 have documented PCB contamination of soil within the floodplain of the Housatonic River downstream of the GE facility. PCBs originating from the GE facility in Pittsfield have been detected in river sediment in Massachusetts as far downstream as the border with Connecticut (BBL, 1996), and in Connecticut as far as the Derby Dam and beyond into Long Island Sound (other sources have been identified downstream of this dam). PCBs detected in Housatonic River floodplain soil and sediment consist of predominantly Aroclor 1260, with a minor contribution of Aroclor 1254.

Contaminants released from the GE facility entered the Housatonic River and its sediment via surface water runoff, riverbank soil erosion, and contaminated groundwater (primarily as a non-aqueous phase liquid [NAPL] plume). Contaminants were transported downstream to the Rest of River as three distinct phases: freely dissolved, bound to particulates, and bound to dissolved organic carbon (DOC). Floodplain soil in the Rest of River became contaminated during flooding events when contaminated sediment suspended in the floodwaters was deposited onto the floodplain.

As discussed above, the Rest of River encompasses the Housatonic River and its associated floodplain from the confluence of the East and West Branches downstream to Long Island

Sound. To simplify the description of the Rest of River evaluation, reaches of the river were designated. Figures 1-1 through 1-4 present an overview of the Rest of River and the reach designations. The 13 reaches are described below:

- ***Reach 5*** **–** From the confluence of the East and West Branches to the Woods Pond headwaters.
- ***Reach 6*** **–** Woods Pond impoundment.
- ***Reach 7*** **–** From Woods Pond Dam to the upstream extent of the Rising Pond impoundment.
- ***Reach 8*** **–** Rising Pond impoundment.
- ***Reach 9*** **–** From Rising Pond Dam to the Massachusetts/Connecticut border.
- ***Reach 10*** **–** From the Massachusetts/Connecticut border to the Great Falls Dam.
- ***Reach 11*** **–** From Great Falls Dam to Cornwall Bridge.
- ***Reach 12*** **–** From Cornwall Bridge to Bulls Bridge Dam.
- ***Reach 13*** **–** From Bulls Bridge Dam to Bleachery (New Milford) Dam.
- ***Reach 14*** **–** From Bleachery Dam to Shepaug Dam (Lake Lillinonah).
- ***Reach 15*** **–** From Shepaug Dam to Stevenson Dam (Lake Zoar).
- ***Reach 16*** **–** From Stevenson Dam to Derby Dam (Lake Housatonic).
- ***Reach 17*** **–** From Derby Dam to Long Island Sound.

1.3 RISK ASSESSMENT OVERVIEW

The human health risk assessment (HHRA) represents an important component of EPA’s Supplemental Investigation of the Rest of River, along with the Ecological Risk Assessment and Modeling Study. The HHRA provides the following:

- A characterization of the potential human health risks under baseline conditions (i.e., no action) for current and future uses,
- A basis for determining the need for remedial actions, and
- A basis for setting media protection goals for contaminants of concern.

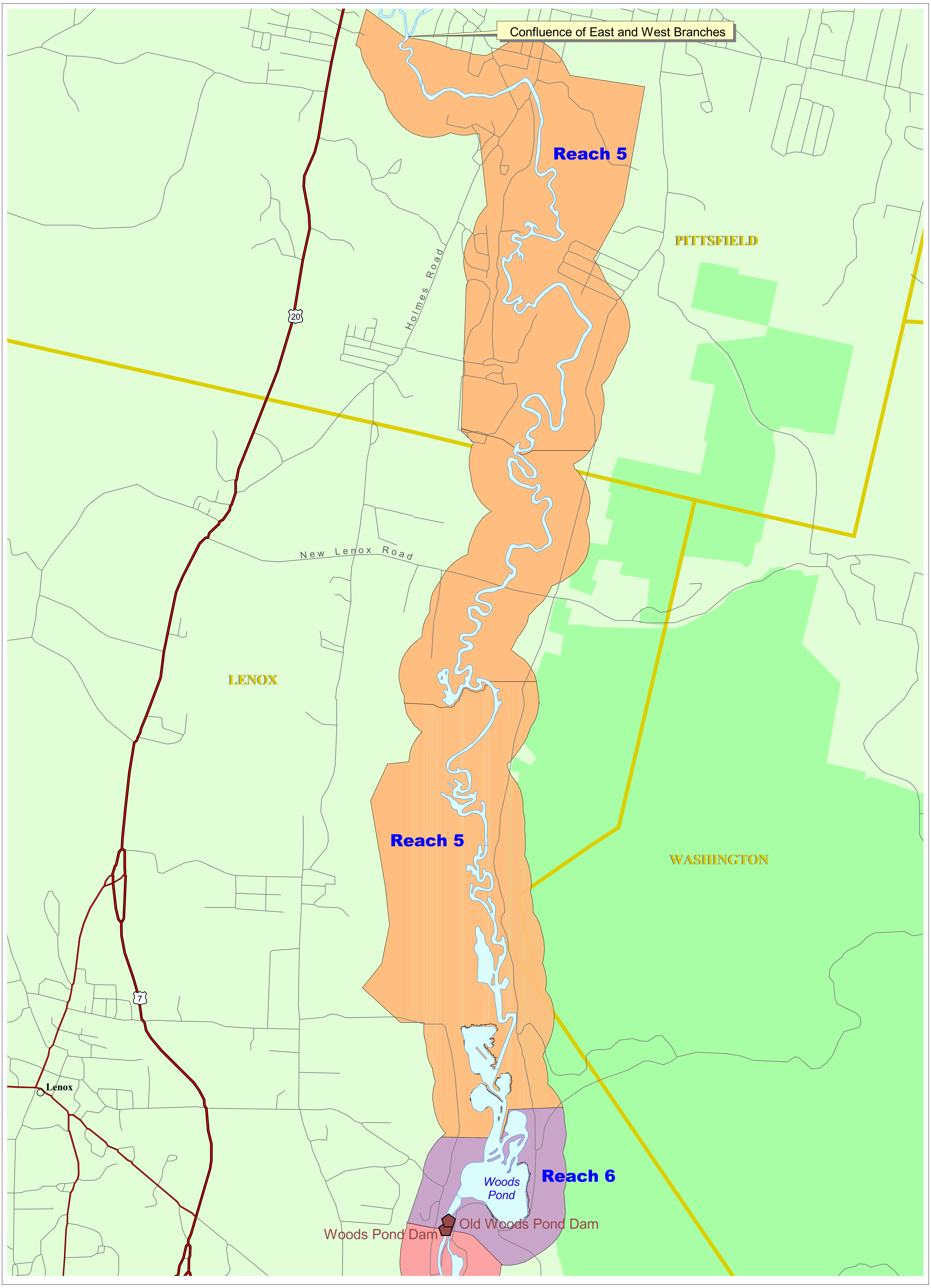
Figure 1-5 presents the conceptual site model (CSM) for the HHRA. The CSM depicts the pathways from the source of contamination through the various environmental media to exposure to individuals categorized by activity and age group.

This report, Consumption of Fish and Waterfowl Risk Assessment (Appendix C), is part of the overall Human Health Risk Assessment, which consists of the HHRA report and four technical appendices (Appendices A through D). These appendices provide detailed evaluations of the risk to individuals who may come in contact with contaminants in the Housatonic River and associated floodplain by direct contact with soil and sediment, and by eating fish and waterfowl, locally raised crops, locally produced animal products, and edible wild plants.

The other technical appendices are:

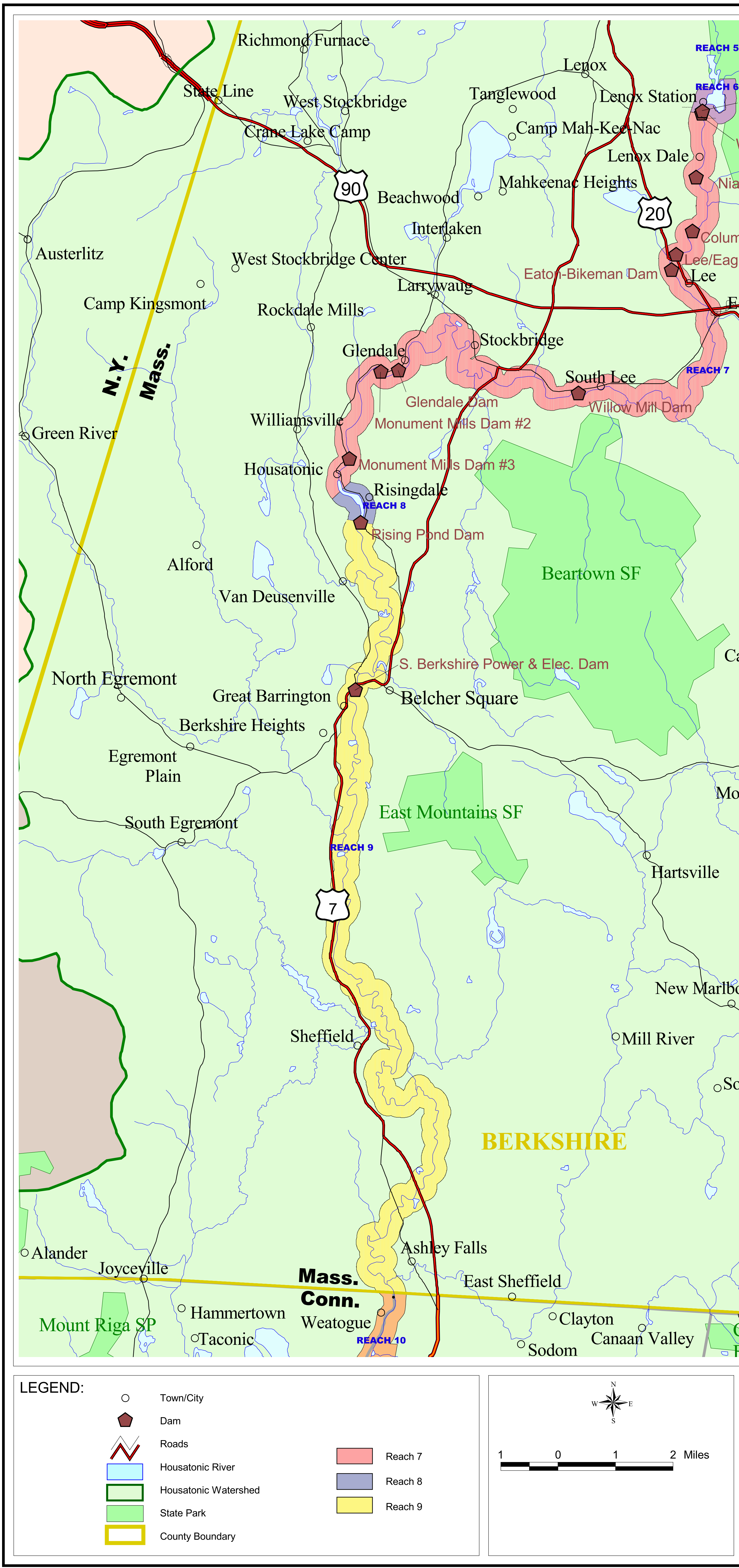
- ***Appendix A - Phase 1 Direct Contact Screening Risk Assessment (Volumes IIA and IIB) –*** This appendix presents the conservative screening analysis of the potential risks from direct contact (ingestion and dermal contact) exposure to PCB-contaminated soil and sediment throughout the Rest of River. Risk-based screening levels were developed for several different land uses. Land use was determined for tax parcels or groups of tax parcels, where appropriate. Soil and sediment areas that had PCB concentrations below the screening criteria were eliminated from further evaluation. Soil and sediment areas that had PCB concentrations greater than the screening criteria were identified and evaluated more fully in the Phase 2 Direct Contact Risk Assessment.

- ***Appendix B - Phase 2 Direct Contact Risk Assessment (Volumes IIIA and IIIB)–*** This report provides risk assessments for all soil and sediment areas in which the PCB concentrations exceeded the screening criteria used in Appendix A. Although all contaminants of potential concern (COPCs) were included in the hazard identification, PCBs and polychlorinated dioxins and furans were retained for evaluation in the Phase 2 report. The exposure scenarios included residential, commercial/industrial, agricultural, and a variety of recreational scenarios. Assumptions regarding current and future expected use patterns, particularly use patterns that would be reasonably expected in the absence of the known contamination, were incorporated into the exposure assessment. Probabilistic exposure analyses of the recreational scenarios are also included.



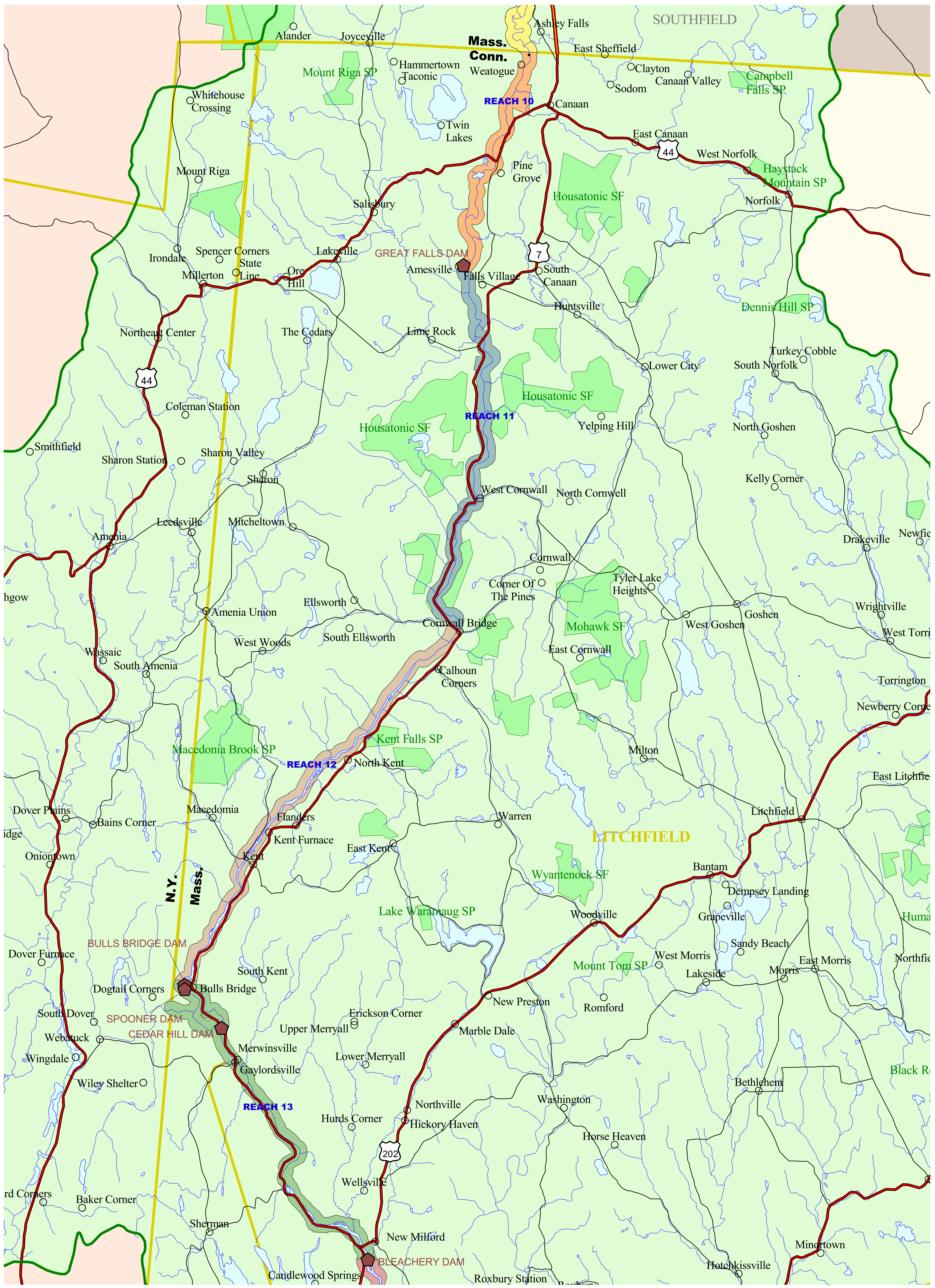
Fish and Waterfowl Consumption
Risk Assessment
GE/Housatonic River Site
Rest of River

FIGURE 1-1
PRIMARY STUDY AREA



Fish and Waterfowl Consumption
Risk Assessment
GE/Housatonic River Site
Rest of River

FIGURE 1-2
REACHES 7 TO 9



LEGEND:

○ Town/City

⬟ Dam

Roads

Housatonic River

🟩 State Park

County Boundary

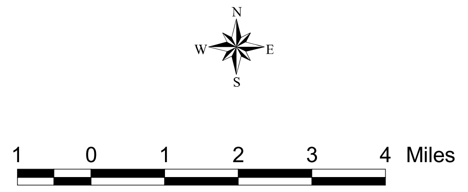
Housatonic Watershed

🟧 Reach 10

Reach 11

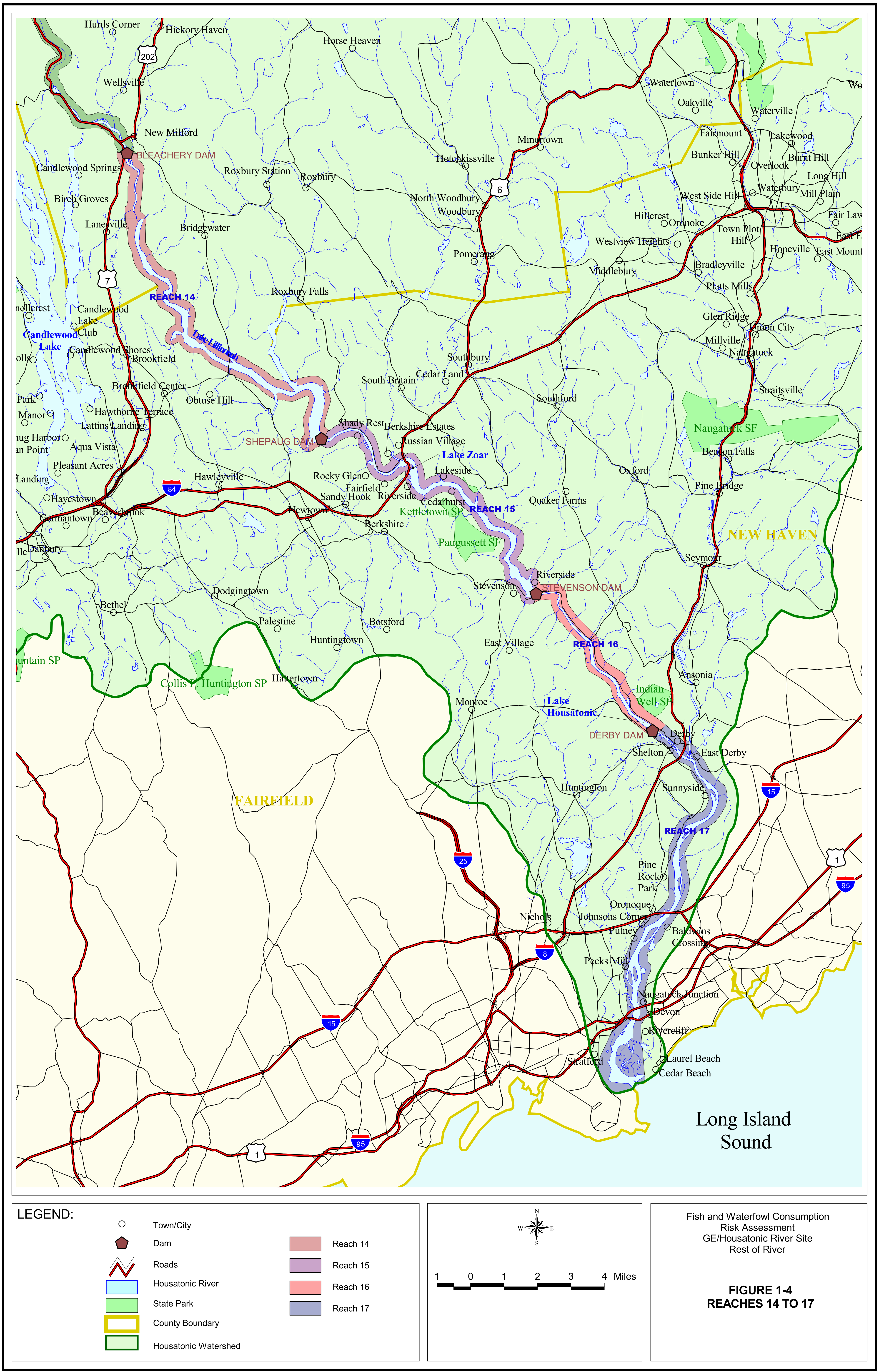
Reach 12

🟩 Reach 13



Fish and Waterfowl Consumption
Risk Assessment
GE/Housatonic River Site
Rest of River

FIGURE 1-3
REACHES 10 TO 13



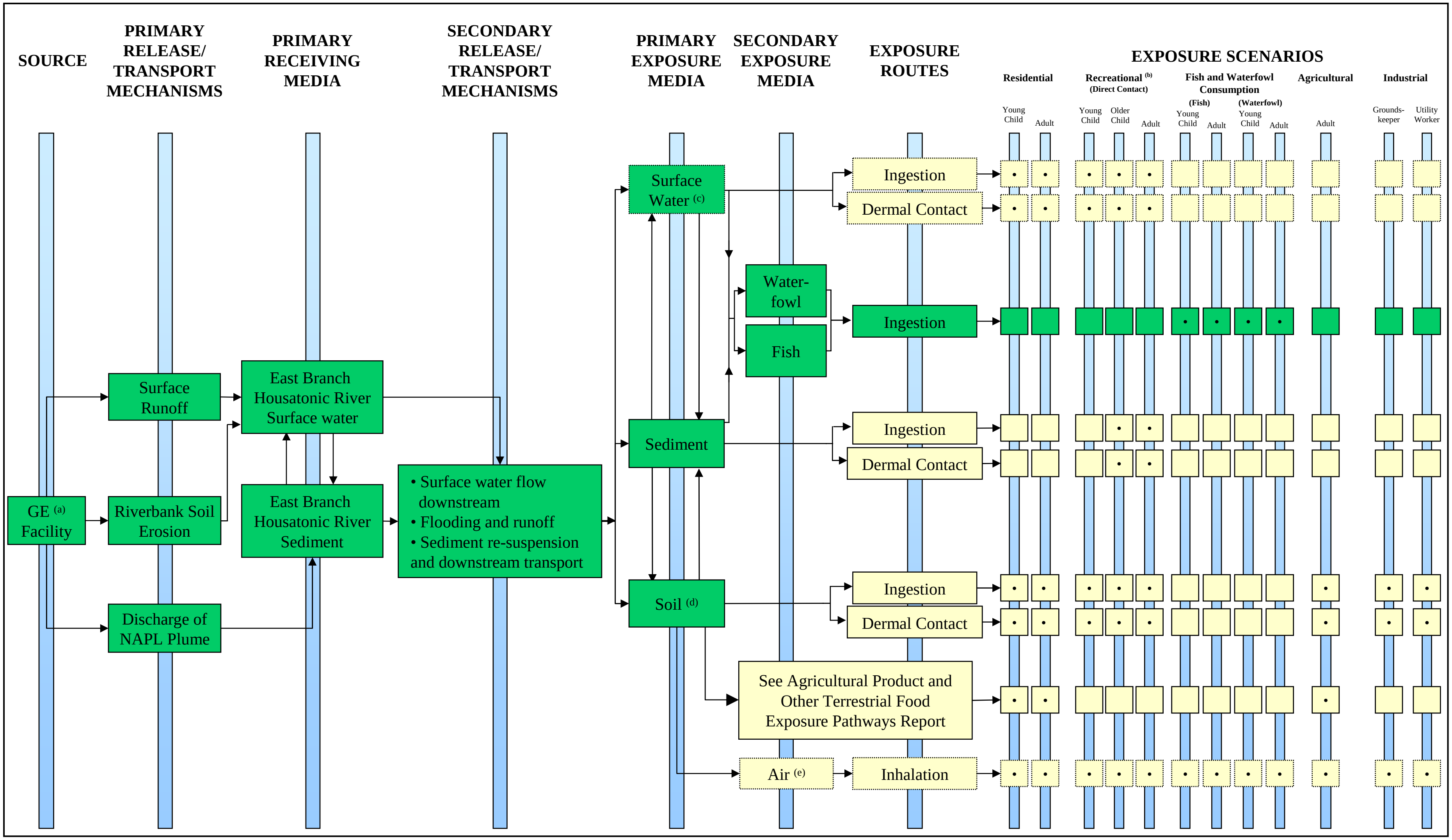
LEGEND:

- ○ Town/City
- ⬟ Dam
- Roads
- Housatonic River
- 🟩 State Park
- County Boundary
- Housatonic Watershed
- Reach 14
- Reach 15
- Reach 16
- Reach 17

Fish and Waterfowl Consumption
Risk Assessment
GE/Housatonic River Site
Rest of River

FIGURE 1-4
REACHES 14 TO 17

| o:\gepitt\aprs\fish_waterfowl_figs.apr | layout - fig 1-4 | o:\gepitt\epsfiles\plots\in\fw1-4.eps | 9:22 AM, 4/8/2003 |



• = Complete exposure pathway

☐ = Incomplete exposure pathway

⬚ = Not evaluated quantitatively.

🟩 = Pathways of concern.

NAPL = nonaqueous phase liquid.

(a) = Includes all facility-related sources such as site soils, Unkamet Brook, Silver Lake, former oxbows, fill areas, etc.

(b) = There are seven variations of the recreational scenario, including: general recreation, ATV/dirt and mountain biker, marathon canoeist, recreational canoeist, angler, waterfowl hunter, and sediment exposure. The scenario selected will depend on the medium and exposure area of concern being evaluated.

(c) = Chemical concentrations in surface water were compared to conservative, site-specific screening risk based concentrations (SRBCs) as an initial screening step. Results of the screening process indicated chemical concentrations in surface water below levels of human health concern. Thus, direct contact to surface water was not evaluated quantitatively.

(d) = Includes floodplain and riverbank soil.

(e) = Air sampling conducted at various points along the Lower River resulted in low concentrations of PCBs. An additional sampling and screening level risk assessment was performed. Results of the screening process indicated chemical concentrations in air below levels of human health concern. Thus, inhalation of air was not evaluated quantitatively.

Figure 1-5
Conceptual Site Model

Fish and Waterfowl
Consumption Risk Assessment
General Electric Housatonic River Site
Rest of River

MK01|O:\20123001.096\HHRA_FNL_FW\FW_FNL_1_fig1-5.ppt

- ***Appendix D - Agricultural Product Consumption Risk Assessment (Volume V)*** **–** This appendix provides point estimate and probabilistic risk assessments for the consumption of agricultural products, specifically milk, beef, poultry, eggs, and home gardens, based on both commercial and non-commercial (i.e., “backyard”) farming practices. It also includes a qualitative assessment of the risks from other food sources that may be contaminated by PCBs in floodplain soil, such as goats, edible wild plants, and deer. The assessment is based on agricultural activities that are occurring now or reasonably may occur in the future in the Massachusetts portion of the site.

1.4 OVERVIEW OF FISH AND WATERFOWL RISK ASSESSMENT (APPENDIX C)

This report provides quantitative point estimate and probabilistic risk assessments for the consumption of fish and waterfowl. Potential consumption of frogs and turtles is discussed qualitatively. Risks due to fish consumption were evaluated for locations in Massachusetts and Connecticut. Risks due to waterfowl consumption were evaluated only in Massachusetts, near the Pittsfield area. PCBs, polychlorinated dioxins and furans (PCDDs/PCDFs), and several organochlorine pesticides were included as COPCs. The consumption of fish and waterfowl such as ducks and geese is a particular concern because of the ability of contaminants such as PCBs and other persistent organic pollutants to bioaccumulate and biomagnify in animals. Biomagnification refers to the process by which contaminants such as PCBs accumulate in animal tissue in increasing concentrations as the contaminants transfer to higher concentrations in the food chain. PCBs accumulate in fat, edible tissue, and internal organs of lower trophic-level animals that contact and/or ingest water, sediment, and soil as part of their feeding habits, and then concentrate (biomagnify) even further in predators of these organisms.

The public awareness of the PCB contamination, in addition to the fish and duck consumption bans, has resulted in less recreational activity than if there were no consumption advisories (Connelly et al., 1992). Estimates of consumption rates in this risk assessment were based on the rates expected to occur if the river and the biota were not contaminated and in the absence of consumption advisories. This approach is consistent with EPA policy and guidance (EPA, 1990).

Even with the consumption advisories in place, the Housatonic River remains an attractive option for recreational fishing, and previous studies have shown that local residents have consumed fish taken from the river, either at some point in the past or fairly recently (MDPH, 1997; ChemRisk, 1994). Other information sources, such as interviews with anglers in the area, indicate that consumption of locally caught fish still takes place to some degree. Recent sampling efforts along the Massachusetts portion of the Housatonic River have shown that the river has a fishery that is capable of supporting a considerable amount of recreational fishing (WESTON, 2004). In addition, Massachusetts Division of Fisheries and Wildlife (MassWildlife) designated two catch and release areas in Reach 7 in 2004:

- From the Route 20 Bridge in Lee downstream to the Willow Mill Dam in South Lee.
- From the Glendale Dam downstream to the railroad bridge. MassWildlife began stocking trout in the Housatonic River in these areas in spring 2004.

For the fish consumption portion of the risk assessment, four areas were evaluated in the Rest of River:

- The Primary Study Area (PSA) – From the confluence of the East and West Branches of the Housatonic River to Woods Pond Dam (Reaches 5 and 6).
- Rising Pond in Great Barrington, MA (Reach 8).
- West Cornwall and Bulls Bridge, CT (Reaches 11 and 12)
- Lake Lillinonah and Lake Zoar, CT (Reaches 14 and 15).

PCB contamination was found in mallards and wood ducks collected by EPA and MassWildlife from the river in 1998 (MDPH, 1999). Both species breed and raise young in the wetlands adjacent to the main stem of the river. Although mallards are dabbling ducks and wood ducks are perching ducks, their diets are similar, in that the young of both species eat invertebrates almost exclusively, and more-mature individuals eat primarily plants and lesser quantities of invertebrates (Bellrose, 1980; Grice and Rogers, 1965). In addition to ducks, Canada geese are year-round residents on the Housatonic River (WESTON, 2004); adults and goslings were observed foraging in the river channel, backwaters, and adjacent uplands. Similar to mallards and wood ducks, Canada goose broods feed on invertebrates in the river and backwaters as young goslings and shift to consumption of macrophytes, emergent plants, and upland herbs in and near the river as they mature (Terres, 1980).

Because of the similarities in habitat use and foraging between the two duck species, for which site-specific data are available, and geese, this assessment is designed to represent individuals consuming any of these waterfowl. Duck tissue concentration data from the PSA were used for the evaluation of risk from consumption of waterfowl.

1.4.1 Point Estimate and Probabilistic Methodologies

Both point estimate and probabilistic methodologies were used in this risk assessment to characterize risk to individuals who consume fish and waterfowl. Both methodologies evaluated potential cancer risks and noncancer health effects to children and adults from fish consumption for each of the four separate areas and from waterfowl consumption from the PSA. In addition, both methodologies used the same site-specific and literature data for exposure parameters and toxicity factors.

The first part of this report focuses on the point estimate methodology, as it represents the methodology typically used by EPA to support risk management decisions on remediation of contaminated sites (EPA, 1989 and 1990). The probabilistic approach is described in detail, with all applicable calculations, in Section 6. The probabilistic risk assessment (PRA) provides a more complete quantitative characterization of the variability and uncertainty in the risk estimates that can be used in the decision-making process. A brief description of each methodology follows.

1.4.1.1 Point Estimate Approach

In the point estimate approach, a single value is selected for each parameter for the calculation of dose or intake, which in turn, is used to calculate risk. In accordance with EPA guidance (EPA, 1992), point estimate risks were calculated for two exposures in this assessment: the reasonable maximum exposure (RME) and the central tendency exposure (CTE). The RME is the greatest exposure that is reasonably expected to occur at a site and would be representative of a “high-end” risk (EPA, 1989). According to EPA (1992), “The high-end risk description is a plausible estimate of the individual risk for those persons at the upper end of the risk distribution. The intent of this description is to convey an estimate of risk in the upper range of the distribution, but to avoid estimates which are beyond the true distribution.” The CTE is the central tendency (i.e., average) exposure, which uses average exposure assumptions to yield an average risk to the individual (EPA, 1992). Both an RME and a CTE case were calculated for each exposure scenario. The point estimate approach does not provide detailed evaluations of the impact of variability and uncertainty.

1.4.1.2 Probabilistic Approaches

Two probabilistic risk assessment approaches were used to evaluate the uncertainty and variability associated with the point estimate of risk, Monte Carlo simulation and probability bounds. Uncertainty occurs because of a lack of knowledge and can be reduced by collecting more and better data. Variability refers to true heterogeneity or diversity, which can be better characterized with more data, but cannot be reduced or eliminated (EPA, 2001).

In the Monte Carlo simulation, distributions, rather than point estimates, were used to represent model inputs that represent the variability associated with that input parameter. For example, in the point estimate approach, one value is selected for the fish ingestion variable, in contrast to the probabilistic assessment, in which the entire range of possible fish ingestion rates is used. Distributions also are used for other exposure variables, as appropriate. Distributions were developed to parameterize four risk models: cancer risk from fish consumption, noncancer hazard indices from fish consumption, cancer risk from waterfowl consumption, and noncancer hazard indices from waterfowl consumption. Each of these models is analyzed using both a one-dimensional Monte Carlo simulation and a microexposure event analysis Monte Carlo simulation as a means of bounding the estimates of variability. These simulations are used to develop distributions of risk (rather than single values). These distributions of risk represent the likelihood of different risk levels experienced by a population, and express the variability among individuals in the population in terms of their individual characteristics and other parameters that lead to their specific exposure. Details of these approaches are presented in Section 6.

The uncertainty associated with the Monte Carlo assessments is further evaluated using probability bounds analysis (for further discussion of probability bounds analysis, see Attachment 5 of HHRA Volume I). This analysis results in bounds on the distributions of risk that illustrate the effects of both variability and uncertainty on the risk estimates. In particular, the resulting bounds delineate how both the uncertainty regarding the value chosen as the input to the calculation of dose or intake and the uncertainty regarding the probability distributions used for the other inputs affect the magnitude and distribution of estimated risks. This uncertainty is due to factors such as measurement error, data censoring, small sample sizes, and lack of quantitative information regarding some inputs. The probability bounds also show the effect of uncertainty regarding each probability distribution used to represent inputs and the effect of uncertainty regarding dependencies between model inputs. Probability bounds analyses were conducted for both the one-dimensional analysis and the microexposure event analysis. In addition, a two-dimensional Monte Carlo analysis was conducted, and the uncertainty predicted by this approach was compared with the probability bounds approach.

1.5 REPORT ORGANIZATION

The report is organized into the following sections:

- ***Section 2 – Hazard Identification*** – Describes the available data, indicates how the data are evaluated in the risk assessment, and identifies the COPCs that are evaluated in the fish and waterfowl risk assessment.

- ***Section 3 – Dose-Response Assessment*** – Presents the approach to evaluating the potential cancer risks and noncancer health effects and presents the toxicity factors that are used for the COPCs identified in Section 2.

- ***Section 4 – Exposure Assessment*** – Presents the data used in both the point and probabilistic assessments that describe the magnitude, frequency, and duration of exposure. This section also provides the results of the point estimate quantification of contaminant intake for children and adults who would consume fish and waterfowl from the area.

- ***Section 5 – Point Estimate Risk Characterization*** – The risk characterization section integrates the toxicity assessment and the exposure assessment to characterize both potential cancer and noncancer health effects from fish and waterfowl consumption for the RME and CTE scenarios.

- ***Section 6 – Probabilistic Risk Characterization*** – Presents the exposure assessment and risk characterization using a probabilistic approach as supplemental information to the point estimate approach.

- ***Section 7 – Uncertainty Analysis*** – Identifies the important uncertainties in the risk assessment process and describes the potential impact of these uncertainties on the overall estimate of risk.

- ***Section 8 – Risk Summary*** – Summarizes both the point estimate and probabilistic risk assessment results.

1.6 REFERENCES

BBL (Blasland, Bouck, & Lee, Inc.). 1996. *Supplemental Phase II/RCRA Facility Investigation for Housatonic River and Silver Lake.* Prepared for General Electric Company.

BBL (Blasland, Bouck & Lee, Inc.) and QEA (Quantitative Environmental Analysis, LLC). 2003. *Housatonic River – Rest of River RCRA Facility Investigation Report*. Prepared for General Electric Company.

Bellrose, F.C., G.C. Sanderson, H.C. Schultz, and A.S. Hawkins. 1980. *Ducks, Geese and Swans of North America.* Stackpole Books. 540 pp.

ChemRisk. 1994. *Methodology and Results of the Housatonic River Creel Survey*. Prepared for: General Electric Company. 25 March 1994.

Connelly, N.A., B.A. Knuth, and C.A. Bisogni. 1992. *Effects of the Health Advisory Changes on Fishing Habits and Fish Consumption in New York Sport Fisheries*. Human Dimension Research Unit, Department of Natural Resources, New York State College of Agriculture and Life Sciences, Fernow Hall, Cornell University, Ithaca, NY. Report for the New York Sea Grant Institute Project No. R/FHD-2-PD. September 1992.

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final.* Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002. December 1989.

EPA (U.S. Environmental Protection Agency). 1990. National Oil and Hazardous Substances Pollution Contingency Plan. Final Rule. 40 CFR 300: *55 Federal Register,* 8666-8865, 8 March 1990.

EPA (U.S. Environmental Protection Agency). 1992. Guidance on Risk Characterization for Risk Managers and Risk Assessors. Memorandum from F. Henry Habicht, II to Assistant and Regional Administrators.

EPA (U.S. Environmental Protection Agency). 2001. *Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment.* Office of Emergency and Remedial Response. Washington, DC. EPA 540-R-02-002. December 2001.

Grice, D. and J.P. Rogers. 1965. *The Wood Duck in Massachusetts*. Massachusetts Division of Fisheries and Game. 96 pp.

MDPH (Massachusetts Department of Public Health). 1997. *Housatonic River Area PCB Exposure Assessment Study, Final Report.* Bureau of Environmental Health Assessment, Environmental Toxicology Unit. September 1997.

MDPH (Massachusetts Department of Public Health). 1999. Statewide Provisional Waterfowl Consumption Advisory – August 1999.

Terres, John K. 1980. *The Audubon Society Encyclopedia of North American Birds.* Alfred A. Knopf, New York, NY. 1109 p.

WESTON (Weston Solutions, Inc.). 2004. *Ecological Risk Assessment for General Electric (GE)/Housatonic River Site, Rest of River*. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. DCN GE-100504-ACJS. November 12, 2004.

2. HAZARD IDENTIFICATION

2.1 INTRODUCTION

The purpose of the hazard identification is to:

- Identify the data available to assess risks.
- Evaluate the quality of the data based on data useability and data validation criteria.
- Summarize the data relevant to human consumption.
- Identify contaminants of potential concern (COPCs) for the fish and waterfowl consumption exposure pathways.

In addition, because of the size of the area under evaluation and the number of fish species and tissue types for which data are available, the hazard evaluation describes how species and locations were grouped for the purposes of evaluation.

2.2 AVAILABLE DATA

Fish Data—Fish have been sampled for PCBs in many locations throughout the Rest of River since the 1970s. In 1998, fish were also sampled in two reference areas. The fish samples have included various fish species and tissue types (e.g., fillet, offal, whole fish). Some sampling programs have included analytes in addition to PCBs. Data that met the following criteria were used in the risk assessment for fish consumption:

- The species is typical of those consumed by humans in the Housatonic River area.
- The tissue type collected is representative of those consumed by humans (fillet, not offal or whole fish).
- Data quality objectives of the sampling program were consistent with EPA guidance (EPA, 1987).

Waterfowl Data—Waterfowl were sampled for PCBs from Woods Pond and a reference area during sampling programs conducted in 1998 by the Massachusetts Division of Fisheries and Wildlife (MassWildlife) and EPA. Samples collected from mallards and wood ducks included both breast and liver tissue.

The Connecticut DEP reportedly collected one mallard duck in the Connecticut portion of the Housatonic River, in the vicinity of Newtown, CT. One tissue sample was analyzed for PCBs (BBL and QEA, 2003). Information such as the exact location of collection and type of PCB analysis are not available.

Sources of data available for use in the risk assessment are listed in Table 2-1.

The following sections describe the data collected for EPA's Supplemental Investigation (SI), recent GE data, and historical data.

2.2.1 Supplemental Investigation Data

The Consent Decree between General Electric (GE) and the U.S. Environmental Protection Agency (EPA) required a Supplemental Investigation (SI) of the Lower Housatonic River, or "Rest of River." The additional data collection and evaluation activities were detailed in the Supplemental Investigation Work Plan (SIWP) prepared by Roy F. Weston, Inc. (WESTON®) under contract to the U.S. Army Corps of Engineers and EPA (WESTON, 2000). Implementation of the major elements of the SIWP was completed in 2001. The results were summarized as part of the Rest of River RCRA Facility Investigation (RFI) Report (BBL and QEA, 2003).

The objectives of the SI were as follows:

- Provide surface water, hydrology, and sediment data to support the development of a site-specific hydrodynamic, sediment transport, and PCB fate model.
- Characterize and sample biological media and ecological communities to support human health and ecological risk assessments and modeling study. Acquire sufficient information to compare soil and sediment concentrations against screening risk-based concentrations.
- Develop site-specific human health and ecological risk assessments for the Rest of River.
- Define the nature and extent of the soil and sediment contamination in the Rest of River and associated floodplain by PCBs and other contaminants, and further delineate pathways of contaminant migration to support the above objectives.

Table 2-1

Sources of Fish and Waterfowl Data

Source	Reference	Data Collection Location	
		Massachusetts	Connecticut
EPA	Supplemental Investigation for the Lower Housatonic River (1998 through April 2002)	F, W	
GE	Monthly Data Exchange	F	F
	Academy of Natural Sciences of Philadelphia. PCB Concentration in Fishes from the Housatonic River, Connecticut. Reports for Fish Collected from 1984 through 2000 (ANS, 2001)		F
	Stewart Laboratories. 1982. Housatonic River Studies - 1980 and 1982 Investigations.	F	
State of Connecticut	Department of Environmental Protection. Letter to Mr. Richard Thibedeau, Massachusetts Department of Environmental Management, from Michael J. Harder, April 6, 1994.		F
	Department of Health Services. Housatonic River PCB Fish Log Book. 1979.		F
	Beck, G.J. 1982. PCBs in Housatonic River Fish – Statistical Analyses		F
	Connecticut Department of Environmental Protection (cited in BBL and QEA, 2003)		W
Commonwealth of Massachusetts	Massachusetts Department of Environmental Protection. Summary of Fish PCB Data for 1977.	F	F
USGS	Coles, J.F. 1996. Organochlorine Compounds and Trace Elements in Fish Tissue and Ancillary Data for the Connecticut, Housatonic, and Thames River Basin Study Unit, 1992-94. U.S. Geological Survey Open-File Report 96-358, 26 p.	F	F
	Smith, S.B. and J.F. Coles. 1997. Endocrine Biomarkers, Organochlorine Pesticides, and Congener-Specific Polychlorinated Biphenyls (PCBs) in Largemouth Bass from Woods Pond, Housatonic River, MA. Sept 1994 and May 1995.	F	

F = Fish; W = Waterfowl

The SIWP presented a detailed work plan rationale. This rationale outlined the data requirements, data quality objectives, and data management procedures and controls. A project-specific Quality Assurance Project Plan (QAPP) was also prepared (WESTON, 1998, revised 2003) and implemented in concert with the SI activities. A summary of the fish and waterfowl data collection activities is presented below.

2.2.1.1 Fish Tissue

To supplement historical fish tissue data, fish were collected from the Housatonic River and reference areas to determine PCB and other contaminant concentrations in tissue for use in both the human health and ecological risk assessments, to evaluate congener patterns by species for use in fish and mink reproduction studies, and for use in the modeling study. Detailed protocols for the fish tissue sampling and processing can be found in Appendix A.20 of the *Supplemental Investigation Work Plan for the Lower Housatonic River* (WESTON, 2000).

Fish were collected from two locations in the Rest of River: the Primary Study Area (PSA) comprising Reaches 5 and 6 (confluence to Woods Pond Dam) and Reach 8 (Rising Pond). Fish data are also available from two reference locations (Threemile Pond and the East Branch of the Housatonic River above Newell Street). To fulfill the objectives of the SI, both adult and juvenile fish were collected for each species (largemouth bass and other centrarchids, yellow perch, brown bullhead, and goldfish and other cyprinids). Metrics recorded for each fish included total length, total weight, sex, age, and fillet (skin-off) and offal (everything other than the fillet) weight as appropriate. Fish not retained for analysis were released unharmed to the locations from which they were captured.

Each sample was analyzed for PCB congeners, percent lipids, and percent moisture. The majority of the samples were also analyzed for dioxins/furans and organochlorine pesticides. A small subset was analyzed for inorganics. Data for total PCBs (tPCBs) were developed as both the sum of Aroclors, and as the sum of 120 individual congeners. These methods are described in Attachment 7 of the HHRA. The sum of congeners method differs from the Aroclor analysis method of quantifying tPCB concentrations that was used in some historical fish sampling programs and soil and sediment sampling (see Attachment 7). Table 2-2 provides a summary of the EPA fish tissue sampling program.

Table 2-2

EPA Samples Available from the PSA, Rising Pond, and Reference Locations[a]

Fish Species	Composite[b]	Whole Body[c]	Fillet (skin-off)	Offal	Ovaries
PSA					
Bluegill	---	---	**1**	1	---
Brown Bullhead	---	2	**43**	43	---
Common Carp	3	8	---	---	---
Fallfish	5	---	---	---	---
Golden Shiner	10	---	---	---	---
Goldfish	---	42	---	---	---
Largemouth Bass	12	26	**32**	38	6
Pumpkinseed	10	---	**51**	51	---
Smallmouth Bass	---	2	---	---	---
White Sucker	---	57	---	---	---
Yellow Perch	15	---	**75**	75	---
Rising Pond					
Brown Bullhead	---	---	**7**	7	---
Largemouth Bass	5	14	**11**	17	6
Pumpkinseed	5	---	**13**	13	---
Yellow Perch	5	---	**6**	6	---
Reference Location – East Branch Housatonic River – Upstream of Newell Street					
Bluntnose Minnow	2	---	---	---	---
Brown Bullhead	9	---	5	5	---
Common Shiner	1	---	---	---	---
Fallfish	2	---	---	---	---
Golden Shiner	2	---	---	---	---
Pumpkinseed	10	---	---	---	---
Largemouth Bass	1	19	1	1	---
Yellow Perch	5	---	19	19	---
Reference Location – Threemile Pond					
Brown Bullhead	---	---	6	6	---
Golden Shiner	6	---	---	---	---
Largemouth Bass	4	7	15	20	6

Table 2-2

EPA Samples Available from the PSA, Rising Pond, and Background Locations[a] (Continued)

Fish Species	Composite[b]	Whole Body[c]	Fillet (skin-off)	Offal	Ovaries
Background Location - Threemile Pond (cont'd)					
Pumpkinseed	5	---	12	12	---
Yellow Perch	2	---	18	17	---

Numbers in bold indicate the samples used in the quantitative risk assessment.

--- = No samples available.

[a] Data available in project database as of 3 March 2003.

[b] Composite samples contain several whole fish.

[c] Whole body samples are individual whole fish.

Most of the tissue samples collected during the SI were analyzed using gas chromatography/electron capture detection (GC/ECD) (GERG SOP-9810), and concentrations were reported on a wet weight basis. In general, GC/ECD analysis is subject to several different types of interferences, which can range from contaminated solvent used during the extraction procedure to non-target compounds extracted from the sample matrix to which the detector will respond. In the case of Housatonic River tissue samples analyzed by this method, the pesticide results were subject to interferences from PCB compounds, which were extracted from the sample matrix along with the pesticides. Because of high concentrations of PCBs in the tissue samples and their potential to interfere with pesticide quantification, 10 fish tissue extracts were reanalyzed by Selected Ion Monitoring (SIM) gas chromatography/mass spectrometry (GC/MS) to evaluate any potential interference from PCBs. Eleven pesticides were targeted for this reanalysis.

The presence of 10 of the 11 pesticides was confirmed by the GC/MS SIM reanalysis, but at substantially lower frequencies of detection and lower concentrations. Reanalysis of selected fish tissue extracts by GC/MS SIM did not confirm the presence of heptachlor epoxide in any of the samples. A comparison of pesticide concentrations resulting from GC/ECD and GC/MS SIM analyses is discussed further in Section 2.7.1.1.

2.2.1.2 Waterfowl Tissue

During surveys conducted in the spring and summer of 1998, waterfowl were observed using Woods Pond and floodplain wetlands and backwaters for breeding, brood rearing, and feeding (WESTON, 2004, Appendix A). Two of the species commonly observed included mallards (*Anas platyrhynchos*) and wood ducks (*Aix sponsa*). Both species breed and raise young in the wetlands adjacent to the main stem of the river. Although mallards are dabbling ducks and wood ducks are perching ducks, their diets are similar, in that the young of both species eat invertebrates almost exclusively, and more-mature individuals eat primarily plants and lesser quantities of invertebrates (Bellrose, 1980; Grice and Rogers, 1965).

In addition to ducks, Canada geese are year-round inhabitants of the Housatonic River (WESTON, 2004); adults and goslings were observed foraging in the river channel, backwaters, and adjacent uplands. Similar to mallards and wood ducks, Canada goose broods feed on invertebrates in the river and backwaters as young goslings. As the goslings mature, they shift to consumption of macrophytes, emergent plants, and upland herbs in and near the river (Terres, 1980).

As a result of their dietary habits and the bioaccumulative potential of PCBs and other persistent organic contaminants, individuals of these species nesting in the study area, and their offspring, were expected to accumulate PCBs in their tissue. Waterfowl hunting was a popular activity along this portion of the Housatonic River in 1998 at the time the SI began. For these reasons, Woods Pond and backwaters were selected, along with a reference area, as waterfowl collection sites.

In August 1998, prior to the fall migration, the Massachusetts Division of Fisheries and Wildlife (MassWildlife) captured ducks for its annual banding study in Woods Pond. A few of these ducks were provided to EPA for analysis. To supplement those ducks received from MassWildlife, trapping was conducted in Woods Pond and backwaters. Two floating box traps and one walk-in trap were used to capture waterfowl in the backwaters and from Threemile Pond, a reference area located within the Housatonic River Watershed in Sheffield, MA, in August and September 1998. The two efforts combined resulted in a total of 45 ducks from which tissue samples were submitted for analysis.

Morphometric data collected from specimens included age, sex, wing chord length, and total weight. Any gross pathological abnormalities, if observed, were recorded. Breast and liver tissue were analyzed from each duck. Whole breasts (skin-on) were submitted for analysis, except for five instances when duplicate analyses were performed in accordance with the QAPP (WESTON, 1998, revised 2003). In those cases, the breast was split, with one-half of the breast serving as the primary and the other half serving as the duplicate tissue sample.

Each sample was analyzed for PCB congeners, dioxins/furans, pesticides, percent lipids, and percent moisture. Total PCB concentrations were calculated by summing the concentrations of 120 individual PCB congeners. Pesticides were analyzed using GC/ECD methodology, and, as described for fish, were subject to interferences from PCBs, which were extracted from the sample matrix along with pesticide compounds. Table 2-3 summarizes the samples collected by location, species, sex, and age. A detailed protocol for duck collection and processing is presented in Appendix A.23 of the SIWP (WESTON, 2000).

2.2.2 Recent GE Data

As part of the Revised RCRA permit (Appendix G of the Consent Decree), EPA and GE agreed to provide an electronic exchange of data collected for the Housatonic River. Data collected during current and previous GE investigations are provided to EPA in this monthly database exchange. For the purposes of this assessment, only recent data were considered, including data collected from January 1998 and later. Fish tissue samples collected in Massachusetts by GE prior to 1992 were analyzed for tPCBs as Aroclors, but not for individual PCB congeners or dioxins/furans.

The Academy of Natural Sciences of Philadelphia (ANS), on behalf of GE, has conducted a biennial monitoring program of PCB concentrations in selected fish species and benthic insects at four locations in Connecticut since 1984 (ANS, 2001). PCB congener analysis has been conducted on these fish tissue samples since 1992. ANS (2001) quantifies tPCBs in two ways: as the sum of 121 congeners and as Aroclors (based on the concentrations of a smaller number of congeners that are essentially unique to either Aroclor 1254 or 1260). The quantification based on the sum of 121 congeners was used in this risk assessment. The use of the sum of congeners data enhances the comparability with the analytical methodology used by EPA in the Massachusetts reaches of the Housatonic River. Data on individual congeners were not usable in the analysis for this report. No analytical data are available for dioxins and furans. GE did not collect any data on waterfowl.

A summary of the recent GE fish data is provided in Table 2-4.

Table 2-3

Waterfowl Collection Summary

Species	Location	
	Housatonic River (PSA)	**Reference Area (Threemile Pond)**
<u>WOOD DUCK</u>		
Female		
Immature	**6**	3
Adult	**3**	5
Male		
Immature	**9**	7
Adult	**2**	5
<u>MALLARD</u>		
Female		
Immature	**1**	0
Adult	0	0
Male		
Immature	**4**	0
Adult	0	0

Numbers in bold indicate the samples used in the quantitative risk assessment.

Table 2-4

Recent GE Fish Samples Available from the PSA, Rising Pond, and Connecticut*

Fish Species/Sample Type	Primary Study Area	Rising Pond	Connecticut
Bluegill			
Composite	27 – whole fish	---	2 – whole fish
Bluntnose Minnow			
Composite	---	5 – whole fish	---
Brown Bullhead			
Individual	---	**15 – fillet, skin-off**	---
Composite	---	---	1 – whole fish
Brown Trout			
Individual	---	---	**60 – fillet, skin-on**
Largemouth Bass			
Composite	28 – whole fish	---	---
Pumpkinseed			
Composite	1 – whole fish	---	1 – whole fish
Redbreasted Sunfish			
Composite	---	---	4 – whole fish
Smallmouth Bass			
Individual	---	---	**80 – fillet, skin-on**
Yellow Perch			
Composite	28 – whole fish	---	4 – whole fish
Individual	---	**8 – fillet, skin-off**	---

--- = No samples available.

*Includes 1998 and 2000 ANS data, 1998 GE Supplemental EPA Data Sampling, 1998 Young-of-Year Fish Sampling, and 2000 Young-of-Year Fish Sampling.

See Section 2.3 for determination of QA/QC adequacy.

Numbers in bold indicate the samples used in the quantitative risk assessment.

2.2.3 Historical Data

Data collected prior to EPA's Supplemental Investigation are referred to as historical data. These data were collected by GE, the State of Connecticut, the Commonwealth of Massachusetts, and the U.S. Geological Survey from the mid-1970s to 1997. Table 2-5 provides a summary of the species sampled and sample type. Fish samples were analyzed for PCBs using a variety of analytical protocols that are described in Section 2.3 in conjunction with the determination of data useability.

2.3 DATA USEABILITY AND VALIDATION

Data useability is the process of ensuring that the quality of the data meets the intended uses and satisfies the data quality objectives (DQOs) established for sampling and analysis. DQOs are qualitative and quantitative statements that specify the quality of data required to support decisions during remedial response activities and derive from the concept that the end uses of the data should determine the type and quantity of data to be collected.

To obtain data of known and adequate quality, measurement performance criteria, commonly known as Data Quality Indicators, are established for the various data types necessary to achieve the objectives of each study component. These indicators are both quantitative (e.g., precision, accuracy/bias, completeness, sensitivity) and qualitative (e.g., selectivity, representativeness, comparability) and need to be established for each matrix and analyte.

The DQOs for this project are provided in the Final Quality Assurance Project Plan (QAPP) (WESTON, 1998, revised 2003) and the SIWP (WESTON, 2000). The following tables can be found in the QAPP and provide important information on DQOs and DQIs:

- QAPP, Table 4-1—Field Measurement Quality Control Specifications
- QAPP, Table 4-2—Analytical Measurements Quality Control Requirements
- QAPP, Table 4-3—Spike Accuracy and Precision Limits
- QAPP, Table 4-4—Surrogate Spike Recovery Limits

Table 2-5

Historical Fish Samples[a]

Source/Fish Species/Sample Type	Number of Samples and Preparation Method[b]	
	Primary Study Area	Connecticut
ANS, 1990		
Bluegill – Composite	---	6
Bluegill – Fillet	---	14 – skin-on
Brown Bullhead – Fillet	---	45 – skin-on
Brown Trout – Fillet	---	118 – skin-on
Common Carp – Fillet	---	12 – skin-on
Largemouth Bass – Composite	---	5
Largemouth Bass – Fillet	---	57 – skin-on
Largemouth Bass – Whole Body	---	2
Pumpkinseed – Composite	---	6
Pumpkinseed – Fillet	---	5 – skin-on
Rainbow Trout – Fillet	---	15 – skin-on
Redbreasted Sunfish – Fillet	---	11 – skin-on
Smallmouth Bass – Fillet	---	196 – skin-on
Unidentified Sunfish Hybrid – Fillet	---	1 – skin-on
White Catfish – Fillet	---	92 – skin-on
White Perch – Fillet	---	86 – skin-on
Yellow Perch – Fillet	---	89 – skin-on
ANS, 1991		
Bluegill – Fillet	---	12 – skin-on
Brown Trout – Fillet	---	50 – skin-on
Pumpkinseed – Fillet	---	12 – skin-on
Rainbow Trout – Fillet	---	6 – skin-on
Redbreasted Sunfish – Fillet	---	12 – skin-on
Smallmouth Bass – Fillet	---	30 – skin-on
White Perch – Fillet	---	18 – skin-on
Yellow Perch – Fillet	---	54 – skin-on

Table 2-5

Historical Fish Samples[a]
(Continued)

Source/Fish Species/Sample Type	Number of Samples and Preparation Method[b]	
	Primary Study Area	**Connecticut**
ANS, 1993		
Bluegill – Fillet	---	7 – skin-on
Brown Trout – Fillet	---	44 – skin-on
Redbreasted Sunfish – Fillet	---	6 – skin-on
Smallmouth Bass – Fillet	---	37 – skin-on
White Perch – Fillet	---	14 – skin-on
Yellow Perch – Fillet	---	28 – skin-on
ANS, 1995		
Bluegill – Fillet	---	6 – skin-on
Brown Trout – Fillet	---	38 – skin-on
Largemouth Bass – Fillet	---	1 – skin-on
Pumpkinseed – Fillet	---	6 – skin-on
Redbreasted Sunfish – Fillet	---	6 – skin-on
Smallmouth Bass – Fillet	---	58 – skin-on
White Perch – Fillet	---	18 – skin-on
Yellow Perch – Fillet	---	18 – skin-on
ANS, 1997		
Brown Trout – Fillet	---	22 – skin-on
Smallmouth Bass – Fillet	---	20 – skin-on
CTDEP, 1994		
Brown Trout – Fillet	---	18 – skin-on
Rainbow Trout – Fillet	---	12 – skin-on
Smallmouth Bass – Fillet	---	12 – skin-on
CTDHS, 1979		
Black Crappie – Fillet	---	10 – skin-on; 23 – skin-off
Bluegill – Fillet	---	20 – skin-on; 10 – skin-off; 8 – preparation unknown
Brown Bullhead – Fillet	---	40 – skin-off
Chain Pickerel – Fillet	---	1 – skin-on; 9 – skin-off

Table 2-5

Historical Fish Samples[a] (Continued)

Source/Fish Species/Sample Type	Number of Samples and Preparation Method[b]	
	Primary Study Area	Connecticut
CTDHS, 1979 (cont.)		
Common Carp – Fillet	---	37 – skin-off
Largemouth Bass – Fillet	---	30 – skin-off; 10 – preparation unknown
White Catfish – Fillet	---	30 – skin-off
White Perch – Fillet	---	30 – skin-off
White Sucker – Fillet	---	26 – skin-off; 10– preparation unknown
Yellow Perch – Fillet	---	40 – skin-off
Beck, 1982		
Bluegill – Fillet	---	1 – skin-off
Brown Trout – Fillet	---	26 – skin-on; 19 – skin-off
Largemouth Bass – Fillet	---	1 – skin-off
Rainbow Trout – Fillet	---	13 – skin-on; 20 – skin-off
Smallmouth Bass – Fillet	---	2 – skin-on
White Sucker – Fillet	---	3 – skin-off
MDEP, 1977		
Black Crappie – sample type unknown	1 – preparation unknown	---
Brook Trout – sample type unknown	1 – preparation unknown	---
Brown Bullhead – sample type unknown	1 – preparation unknown	---
Brown Trout – sample type unknown	14 – preparation unknown	---
Common Carp – sample type unknown	1 – preparation unknown	---
Golden Trout – sample type unknown	1 – preparation unknown	---
Largemouth Bass – sample type unknown	8 – preparation unknown	---
Rainbow Trout – sample type unknown	4 – preparation unknown	---
Smallmouth Bass – sample type unknown	7 – preparation unknown	---
White Catfish – sample type unknown	8 – preparation unknown	---
White Catfish – Composite	1	---
White Perch – sample type unknown	8 – preparation unknown	---

Table 2-5

Historical Fish Samples[a]
(Continued)

Source/Fish Species/Sample Type	Number of Samples and Preparation Method[b]	
	Primary Study Area	Connecticut
MDEP, 1977 (cont'd.)		
Yellow Perch – sample type unknown	6 – preparation unknown	---
Coles, 1996		
White Sucker – Composite	1	1
Smith and Coles, 1997		
Largemouth Bass – Whole Body	28	---
Stewart Laboratories, 1980 and 1982		
Bluegill – Composite	3	---
Brown Bullhead – Composite	1	---
Brown Trout – Composite	1	---
Chain Pickerel – Composite	1	---
Largemouth Bass – Composite	2	---
Largemouth Bass – Fillet	1 – skin-on	---
Rock Bass – Composite	1	---
Unidentified Bass – Composite	4	---
Unidentified Crappie – Composite	1	---
Unidentified Sunfish – Composite	3	---
Unidentified Trout – Composite	2	---
Yellow Perch – Composite	6	---

--- = No samples available.

[a] Rising Pond had no historical data.

[b] Composites and whole body samples assumed to be skin-on.

See Subsection 2.3 for evaluation of data useability.

2.3.1 EPA Supplemental Investigation Data

All tissue analyses for the SI that were used in the HHRA were conducted by the Geochemical and Environmental Research Group (GERG) at Texas A&M University (College Station, TX). Tissue samples of various types were analyzed for PCBs as congeners via gas chromatography with electron capture detector (GC/ECD). This procedure provides for quantification of approximately 120 PCB congeners, some of which are part of unresolved doublet or triplet peaks. Appendices C and D of the QAPP (WESTON, 1999, revised 2003) provide procedures relevant to the tissue analyses, including SOPs for laboratory procedures.

In addition to PCB analyses, a subset of tissue samples was also analyzed for a list of Appendix IX constituents (40 CFR 264), including pesticides and herbicides, dioxins, furans, and inorganics. The list of Appendix IX constituents analyzed is included in both the SIWP (WESTON, 2000) and the QAPP (WESTON, 1998, revised 2003). Methods and analytical details, including method detection limits, for the procedures used in the analysis of these additional constituents are described in the QAPP.

EPA data used in this fish and waterfowl consumption risk assessment met the DQOs, and therefore were considered usable for risk assessment purposes. Additional analysis of the pesticide data in fish samples based on a methodology (GC/MS SIM) that eliminated potential analytical interferences with PCBs indicated that heptachlor epoxide was not present, as reported in the GC/ECD dataset. Therefore, heptachlor epoxide concentrations were eliminated from the fish dataset. The GC/MS SIM analysis also indicated that the concentrations of 10 additional pesticides were substantially lower than reported using GC/ECD methodology. The concentrations of these pesticides were reduced, based on the GC/MS SIM data, prior to use.

2.3.2 Recent GE Data

The Consent Decree provided for a “Data Exchange Agreement for Housatonic River Watershed,” which requires the exchange of data collected by GE and EPA in the Housatonic River watershed for consideration in the preparation of the RFI Report, the modeling, and the risk assessment efforts, as well as the dialogue in the technical working groups. All recently collected GE data, i.e., those collected concurrent with and subsequent to the Supplemental

Investigation (1998 forward), were reviewed generally for data useability and were determined to be useable for risk assessment. Therefore, these data were not formally evaluated against the six data evaluation criteria that are described in the next section and Attachment C.2. These evaluations were conducted only on historical data sets.

2.3.3 Historical and Other Data

As shown in Table 2-5, a number of historical data sets were identified. To determine if historical data met the project useability requirements for the HHRA, an evaluation process was developed and summarized in *Review of Historical Data Sets for Useability in the Housatonic River Project* (see Attachment C.2). This process included six data evaluation criteria described in *Guidance for Data Useability in Risk Assessment* (EPA, 1992), modified to be directly applicable to the Housatonic River studies. Four levels of data useability were defined to score each criterion, shown in Table 2-6.

After deriving a separate score for each criterion, each data set was assigned an overall score generally equivalent to the lowest score applied to any single criterion. For example, a data set that was ranked Level A for four of the criteria and Level B for two would be considered Level B overall. Scores for each of the historical data sets are presented in Table 2-7. A detailed analysis of each of the historical data sets, including scores for individual criteria, is provided in Attachment 8 to Volume I of the HHRA. All applicable EPA and GE data that met the project historical data useability Level A or B criteria were considered for use in the risk assessment.

The data from the single mallard sample collected in Connecticut is considered unusable. It was rejected on the basis of all six useability criteria.

2.3.4 Summary of Usable Data Sources

The following data sources met the project data useability criteria and were considered usable for this risk assessment: EPA data, recent GE data, and the data from Coles, 1996.

Table 2-6

Criteria for Ranking Data Useability of Historical Data

Criterion	Level A - Acceptable, Unrestricted Use	Level B - Acceptable, Some Use Restrictions May Apply	Level C - Conditionally Acceptable for Limited Uses	Level D - Conditionally Acceptable, Use With Caution
Criterion 1: Overall quality of and level of detail in report(s)	Accompanying report provides complete description of study design and sample location(s) with justification and rationale.	Report is generally complete and well-written but lacks sufficient detail in a few areas. Sampling locations specified, but not located with GPS or equivalent.	Accompanying report is incomplete but does provide sufficient information for one or more parameters of interest. Sampling locations may not be well specified.	No information available on background and conduct of study. Significant questions regarding sampling locations.
Criterion 2: Formal documentation of procedures	Work Plan, Quality Assurance Plan, Chain-of-custody records, SOPs, and similar field and laboratory documentation exists and is available for review.	Documentation exists for most areas but is insufficient or lacking in a few areas considered noncritical.	Documentation generally not available but sufficient information is known or available from other sources to establish validity of field and analytical procedures.	Documentation non-existent, not available for review, or status unknown.
Criterion 3: Analytical methods used and detection limits achieved	Analytical procedures follow documented standard methods such as EPA or ASTM.	Analytical procedures nonstandard but sufficiently documented to establish validity of and ensure confidence in data.	Analytical procedures nonstandard and not well-documented, but data are believed to be valid due to other information provided.	Insufficient information provided or available via other sources to establish validity of data.
Criterion 4: Data review, validation, and quality assurance	Study incorporated all or most of the full range of QA/QC procedures, e.g., blanks, spikes, duplicates, data review, and data validation.	Study generally employed and documented established QA/QC procedures but did not conduct data validation.	Nonstandard or incomplete QA/QC procedures were followed.	No QA/QC procedures employed or documented.
Criterion 5: Assessment of data quality indicators	Study had established Data Quality Indicators and data substantially meet all acceptability criteria for completeness, comparability, representativeness, precision, and accuracy.	Data Quality Indicators not established, but data appear to meet minimum standards for DQIs.	Data Quality Indicators not established; data appear to not satisfy minimum standards for one or more noncritical DQIs.	Data fail to meet minimum standards for one or more critical DQIs, or not possible to evaluate DQIs.
Criterion 6: Data History and Overall Apparent Data Quality	Data are recent (i.e., within past 5 years), reported in standard units, and are reasonable and internally consistent. Methods followed meet current standards for scientific investigation and were followed consistently.	Data appear to be of acceptable quality but derive from a study conducted prior to 1995. Methods may not meet current standards but are judged to have produced data equivalent to current methodologies.	Portions of the data appear to be of questionable quality due to age, changes in methods, and/or failure to follow current standards for scientific investigation.	The overall data quality is questionable due to outmoded methodologies, poor performance, and/or apparent lack of consistency with current standards.

Table 2-7

Evaluation of Useability of Historical Data Sets

Source	Reference	Score
GE	Academy of Natural Sciences of Philadelphia, Division of Environmental Research. PCB Concentration in Fishes from the Housatonic River, Connecticut in 1984, 1986, and 1988, Report No. 89-30F, January 11, 1990.	B
	Academy of Natural Sciences of Philadelphia. 1991. PCB Concentration in Fishes from the Housatonic River, Connecticut, 1984 to 1990.	C
	Academy of Natural Sciences of Philadelphia 1993. PCB Concentrations in Fishes from the Housatonic River, Connecticut, in 1984-1992.	B
	Academy of Natural Sciences of Philadelphia 1995. PCB Concentrations in Fishes and Benthic Insects from the Housatonic River, Connecticut in 1984 to 1994.	B
	Letter from Andrew Silfer (GE) to Charles Fredette, Water Compliance Unit, and Bryan Olson, U.S. Environmental Protection Agency, Re: Academy of Natural Sciences of Philadelphia (1997): PCB Concentrations in Fishes and Benthic Insects from the Housatonic River, Connecticut in 1984 to 1996.	B
	Stewart Laboratories. 1982. Housatonic River Studies-1980 and 1982 Investigations.	C
Connecticut	Department of Environmental Protection. Letter to Mr. Richard Thibedeau, Massachusetts Department of Environmental Management, from Michael J. Harder, April 6, 1994.	C
	Department of Health Services. Housatonic River PCB Fish Log Book, 1979.	D
	Beck, G.J. 1982. PCBs in Housatonic River Fish – Statistical Analyses.	C
Massachusetts	Department of Environmental Protection. Summary of Fish PCB Data for 1977.	D
USGS	Coles, J.F. 1996. Organochlorine Compounds and Trace Elements in Fish Tissue and Ancillary Data for the Connecticut, Housatonic, and Thames River Basin Study Unit, 1992-94. U.S. Geological Survey Open-File Report 96-358, 26 p.	B
	Smith, S.B. and J.F. Coles. 1997. Endocrine Biomarkers, Organochlorine Pesticides, and Congener-Specific Polychlorinated Biphenyls (PCBs) in Largemouth Bass from Woods Pond, Housatonic River, MA. Sept 1994 and May 1995.	C

2.4 DATA SETS RELEVANT TO HUMAN HEATH RISK ASSESSMENT

2.4.1 Introduction

Data sources that met the Level A or B project useability criteria were evaluated regarding their relevance to consumption by the receptors of concern for human health risk assessment (i.e., anglers, waterfowl hunters, and their families). This step was necessary because fish and waterfowl tissue data were collected for ecological risk assessment and modeling purposes as well as for human health risk assessment. For example, the EPA Supplemental Investigation included sampling data from forage species such as golden shiner, goldfish, and fallfish, which are typically consumed by piscivorous fish or mammals, but not by humans. The tissues analyzed included whole body samples typically consumed by ecological receptors, in addition to fillets that are typically consumed by humans.

2.4.2 Fish

The fish data sets were screened for relevance to the HHRA based on the following criteria:

- Species preferred for consumption.
- Tissue types relevant to human consumption.
- Legal length limits for species.

The date of sampling was not explicitly used as a criterion for data selection, because there have been no discernible temporal trends in PCB concentrations after 1994, as discussed in Section 2.4.2.4 and in the RFI (BBL and QEA, 2003). All of the usable data for Massachusetts were collected after this time period. Data from Connecticut were selected to include only the comparable years of sampling in Massachusetts.

2.4.2.1 Species Preferred for Consumption

Fish species typically consumed by residents of the Housatonic River area were identified and included in the data set used for risk assessment. Optimally, the identification of species typically consumed would be based on site-specific data collected in the absence of fish consumption advisories. However, this information is not available; therefore, species preference data collected in surveys conducted after the fish consumption advisories were issued were evaluated. The following sources contain information helpful in determining species likely consumed from the Housatonic River:

- *Housatonic River Area PCB Exposure Assessment Study* (MDPH, 1997)
- *Methodology and Results of the Housatonic River Creel Survey* (ChemRisk, 1994)
- *An Angler Survey and Economic Study of the Housatonic River Fishery Resource* (CTDEP, 1988)

Table 2-8 summarizes the survey designs and demographics for each of these surveys (see Section 4 for a more complete presentation), and a detailed discussion of each survey is presented below.

2.4.2.1.1 Massachusetts DPH PCB Exposure Study

The Massachusetts Department of Public Health (MDPH) conducted a PCB Exposure Assessment Study of residents in the Housatonic River Area (HRA) in 1995/1996 (MDPH, 1997). The two objectives of the study were to identify patterns of activities that may have resulted in PCB exposure, and to assess the relationship between potential exposure pathways and serum PCB concentrations among residents at greatest risk of exposure. A consumption advisory for fish, frogs, and turtles in the Housatonic River was in effect during the time of the survey.

To achieve the first objective, 800 randomly selected households within a half-mile of the Housatonic River between Pittsfield and the Connecticut border were contacted by telephone or visit and asked to participate in the survey. Seventeen of the original 800 households were not occupied at the time of contact, leaving a final sample size of 783 households, nearly equally divided between Pittsfield and other communities. A total of 658 households (1,529 individuals) participated in this "Exposure Prevalence Study," and completed household screening questionnaires administered by trained interviewers. An additional study, known as the Volunteer Study, was also conducted. In the Volunteer Study, the same household screening questionnaires and serum testing were offered to any resident in the Housatonic River Area, regardless of household proximity to the river. A total of 65 households (158 individuals) were included in the Volunteer Study during the period from March to May 1996. Since the 1995/1996 study, MDPH has screened additional volunteers on an ongoing basis.

Table 2-8

Survey Demographics

Demographic	MDPH, 1997		ChemRisk, 1994	CTDEP, 1988
	Exposure Prevalence	**Volunteer**		
Survey Dates	1995	1996	1992	1984 to 1986
Geographic Area	Residences within 0.5 mile radius of the Housatonic River from Lanesborough and Dalton to the CT border.	---	Housatonic River: Location 1 - Newell Street Bridge to Woods Pond Dam; Location 2 - Woods Pond Dam to the CT Border	Housatonic River: Six locations from Massachusetts border to Stevenson Dam (Lake Zoar, CT)
Study Type	Household screening questionnaire, via phone	Household screening questionnaire, via phone	Creel Survey	Angler Survey
Sample Selection	Stratified systematic cluster sampling scheme	---	Location 1 – Clerk stationary, interviewed all anglers accessible from shore access points; Location 2 – Clerk roved, interviewed all anglers encountered	Roving census combined with a stratified design
Population	Households in Pittsfield Households from the rest of the HRA communities	117 individuals from Pittsfield 41 individuals from the rest of the HRA communities	Housatonic River Anglers in MA	Housatonic River Anglers in CT
Sample Size	783 households representing 1,820 individuals	Not applicable	85	1,598
Response Rates (%)	84	Not applicable	100	95
Total Participants	658 households representing 1,529 individuals	158	85	1,515
Sex:				
Male	724	76	---	1,424
Female	805	82	---	30

Table 2-8

Survey Demographics
(Continued)

Demographic	MDPH, 1997		ChemRisk, 1994	CTDEP, 1988
	Exposure Prevalence	Volunteer		
Unknown	---	---	---	61
Age:				
0-19	402	---	---	61
20-39	380	---	---	742
40-59	432	---	---	439
0-59	1214	107	---	1,242
60+	315	51	---	152
Unknown	---	---	---	121

1

The MDPH survey (1997) asked participants to indicate the three freshwater fish species they ate most frequently. Species listed as being consumed, in order of preference based on the exposure prevalence study, were as follows:

- Trout
- Bass
- Perch
- Bullhead
- Pickerel
- Other
- Crappie
- Sunfish
- Carp

Although these data were reflective of all freshwater fish consumed, not just fish obtained from the Housatonic River, these data include the species of freshwater fish that Massachusetts Housatonic River area residents prefer to consume.

2.4.2.1.2 ChemRisk Massachusetts Creel Survey

ChemRisk conducted a creel survey in 1992 under contract to GE, characterizing angler activity and consumption practices among anglers who fished the Housatonic River (ChemRisk, 1994). The main objectives of the study were to identify the level of fishing effort that occurred along the Housatonic River, identify the areas of highest use, and characterize fish consumption rates by anglers who fish from the river. In addition, data were collected on target fish species, subsistence fishing activity, and human consumption of turtles or frogs collected from the river. The fish, frog, and turtle consumption advisory was in effect on the Housatonic River when the survey was conducted.

For the purpose of this survey, the Housatonic River was divided into two study areas. The first extended from the Newell Street Bridge in Pittsfield to Woods Pond Dam (Location 1) in Lee, and the second from Woods Pond Dam to the Massachusetts/Connecticut border (Location 2).

The survey was conducted from May through October 1992, and consisted of two components. The first was an aerial survey designed to collect information on areas and times of highest fishing activity, and to derive estimates of angler effort. The second was a creel survey of anglers observed using the river. Information was collected on frequency of fishing trips, species targeted, species caught and creeled at the time of interview, size of creeled fish, final disposition of the creeled fish, and whether anglers ever caught and consumed turtles or frogs from the river. The creel survey clerk was present on the river for a minimum of 3 days per week, including at least one weekend day, between 6 to 8 hours each day.

The greatest number of anglers was observed during summer weekends and holidays, and the smallest number of anglers was observed on fall weekdays. The highest level of fishing activity was between John Decker Canoe Launch off New Lenox Road in Lenox and Woods Pond Dam.

A total of 62 creel survey days were completed on the river, and a total of 85 anglers were interviewed. Twenty-nine of the 41 anglers interviewed in Location 1 indicated that they were targeting one or more species while 30 of the 44 individuals interviewed in Location 2 indicated that they were targeting one or more species. Species targeted by the anglers that noted that they were targeting specific species were as follows:

- Bass
- Pike
- Trout

Although this study was conducted in the Housatonic River, these results were derived from a small sample size, and were influenced by the fact that the study was conducted while a fish consumption advisory was in effect. In addition, the period of the study did not include the winter season, even though Woods Pond is a popular location for ice fishing, with many groups of anglers observed on the pond on winter weekends. Therefore, there is a moderate level of uncertainty associated with deriving fish preferences from these results.

2.4.2.1.3 Connecticut Housatonic River Creel Survey

The Connecticut Department of Environmental Protection (CTDEP), Bureau of Fisheries, conducted an annual roving creel survey along the Housatonic River in Connecticut from 1984 to 1986. The primary objectives of this survey were to estimate the economic value of the Housatonic River fisheries, to establish a database for each of the fisheries, and to characterize angler awareness of PCB contamination. The fish consumption advisory was also in effect during this survey. The survey area was divided into six sections, and extended from the Connecticut-Massachusetts border to Stevenson Dam. Information was collected on demographics, catch, harvest, angling effort, expenses, likelihood of fish consumption, and economic value of the fishery (CTDEP, 1988). Of the five types of forms that were used in the survey, only one type (the long form) requested which species were caught (Ebert et al., 1996).

There were 1,598 anglers for whom long forms were completed. Of these, 1,515 (95%) were residents of Connecticut, Massachusetts, or New York. A median of 30% of total fishing trips taken by responding anglers were spent fishing the Housatonic River. Twenty-three (1.5%) of the 1,515 respondents indicated that all of their fishing was in the Housatonic River, and 150 respondents (9.9%) reported that at least 95% of their fishing trips were to the Housatonic River. The median frequency of trips to the Housatonic River was 10/year (Ebert, 1996).

Of the 1,515 respondents who were residents of Connecticut, Massachusetts, or New York, 838 (55%) had caught fish at the time of the interview. The species most frequently targeted by the anglers were bass (both largemouth and smallmouth) and trout. Most of the anglers in the upper sections of the river practiced catch and release (corresponding to the reaches where the fishery is managed as catch and release), while those in the lower sections retained at least some of their catch. Of these 838 respondents, 211 (25%) had harvested (retained) any of the fish they had caught, which totaled 1,161 fish at the time of the interviews. Of all harvested fish, the most frequently taken were as follows (Ebert, 1996):

- Redbreast sunfish
- Smallmouth bass
- Yellow perch
- White perch

In contrast to the previous lists, no trout appear on this list; however, this does not represent a lack of preference for consuming trout. In the areas surveyed, the majority of the reaches with a trout fishery are (and remain) limited to catch and release, and thus it was and is illegal to retain trout for consumption.

2.4.2.1.4 Results

Based on the specific fish species known to be consumed and/or targeted by anglers, the species assumed to be potentially consumed from the Housatonic River are as follows:

- Bass
- Carp
- Crappie
- Bullhead
- Perch
- Pickerel
- Pike
- Sunfish
- Trout

2.4.2.2 Tissue Types Relevant to Human Consumption

The majority of fish species are generally prepared for consumption as fillets (see Section 4.5.2.3 for further discussion of fish preparation and cooking methods), and guidance for determining fish consumption advisories (EPA, 2000) notes that data from samples that are representative of the dietary customs of the local population should be considered. Therefore, all non-fillet data (e.g., whole body and offal) were eliminated from the data set used for the exposure assessment. Sample preparation methods are reported in Tables 2-2, 2-4, and 2-5.

2.4.2.3 Species with Legal Length Limits

To assess the risk from fish most likely to be consumed by humans, the data set was evaluated with respect to species length and legal limits for keeping fish. Fish length is potentially an important consideration in the risk evaluation because larger fish tend to have higher concentrations of PCBs. This relationship has been observed for largemouth bass and perch in the Massachusetts portion of the Housatonic River (BBL and QEA, 2003). Thus, use of concentration data for fish that are below the legal limit could lead to an underestimate of PCB concentrations in fish most likely to be consumed.

Largemouth bass are the only species for which samples were collected in Massachusetts that have a minimum legal size requirement (12 inches [30.45 cm]). Any samples from fish smaller than the legal limit were not included in the data sets for the Massachusetts reaches.

Smallmouth bass are the only species evaluated in Connecticut that have a minimum size requirement (12 inches [30.45 cm]). However, if smallmouth bass less than 12 inches were eliminated, there would only be two data points in Lake Zoar from the 2000 sampling. To retain a more robust data set, smallmouth bass of all sizes were retained. The minimum fish length in the data set was 10.5 inches. The inclusion of smaller fish may lead to an underestimate of the exposure point concentration (EPC).

2.4.2.4 Temporal Trends

Large numbers of adult fish samples were not collected at the same location over a number of sampling periods in Massachusetts. However, sampling of young-of-year largemouth bass, yellow perch, and sunfish from 1994 to 2002 showed no trend in average PCB concentrations (BBL and QEA, 2003). In Connecticut, however, smallmouth bass and brown trout samples were collected from the same four locations from 1977 to 2002 (ANS, 2000; BBL and QEA, 2003). Beginning in 1984, there was biennial monitoring at these locations (West Cornwall, Bulls Bridge, Lake Lillinonah, and Lake Zoar). PCB concentrations show considerable year-to-year variability, although there appears to be a decrease in average PCB concentrations in trout and smallmouth bass, particularly at West Cornwall in the first few years of sampling; concentrations have been generally constant since the early 1990s. At three locations (Bulls Bridge, Lake Lillinonah, and Lake Zoar), no decrease in concentration in smallmouth bass fillets is apparent from 1983 to 2002 when examined on a tPCB (wet weight) basis. For brown trout sampled in West Cornwall, there is no statistically significant difference in PCB concentrations from 1994 to 2002.

2.5 DATA SETS SELECTED FOR QUANTITATIVE ASSESSMENT

This section summarizes the data sets selected for use in the quantitative risk assessment.

2.5.1 Fish Sample Data Set

Data from two sources, SIWP data collected in Massachusetts since 1998 and several GE-sponsored sampling efforts in Connecticut, remained after applying the three criteria (species, tissue, and length) to ensure relevance to human consumption. Some GE data from Rising Pond were also used. The Connecticut data were restricted to samples collected in 1998 and later to provide consistency with the Massachusetts data set and as those data that are most representative of current conditions. A summary of the samples retained for use in the exposure assessment is presented in Table 2-9. The raw data associated with these samples are presented in Attachment C.3. A summary of the tPCB concentrations is presented in Table 2-10, along with comparable data from Threemile Pond, a reference location in the Housatonic River watershed in Massachusetts.

The mean tPCB concentration (wet weight) in fish tissue typically decreases downstream from Reach 5 to Reach 15. For example, the mean tPCB concentration in fillets of largemouth bass from the PSA was 16.7 mg/kg, with one individual fillet exceeding 150 mg/kg. The mean concentration decreased to 3.8 mg/kg in Reach 8. In smallmouth bass, the mean tPCB concentrations were less than 1 mg/kg in Connecticut. The concentrations of tPCB in fillets (skin-off) in the Threemile Pond reference area are substantially lower than those observed in the Rest of River reaches, although the data in the Connecticut reaches (11 to 15) are not fully comparable because of the differences in bass species (largemouth in Massachusetts, smallmouth in Connecticut) and the fillets in Connecticut were analyzed skin-on.

2.5.2 Waterfowl Sample Data Set

Waterfowl data available for this assessment were collected as part of the SI. Both mallards and wood ducks are legal to hunt according to the Massachusetts Migratory Bird Regulations for 2004-2005 (MassWildlife, 2004), and both are included in the data set. The duck samples included two tissue types, skin-on breast and liver as separate samples. Although tissues that are considered dark meat (e.g., legs) in domestic fowl were not analyzed, EPA believes that the concentrations of persistent organochlorine compounds, such as PCBs, will be similar in the breast and leg meat in wild ducks. The difference in composition between muscles that are used regularly (e.g., leg, or dark meat) compared with muscles that are used rarely (e.g., breast, or light meat) is a characteristic of gallinaceous birds such as chicken or turkey that are adapted for walking rather than flying. The difference in coloration is due to a higher concentration of the protein myoglobin in dark meat (Labensky and Hause, 1995). In the case of ducks, particularly

Table 2-9

Summary of Samples in Fish Data Sets Based on Combined EPA and GE Data

Species	PSA	Rising Pond	Connecticut
Brown Bullhead	43	22	---
Brown Trout	---	---	60
Largemouth Bass	30	11	---
Smallmouth Bass	---	---	80
Sunfish (Bluegill and Pumpkinseed)	1 Bluegill 51 Pumpkinseed	13 Pumpkinseed	---
Yellow Perch	75	14	---
Totals	200	60	140

Note: All fillet samples. Massachusetts data skin-off. Connecticut samples skin-on.

Table 2-10

Summary of tPCB Concentrations in Fish Fillets Used for Human Health Risk Assessment and Reference Areas

	Bass	Bullhead	Perch	Sunfish	Trout
PSA (Reaches 5 and 6)	16.7 (151)	13.2 (90)	7.4 (75.7)	6.5 (47)	---
Reach 8 (Rising Pond)	3.8 (5.8)	4.5 (13)	8.2 (24.9)	2.9 (5.1)	---
Reach 11 (West Cornwall)	0.97 (1.9)	---	---	---	1.9 (11)
Reach 12/13 (Bulls Bridge)	0.96 (2.0)	---	---	---	---
Reach 14 (Lake Lillinonah)	0.67 (1.3)	---	---	---	---
Reach 15 (Lake Zoar)	0.60 (2.9)	---	---	---	---
Reference Area (Threemile Pond, MA)	(0.02)	0.01 (0.02)	0.01 (0.02)	<0.01 (0.01)	---
Reference Area (East Branch Upstream of Newell Street)	---	0.08 (0.15)	0.25 (0.38)	---	---

All data in mg/kg wet weight; samples are fillets.

Each cell lists the arithmetic mean with the maximum in parentheses for the location.

wild ducks, all muscles are used regularly and therefore both breast and leg consist exclusively of dark meat (Gisslen, 1995). In culinary terms, dark meat usually contains more fat and connective tissue and takes longer to cook than light meat (Gisslen, 1995). However, in ducks and geese, the leg and breast meat differ in the amount of connective tissue, but not in the amount of fat, which is the most important parameter governing PCB (and other organochlorine compounds) concentration in the tissue. In addition, the majority of the meat in a wild duck is contained in the breast.

Although it is possible that some consumers eat gizzards and organ tissues such as liver, it is assumed that the amount consumed in comparison with breast meat would be very small. Therefore, only breast tissue samples were included in the quantitative evaluation. The risks associated with consuming liver are discussed in the uncertainty analysis (Section 7.2.1.3).

The 25 duck samples from the PSA included in the data set for use in the exposure assessment are the same as those presented in Table 2-3 (5 mallard and 20 wood duck). The raw data associated with these samples are presented in Attachment C.3. A summary of the tPCB concentrations is discussed in Section 2.8.2, along with comparable data from Threemile Pond, a reference location in Massachusetts.

2.6 DATA REDUCTION

The following guidelines were used to produce the summaries of the data for the contaminants detected in samples from the selected data sets. These approaches are consistent with *Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part A)* (EPA, 1989).

- If a contaminant was not positively identified in any sample from a given medium (i.e., reported as non-detect and/or flagged as corresponding to a contaminated QA blank sample), it was not considered further for that medium.
- All J-qualified data were assumed to be positive identifications within any medium at the reported concentration. A “J” qualifier indicates that the numerical value is an estimated concentration (e.g., reported below the minimum sample quantitation limit (SQL), sample exceeded holding time, positive sample results associated with quality control recoveries below acceptance limits).

- All U-qualified data represent samples for which the analyte was not present or was below the SQL and reported as a "non-detect." There are several ways to handle non-detects. Based on criteria presented in "How Should Non-Detects Be Treated in Data Analysis" (Attachment 1 of the HHRA, Volume I), the substitution method was used in this risk assessment, where the descriptive statistics, exposure point concentrations (EPCs), and risks were calculated assuming that the non-detects were equal to one-half the SQL. The uncertainties associated with the substitution of "0" or the full SQL are discussed in the uncertainty analysis (Section 7).

- If a sample duplicate was collected and analyzed, the average of the two reported concentrations was used for subsequent calculations unless there was a relative percent difference (RPD) between the two concentrations greater than or equal to 50%, in which case the higher of the two concentrations was used.

2.6.1 Toxic Equivalence (TEQ) Calculation Procedure

The toxic equivalence (TEQ) approach, developed to facilitate the assessment of mixtures of polychlorinated dibenzo-p-dioxins and other contaminants with dioxin-like modes of action (e.g., polychlorinated dibenzofurans and certain PCB congeners), was used to represent dioxin/furan and dioxin-like PCB congeners in fish and duck tissues. The Toxic Equivalency Factors (TEFs) adopted by the World Health Organization (WHO) (Van den Berg et al., 1998) were used in this assessment to determine the 2,3,7,8-TCDD TEQ of dioxins, furans, and dioxin-like PCBs. The TEF values used in deriving TEQ are listed in Table 3-2.

The method for calculating TEQ is presented in this section, whereas the discussion of the toxicological basis for using TEQ is included in Section 3 (Toxicity Assessment). Prior to calculating TEQ, two situations were addressed: (1) how to handle congeners that were not detected and (2) how to estimate congener concentrations when the congener co-elutes with others (i.e., two or three congeners are located in the same chromatographic peak and individual congener concentrations are not reported).

The methods used to address these situations are discussed below.

2.6.1.1 Non-Detected TEQ Congeners

If a TEQ congener was not detected within an entire data set, the congener was not included in the total TEQ calculation for the samples in that data set. For example, if OCDD was never detected in duck breast tissue samples, the total TEQ was calculated assuming the concentration of OCDD was zero.

If a congener was positively identified in at least one sample, it was retained in the analysis. For the positively identified congeners, individual sample results reported as "non-detect" were included in the TEQ calculations by setting the value equal to zero (0), half of the SQL, and equal to the SQL, respectively. TEQ calculations were then performed once for each of these options. Only the TEQ derived using one-half the SQL was carried through this report. However, the implications resulting from the substitution of "0" or the full SQL are discussed in the uncertainty analysis (Section 7).

2.6.1.2 Congener Co-Elution

The method used to analyze the majority of the EPA tissue samples resulted in data where concentrations for 2 of the 12 dioxin-like PCB congeners (for which there are TEFs) were not individually reported. PCB-157 and PCB-123 were reported as part of a triplet (PCB-201/**157**/173) and doublet (PCB-149/**123**), respectively. The approach used to generate the TEQ when co-elution of PCB-201/157/173 and PCB-149/123 occurred in a tissue sample is briefly described below.

2.6.1.2.1 Fish Tissue

As described above, the EPA fish tissue samples analyzed by GERG had the PCB-149/123 doublet and PCB-201/157/173 triplet reported. In a study conducted by the United States Geological Survey (USGS) for EPA (Tillitt, 2003a,b) largemouth bass (*Micropterus salmoides*) samples were collected from different locations along the Housatonic River in 1999, and analyzed by the Columbia Environmental Research Center (CERC) of USGS. CERC determined PCB congeners using an analytical protocol that resolved PCB-157 and PCB-123 into separate peaks, allowing them to be quantified separately. From these data, the relative proportion of each of the congeners that make up the doublet (PCB-149/123) and triplet (PCB-201/157/173) in fish tissue was estimated. PCB-123 comprised 0.3% of the PCB-149/123 doublet, and PCB-157 comprised 19.5% of the triplet PCB-201/157/173. These proportions were then applied to the remaining fish tissue data for the calculation of the TEQ.

2.6.1.2.2 Waterfowl

There are no data available for waterfowl from the Housatonic River that can be used to derive estimates for the co-eluting TEQ congeners. The applicability of the congener ratios developed using the largemouth bass samples to other tissue samples (e.g., mammal and birds) is unknown, as it has been observed that in some circumstances different species metabolize congeners at different rates. Boon et al. (1997) demonstrated that for different fish-eating mammals (e.g., otter, dolphin, seals), there were substantial differences in the ability of these mammals to metabolize PCB congeners. Because PCB-123 and PCB-157 were detected in other environmental samples in the Houstanic River, it was assumed for the waterfowl tissue TEQ that the entire reported concentration of the doublet and triplet corresponded to PCB-123 and PCB-157, respectively.

2.6.1.3 TEQ Calculations

After applying the approaches for non-detect congeners and co-elution of congeners as described above, TEQ was first calculated for individual congeners by multiplying the sample concentration by the TEF. Total TEQ was then calculated on a per sample basis separately for dioxins, furans, and PCB congeners by summing the individual TEQs for each category.

Attachment C.4 presents the TEQ calculations for the final data sets evaluated in this risk assessment.

2.7 FISH COPC SELECTION AND DATA SUMMARY

This section presents the COPC selection and data summaries used for evaluating the fish consumption pathway.

2.7.1 COPC Selection Process

Because of the known releases at the site, and high measured concentrations in site media, PCBs and dioxin/furan congeners were included as COPCs. The maximum concentrations of these contaminants greatly exceed the EPA Region 3 Risk-Based Concentrations (RBCs, described in Section 2.7.1.2) for fish ingestion. The maximum concentration of tPCBs in fish fillet tissue was

150 mg/kg, compared with the RBC of 0.0016 mg/kg. The maximum detected concentration of dioxins/furans, expressed as TEQ, was 0.00005 mg/kg (5E-05 mg/kg), compared with the RBC of 0.000000021 mg/kg (2.1E-08 mg/kg).

The COPC selection process also examined contaminant data for metals and Appendix IX compounds, which include chlorinated pesticides. Although the selection process was based on the more-extensive data from the PSA, this list of COPCs was also used for Rising Pond. In Connecticut, data are available only for tPCBs, and thus, tPCBs are the only COPC.

The criteria used in this analysis were as follows:

- Frequency of detection.
- Frequency of exceeding the EPA Region 3 contaminant-specific risk-based concentrations (RBCs; EPA, 2004a).
- Magnitude by which the RBC was exceeded.

Summaries of the data selected in Section 2.3.4.1, the RBCs, and comparisons of site data to RBCs are presented below.

2.7.1.1 COPC Selection Data Summary

Based on the species of fish observed in the PSA, and fish consumption preferences (see Section 2.3.4.1.1), data were evaluated in the COPC selection for four species: brown bullhead, largemouth bass, sunfish (i.e., bluegill and pumpkinseed), and yellow perch. The data set included 200 fish fillet samples for these species collected from the PSA that were analyzed for compounds other than PCBs.

Tables 2-11 and 2-12 present statistical summaries of Appendix IX contaminants detected in fish fillet samples collected from the PSA and Rising Pond, respectively. The tables include frequency of detection, range of detected concentrations, range of sample quantitation limits, median (i.e., 50th percentile), and interquartile ranges (i.e., 25th and 75th percentiles).

Table 2-11

Fillet Pesticides, Metals, and Lipids Chemistry Summary
Reaches 5 and 6

Contaminant	Frequency of Detection GC/ECD	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)
APP IX PESTICIDES						
1,2,3,4-Tetrachlorobenzene	198 / 200	0.00093 - 0.39	0.00031 - 0.00038	0.0058	0.013	0.020
1,2,4,5-Tetrachlorobenzene	191 / 200	0.000060 - 0.089	0.00053 - 0.0016	0.0018	0.0031	0.0049
4,4'-DDD	199 / 200	0.00028 - 0.33	0.0016 - 0.0016	0.0021	0.0033	0.0060
4,4'-DDE	194 / 200	0.00036 - 0.25	0.00099 - 0.0016	0.0063	0.0094	0.016
4,4'-DDT	115 / 200	0.000040 - 0.017	0.000010 - 0.0025	0.00048	0.00096	0.0012
Aldrin	21 / 200	0.000060 - 0.00076	0.00090 - 0.0025	0.00096	0.00099	0.0011
Alpha-BHC	97 / 200	0.000010 - 0.00061	0.000030 - 0.0025	0.00012	0.00091	0.00099
Alpha-Chlordane	65 / 200	0.000040 - 0.0044	0.000075 - 0.0017	0.00094	0.00099	0.0012
Beta-BHC	41 / 200	0.0000030 - 0.00065	0.0000045 - 0.0025	0.00031	0.00098	0.0010
Chlorpyrifos	75 / 200	0.000010 - 0.0022	0.000010 - 0.0025	0.000080	0.00092	0.00099
cis-Nonachlor	190 / 200	0.00066 - 0.33	0.00094 - 0.0025	0.0072	0.011	0.019
Delta-BHC	73 / 200	0.0000090 - 0.011	0.0000015 - 0.0019	0.00097	0.0010	0.0014
Dieldrin	175 / 199	0.000050 - 0.020	0.00096 - 0.0017	0.00052	0.00079	0.0020
Endosulfan II	141 / 200	0.00039 - 0.12	0.00090 - 0.0017	0.0012	0.0034	0.0075
Endrin	38 / 200	0.000010 - 0.0011	0.00090 - 0.0025	0.00095	0.00099	0.0011
Gamma-BHC (Lindane)	154 / 200	0.0000050 - 0.0020	0.000010 - 0.0019	0.000070	0.00013	0.00033
Gamma-Chlordane	83 / 200	0.000030 - 0.0037	0.0000050 - 0.0016	0.00036	0.00098	0.0011
Heptachlor	66 / 200	0.000020 - 0.0013	0.00090 - 0.0025	0.00034	0.00097	0.0011
Hexachlorobenzene	195 / 200	0.000020 - 0.0071	0.000015 - 0.0016	0.00037	0.00063	0.0010
Mirex	7 / 200	0.0000060 - 0.0011	0.00090 - 0.0025	0.00097	0.00099	0.0011
o,p'-DDD	199 / 200	0.0015 - 0.29	0.00096 - 0.00096	0.013	0.019	0.029
o,p'-DDE	59 / 200	0.000090 - 0.0035	0.000085 - 0.0025	0.00097	0.0010	0.0014
o,p'-DDT	200 / 200	0.0011 - 0.38	N/A	0.012	0.019	0.029
Oxychlordane	95 / 200	0.00010 - 0.016	0.00090 - 0.0025	0.00096	0.0010	0.0014
Pentachloroanisole	168 / 200	0.000010 - 0.0021	0.000015 - 0.00096	0.00014	0.00025	0.00042
Pentachlorobenzene	197 / 200	0.00012 - 0.20	0.000070 - 0.00025	0.0027	0.0054	0.0098
Trans-Nonachlor	186 / 200	0.000010 - 0.011	0.000080 - 0.0016	0.00052	0.00092	0.0014
METALS						
Lead	2 / 6	0.080 - 0.080	0.040 - 0.075	0.070	0.073	0.080
Mercury	6 / 6	0.33 - 0.72	N/A	0.35	0.44	0.54
ORGANIC						
Percent Lipids (GC)	200 / 200	0.0040 - 7.6	N/A	0.40	0.70	1.1
Percent Lipids (GC/MS)	125 / 125	0.020 - 7.6	N/A	0.40	0.70	1.2
Percent Lipids (OTHER)	3 / 6	0.10 - 0.30	0.050 - 0.050	0.050	0.075	0.23

mg/kg = milligrams per kilogram.

N/A = Not applicable.

Note: Summary statistics include non-detects at one-half the detection limit.

Table 2-12

Fillet Pesticides, Metals, and Lipids Chemistry Summary
Rising Pond

Contaminant	Frequency of Detection GC/ECD	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)
APP IX PESTICIDES						
1,2,3,4-Tetrachlorobenzene	33 / 37	0.00022 - 0.0018	0.00014 - 0.00017	0.00035	0.00052	0.00080
1,2,4,5-Tetrachlorobenzene	6 / 37	0.00011 - 0.0021	0.000011 - 0.0010	0.00020	0.00035	0.00069
4,4'-DDD	35 / 37	0.00045 - 0.0066	0.00097 - 0.0010	0.0011	0.0015	0.0020
4,4'-DDE	37 / 37	0.0026 - 0.040	N/A	0.0066	0.0091	0.014
4,4'-DDT	30 / 37	0.00012 - 0.0038	0.00096 - 0.0010	0.00025	0.00030	0.00068
Aldrin	2 / 37	0.000038 - 0.00014	0.00094 - 0.0012	0.00098	0.00099	0.0010
Alpha-BHC	33 / 37	0.000033 - 0.00019	0.00097 - 0.0010	0.000094	0.00014	0.00017
Alpha-Chlordane	18 / 37	0.000098 - 0.0011	0.00094 - 0.0012	0.00043	0.00096	0.00099
Beta-BHC	18 / 37	0.000012 - 0.00016	0.00098 - 0.0012	0.000040	0.00098	0.00099
Chlorpyrifos	7 / 37	0.000019 - 0.00021	0.000013 - 0.0012	0.000050	0.00013	0.00098
cis-Nonachlor	37 / 37	0.0011 - 0.025	N/A	0.0028	0.0037	0.0063
Delta-BHC	7 / 37	0.000017 - 0.000087	0.0000085 - 0.0012	0.00095	0.00099	0.0010
Dieldrin	26 / 37	0.000025 - 0.00067	0.00098 - 0.0010	0.00011	0.00019	0.00099
Endosulfan II	34 / 37	0.00050 - 0.0078	0.00097 - 0.0010	0.00098	0.0015	0.0027
Endrin	8 / 37	0.000011 - 0.000073	0.00094 - 0.0012	0.00095	0.00099	0.0010
Gamma-BHC (Lindane)	37 / 37	0.000066 - 0.00057	N/A	0.000092	0.00012	0.00015
Gamma-Chlordane	19 / 37	0.000040 - 0.00067	0.00094 - 0.0012	0.00014	0.00067	0.00099
Heptachlor	11 / 37	0.000018 - 0.00017	0.00094 - 0.0010	0.00016	0.00099	0.00099
Hexachlorobenzene	12 / 37	0.000092 - 0.00031	0.000031 - 0.00061	0.00012	0.00014	0.00019
Mirex	6 / 37	0.0000060 - 0.000094	0.00096 - 0.0012	0.00098	0.00099	0.0010
o,p'-DDD	37 / 37	0.0018 - 0.038	N/A	0.0053	0.010	0.013
o,p'-DDE	1 / 37	0.00017 - 0.00017	0.00094 - 0.0012	0.00098	0.00099	0.0010
o,p'-DDT	37 / 37	0.0019 - 0.054	N/A	0.0070	0.012	0.016
Oxychlordane	20 / 37	0.00021 - 0.0022	0.00098 - 0.0010	0.00055	0.00098	0.00099
Pentachloroanisole	14 / 37	0.000055 - 0.00075	0.000020 - 0.00011	0.000040	0.000073	0.00031
Pentachlorobenzene	34 / 37	0.000092 - 0.00066	0.000083 - 0.0010	0.00016	0.00023	0.00032
Trans-Nonachlor	37 / 37	0.00020 - 0.0031	N/A	0.00068	0.00090	0.0012
ORGANIC						
Percent Lipids (GC)	60 / 60	0.20 - 3.3	N/A	0.40	0.60	1.2
Percent Lipids (GC/MS)	36 / 36	0.20 - 1.9	N/A	0.30	0.45	0.68

mg/kg = milligrams per kilogram.
N/A = Not applicable.
Note: Summary statistics include non-detects at one-half the detection limit.

Although the data from Rising Pond were not included in the COPC selection process, the Rising Pond summary statistics are included to allow for a comparison between the two Massachusetts sites. There were no contaminants detected in Rising Pond fish samples that were not detected in the PSA.

The concentrations of Appendix IX pesticides listed in Tables 2-11 and 2-12 are the values reported for GC/ECD analyses. However, the presence of PCBs interferes with the analysis of pesticides by GC/ECD, and the quantification of pesticides by GC/ECD can result in overestimating the pesticide concentration. When pesticides are analyzed using another technique, GC/MS Selected Ion Monitoring (SIM) mode, interference is not an issue and the results reflect only the concentration of the target pesticide. Because of the concerns that high concentrations of PCBs may be interfering with the pesticide analysis, 10 fish tissue samples were selected for additional study. Each of these 10 samples was analyzed for pesticides by GC/ECD methodology and by GC/MS SIM, which is not sensitive to interference by PCBs. Eleven pesticides were targeted. The results are summarized in Table 2-13, and the raw data are provided in Attachment C.3. The results for nine of the pesticides indicated much lower concentrations than originally reported, which is consistent with PCB interference with the pesticide analysis. Heptachlor epoxide was not detected in any of the 10 samples by GC/MS SIM, although it was reported in the GC/ECD analysis. Heptachlor epoxide is not believed to be present in fish tissue at the site, and was not included in Tables 2-11 and 2-12.

Table 2-13 compares the analytical results for the 10 samples based on GC/ECD and GC/MS SIM, showing the frequency of detection, median, mean, and maximum concentration detected for each pesticide by the GC/MS SIM and GC/ECD methodologies. The final set of three columns gives the ratio of the results of GC/MS SIM to the GC/ECD. The ratios for the mean range from less than 0.01 (suggesting that the GC/ECD results are overestimated by a factor of >100) for cis-nonachlor, o,p'-DDD, and o,p'-DDT, to 0.23 for trans-nonachlor. The ratio of 0.24 for heptachlor epoxide is spurious, and represents the ratio between the limit of detection and the mean concentration (with the non-detects factored in at the limit of detection). For o,p'-DDE,

Table 2-13

Comparison of Pesticide Analyses Based on GC/MS SIM and GC/ECD Analytical Methodology

	GC/MS SIM				GC/ECD				Ratio of SIM/ECD		
Contaminant	**Frequency of Detection**	**Median**	**Mean**	**Maximum**	**Frequency of Detection**	**Median**	**Mean**	**Maximum**	**Median**	**Mean[d]**	**Maximum**
4,4'-DDD	7/10	29	50	127	9/10	172	314	1645	0.17	0.16	0.077
4,4'-DDE	7/10	104	110	254	9/10	602	599	1203	0.17	0.18	0.21
4,4'-DDT	7/10[a]	1	1	4	4/10	2	16	62	0.46	0.080	0.060
cis-nonachlor	9/10	3	3	7	8/10	413	436	1160	0.0077	0.0080	0.0062
dieldrin	3/10	<1.9	6	37	9/10	16	88	335	0.12	0.064	0.11
heptachlor epoxide	0/10	<1.9	<1.9	<1.9	4/10	<1.9	8	23	0.99	0.24	0.087
o,p'-DDD	3/10	<1.9	4	22	9/10	654	639	1095	0.0030	0.0069	0.020
o,p'-DDE	2/10[b]	<1.9	<1.9	<1.9	5/10	10	23	64	0.19	0.075	0.031
o,p'-DDT	10/10[c]	0.3	6	51	10/10	918	802	1211	0.00033	0.0069	0.042
oxychlordane	4/10	2	4	13	5/10	16	20	56	0.12	0.18	0.24
trans-nonachlor	7/10	4	8	18	9/10	20	33	126	0.20	0.23	0.14

All concentrations in µg/kg.

[a] Six of the reported concentrations are less than the standard detection limits and flagged J.

[b] The reported concentrations are less than the standard detection limits and flagged J.

[c] Nine of the reported concentrations are less than the standard detection limits and flagged J.

[d] Ratio of the SIM GC/MS and GC/ECD was used as a correction factor.

each of the two detections by SIM analysis was lower than the standard detection limits, suggesting a very limited presence of this pesticide.

2.7.1.2 Comparisons with Benchmarks

Concentrations of pesticides and metals in fish were compared with Region 3 RBCs for fish (EPA, 2004a). The parameters used in the calculation of the Region 3 RBC for fish are presented in Table 2-14. These parameters, overall, yield exposure doses that are consistent with exposure parameters appropriate for the Housatonic River. The ingestion rate of 54 g/d for 350 days/year is higher than that used as the RME in this assessment (31 g/d for 365 d/year, see Section 4), whereas the exposure duration of 30 years is lower than the site-specific RME value of 50 years used for the HHRA (see Section 4). The RBCs are presented in Table 2-15.

Table 2-16 presents the number of samples that exceeded the RBC for each contaminant, as well as the magnitude by which the site-specific values exceed the RBC. Contaminants for which all concentrations are less than their respective RBCs were eliminated as COPCs; these contaminants are listed below:

- alpha-Chlordane
- beta-BHC
- Chlorpyrifos
- Endosulfan II
- Endrin
- gamma-BHC (Lindane)
- gamma-Chlordane
- Mirex
- o,p'-DDE

Additional compounds were eliminated from the COPC list based on low frequency and magnitude of exceedance of RBCs. Compounds eliminated for these reasons, based on a comparison with the concentrations detected using the GC/ECD analysis, are identified in Table 2-17 and listed below:

- Aldrin
- alpha-BHC
- 4,4'-DDT
- Heptachlor
- Hexachlorobenzene
- Pentachlorobenzene
- 1,2,4,5-Tetrachlorobenzene

Table 2-14

Parameters Used to Calculate Region 3 Fish Risk-Based Concentrations

Parameter	Value
Carcinogenic potency slope, oral	Chemical-specific $(mg/kg\text{-}d)^{-1}$
Reference dose, oral	Chemical-specific (mg/kg-d)
Target cancer risk	1E-6
Target hazard quotient	0.1
Body weight	70 kg
Averaging time – carcinogens	25,550 days
Averaging time – non-carcinogens	Exposure duration * 365 days/year
Fish ingestion rate	54 g/day
Exposure frequency	350 days/year
Exposure duration	30 years

Source: EPA, 2004a.

Table 2-15

Fish Risk-Based Concentrations

Contaminant	Fish Risk-based Concentration (mg/kg)	Basis
APP IX PESTICIDES		
1,2,3,4-Tetrachlorobenzene	NA	---
1,2,4,5-Tetrachlorobenzene	0.041	N
4,4'-DDD	0.013	C
4,4'-DDE	0.0093	C
4,4'-DDT	0.0093	C
Aldrin	0.00019	C
Alpha-BHC	0.00050	C
Alpha-Chlordane	0.0090	C
Beta-BHC	0.0018	C
Chlorpyrifos	0.41	N
cis-Nonachlor	NA	---
Delta-BHC	NA	---
Dieldrin	0.00020	C
Endosulfan II	0.81	N
Endrin	0.041	N
Gamma BHC (Lindane)	0.0024	C
Gamma-Chlordane	0.0090	C
Heptachlor	0.00070	C
Hexachlorobenzene	0.0020	C
Mirex	0.027	N
o,p'-DDD	0.013	C
o,p'-DDE	0.0093	C
o,p'-DDT	0.0093	C
Oxychlordane	NA	---
Pentachloroanisole	NA	---
Pentachlorobenzene	0.11	N
Toxaphene	0.0029	C
Trans-Nonachlor	NA	---
METALS		
Arsenic	0.0021	C
Lead	NA	---
Mercury (methyl)	0.014	N
Nickel	2.7	N

Source = EPA Region 3 Risk-Based Concentration (RBC) Table, 2004

C = Based on cancer target risk of 1E-06

mg/kg = milligrams per kilogram.

N = Based on noncancer effects using a target hazard quotient of 0.1

NA = Not available

Table 2-16

GC/ECD Fillet Comparison to RBCs
Primary Study Area

Contaminant	Frequency of Samples Exceeding RBC	Number of Samples where	
		1<= Ratio <10	10<= Ratio <100
APP IX PESTICIDES			
1,2,3,4-Tetrachlorobenzene	N/A	---	---
1,2,4,5-Tetrachlorobenzene	2 / 200	2	---
4,4'-DDD	20 / 200	19	1
4,4'-DDE	102 / 200	97	5
4,4'-DDT	1 / 200	1	---
Aldrin	18 / 200	18	---
Alpha-BHC	2 / 200	2	---
Alpha-Chlordane	0 / 200	---	---
Beta-BHC	0 / 200	143	---
Chlorpyrifos	0 / 200	---	---
cis-Nonachlor	N/A	---	---
Delta-BHC	N/A	---	---
Dieldrin	166 / 199	117	49
Endosulfan II	0 / 200	---	---
Endrin	0 / 200	---	---
Gamma-BHC (Lindane)	0 / 200	---	---
Gamma-Chlordane	0 / 200	---	---
Heptachlor	3 / 200	3	---
Hexachlorobenzene	10 / 200	10	---
Mirex	0 / 200	---	---
o,p'-DDD	150 / 200	144	6
o,p'-DDE	0 / 200	---	---
o,p'-DDT	170 / 200	163	7
Oxychlordane	N/A	---	---
Pentachloroanisole	N/A	---	---
Pentachlorobenzene	1 / 200	1	---
Trans-Nonachlor	N/A	---	---
METALS			
Lead	N/A	---	---
Mercury	6 / 6	---	6

N/A = No RBC is available.

Table 2-17

Additional Contaminants Eliminated as Fish Consumption COPCs based on GC/ECD Data

Contaminant	Reason for Elimination
Aldrin	Frequency of RBC exceedance (18/200 or 9% of samples) and degree of exceedance (maximum detected concentration to RBC ratio of 4).
alpha-BHC	Frequency of RBC exceedance (2/200 samples or 1%) and degree of exceedance (maximum detected concentration to RBC ratio of 1.2)
4,4'-DDT	Frequency of RBC exceedance (1/200 or 0.5% of samples) and degree of exceedance (maximum detected concentration to RBC ratio of 1.7)
Heptachlor	Frequency of RBC exceedance (3/200 samples or 1.5%) and degree of exceedance (maximum detected concentration to RBC ratio of 1.9)
Hexachlorobenzene	Frequency of RBC exceedance (10/200 samples or 5%) and degree of exceedance (maximum detected concentration to RBC ratio of 3.6).
Pentachlorobenzene	Frequency of RBC exceedance (1/200 samples or 0.5%) and degree of exceedance (maximum detected concentration to RBC ratio of 1.8).
1,2,4,5-Tetrachlorobenzene	Frequency of RBC exceedance (2/200 samples or 1%) and degree of exceedance (maximum detected concentration to RBC ratio of 2.2).

Because of the likelihood that analytical interferences from the PCBs result in an overestimate of the concentration of these pesticides, it is likely that there are no exceedances of the RBCs.

Three of the 11 pesticides that have GC/MS SIM data for a subset of samples were eliminated from the potential COPC list, based on comparisons of GC/ECD data with RBCs (o,p'-DDE, 4,4'-DDT) or because GC/MS data indicated it was not present (heptachlor epoxide). For the remaining eight pesticides, the concentrations in the larger (200 sample) data set were adjusted for analytical interference by multiplying the measured (with interferences) concentration by a correction factor, based on the data obtained from the sample subset, as summarized in Table 2-13. The correction factor, the ratio of the mean concentrations detected by the GC/MS SIM and GC/ECD methodologies, was selected as a central estimate that could be applied to all of the analytical data. The ratios of the medians were influenced by the detection limits in several cases, and therefore were considered inappropriate. Table 2-18 summarizes the results of this analysis.

Table 2-18

GC/MS SIM Fillet Comparison to RBCs

Contaminant	Frequency of Samples Exceeding RBC	Number of Samples where	
		1<= Ratio <10	10<= Ratio <100
APP IX PESTICIDES			
4,4'-DDD	2 / 200	2 (19)	0 (1)
4,4'-DDE	8 / 200	8 (97)	0 (5)
cis-Nonachlor	N/A	---	---
Dieldrin	44 / 199	44 (127)	0 (63)
o,p'-DDD	0 / 200	0 (144)	0 (6)
o,p'-DDT	0 / 200	0 (163)	0 (7)
Oxychlordane	N/A	---	---
Trans-Nonachlor	N/A	---	---

Values in parentheses are the number of exceedances based on the GC/ECD analysis.
N/A signifies no RBC is available, and no toxicity values have been published in IRIS with which to calculate an RBC.

Based on the corrected concentrations, o,p'-DDD and op'-DDT did not exceed the RBC in any sample, and these pesticides were eliminated as potential COPCs. In addition, 4,4' DDD and 4,4' DDE were eliminated as COPCs based on a low frequency of exceedance (less than 2.5%) and a low maximum exceedance (factor of 4 for each).

Dieldrin exceeded the RBC 44/199, or 22% of the time. The maximum exceedance was a factor of 4; the majority of the exceedances were less than a factor of 2. Because, as shown in Table 2-13, only three of the nine detections of dieldrin by GC/ECD were confirmed by the GC/MS SIM analysis, the frequency of RBC exceedance is likely to be lower than 22%. The arithmetic mean concentration, with non-detects substituted at the detection limit to provide a "worst case," and corrected by the factor calculated by the GC/MS SIM results, is below the RBC. For these reasons, dieldrin was eliminated as a potential COPC.

There are no RBCs for lead, 1,2,3,4-tetrachlorobenzene, cis-nonachlor, trans-nonachlor, oxychlordane, pentachloroanisole, and delta-BHC.

The maximum lead concentration in the PSA was 0.08 mg/kg (frequency of detection 2/6). Risks from exposure to lead were conservatively estimated using the Integrated Exposure Uptake Biokinetic (IEUBK) model (EPA, 2001). The IEUBK model was used to estimate blood lead levels in a child aged 1 to 7 years old. Standard default lead concentrations in air, soil, and water, and the maximum detected fish tissue concentration from the PSA (0.08 mg/kg), as well as the conservative assumption that fish comprised 100% of the dietary intake of meat, were used to estimate blood lead levels. The maximum fish tissue concentration was used as a conservative screen and because of the small sample size. Based on these assumptions, the predicted probability of exceeding the blood lead level of concern, 10 µg/dL, is less than 5%. Therefore, lead was eliminated as a COPC.

The pesticides without RBCs do not have toxicity values published in IRIS. In the PSA, concentrations were as follows:

- 1,2,3,4-Tetrachlorobenzene: ranged to 0.39 mg/kg (frequency of detection 198/200).
- Cis-nonachlor: ranged to 0.33 mg/kg (frequency of detection 190/200).
- Trans-nonachlor: ranged to 0.011 mg/kg (frequency of detection 186/200).
- Oxychlordane: ranged to 0.017 mg/kg (frequency of detection 95/200).
- Pentachloroanisole: ranged to 0.0021 mg/kg (frequency of detection 168/200).

- Delta-BHC: ranged to 0.011 mg/kg (frequency of detection) 73/200.

Chemicals without toxicity data were not carried through the quantitative risk assessment; however, the uncertainty associated with eliminating these pesticides from the risk analysis is discussed in Section 7.

2.7.1.3 Results of COPC Selection

Total PCBs, TEQ (PCB congener-based, dioxin congener-based, and furan congener-based), and mercury were retained as COPCs for the fish consumption pathway. Mercury concentrations in fish tissue are not available for reaches of the river downstream of the PSA. As noted previously, exposure and risks were calculated only for tPCBs (calculated as the sum of 121 congeners) in Connecticut because individual congener data were not available.

2.7.2 Risk Assessment Data Summary

COPC selection was conducted on the entire selected data set for the PSA. However, the PCB tissue data indicate there are differing concentrations among species, which is expected, because species bioaccumulate contaminants to differing degrees based upon trophic level and environmental exposure, differ in lipid concentrations, and may metabolize and excrete contaminants at a different rate. To simplify the analysis, tPCB concentrations in tissue in the different species from the different reaches were compared to determine which, if any, of the species data (for the PSA and Rising Pond) or collection locations (Connecticut) could be combined.

First, normality was tested using the Shapiro-Wilks or Lilliefors test (both at $\alpha = 0.05$ using ProUCL, version 3.1 (EPA, 2004b). Data distributions that were either normal or lognormal were compared using either the Equal-Variance or Aspin-Welch Unequal-Variance t-tests ($\alpha = 0.05$), depending upon the distribution. Species for which the distributions were neither normal nor lognormal were compared using the non-parametric Mann-Whitney Test ($\alpha = 0.05$), which does not require an assumption regarding the distribution. The t-tests and Mann-Whitney tests were performed using the Number Cruncher Statistical System (NCSS, 2000).

Summary statistics for tPCBs for all area/species pairings are presented in Table 2-19. The results of the statistical comparisons are presented for each evaluation area below. Statistical outputs are presented in Attachment C.5.

2.7.2.1 Primary Study Area

Statistical comparisons of the data indicated that within the PSA, concentrations of tPCBs in largemouth bass (predator) and brown bullhead (bottom feeder) were not statistically different (Mann-Whitney; α = 0.05); and that the differences in concentrations of tPCBs in perch and sunfish also were not statistically different (Mann-Whitney; α = 0.05). The data were combined into two groups rather than four to provide data groupings with larger sample sizes.

Summary statistics for the COPCs in each of the Reach 5 and 6 data sets, i.e., brown bullhead/largemouth bass and sunfish/yellow perch, are presented in Tables 2-20 and 2-21, respectively.

2.7.2.2 Rising Pond

Statistical comparisons of the data indicated that within Rising Pond, largemouth bass, brown bullhead, and pumpkinseed were not statistically different with respect to tPCB concentrations (Mann-Whitney; α = 0.05), and that perch had concentrations different from any other species (Mann-Whitney; α = 0.05). Because concentrations of bullhead, sunfish, and bass were not statistically different, they were combined to provide data groupings with larger sample sizes.

Summary statistics for the COPCs in each of the Rising Pond data sets, i.e., brown bullhead/largemouth bass/sunfish (i.e., pumpkinseed), and yellow perch, are presented in Tables 2-22 and 2-23, respectively.

Table 2-19

Total PCB Summary Statistics For Fish Species/Locations
Housatonic River Site

Species/Location	Number of Samples*	Range of Detected Concentrations (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)
Reaches 5 and 6					
Species					
Brown Bullhead	43	0.41 - 90	4.8	9.5	19
Largemouth Bass	30	1.2 - 151	4.7	6.6	14
Sunfish	52	1.1 - 47	4.3	5.4	7.2
Yellow Perch	75	0.54 - 76	3.6	5.4	7.8
Rising Pond					
Species					
Brown Bullhead	22	0.78 - 13	1.7	4.4	5.5
Largemouth Bass	11	1.7 - 5.8	2.8	3.6	4.8
Sunfish	13	0.76 - 5.1	1.8	3.2	3.9
Yellow Perch	14	1.6 - 25	3.7	5.7	9.9
CT - Smallmouth Bass					
Locations					
Bulls Bridge	20	0.36 - 2.0	0.68	0.83	1.3
West Cornwall	20	0.26 - 1.9	0.58	0.80	1.5
Lake Lillinonah	20	0.23 - 1.3	0.37	0.69	0.93
Lake Zoar	20	0.11 - 2.9	0.22	0.45	0.73
CT - Brown Trout					
Location					
West Cornwall	60	0.70 - 11	1.2	1.5	1.8

*Total PCBs detected in every sample.
mg/kg = milligrams per kilogram.

Table 2-20

Concentrations of COPCs in Brown Bullhead and Largemouth Bass Fillets
Reaches 5 and 6

Contaminant	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)
PCBs								
PCB, Total	73 / 73	0.41 - 151	N/A	4.8	8.6	16	lognormal	18
2,3,7,8-TCDD TEQs								
Dioxin Congener-based TEQ	18 / 52	0.0000022 - 0.0000073	0.0000024 - 0.0000077	0.0000031	0.0000036	0.0000038	neither	0.0000042
Furan Congener-based TEQ	51 / 52	0.0000011 - 0.000042	0.0000013 - 0.0000013	0.0000050	0.0000076	0.000011	lognormal	0.000012
Dioxin-like PCB Congener-based TEQ	73 / 73	0.000037 - 0.0036	N/A	0.00012	0.00018	0.00038	lognormal	0.00038
METALS								
Mercury	6 / 6	0.33 - 0.72	N/A	0.35	0.44	0.54	lognormal	0.61

mg/kg = milligrams per kilogram.

N/A = Not applicable.

Note: Summary statistics include non-detects at one-half the detection limit.

Table 2-21

Concentrations of COPCs in Sunfish and Yellow Perch Fillets
Reaches 5 and 6

Contaminant	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)
PCBs								
PCB, Total	127 / 127	0.54 - 76	N/A	4.2	5.4	7.5	neither	9.4
2,3,7,8-TCDD TEQs								
Dioxin Congener-based TEQ	18 / 78	0.00000043 - 0.0000027	0.00000055 - 0.0000020	0.00000070	0.00000077	0.0000015	neither	0.0000011
Furan Congener-based TEQ	77 / 78	0.0000019 - 0.000034	0.0000023 - 0.0000023	0.0000030	0.0000046	0.0000082	lognormal	0.0000071
Dioxin-like PCB Congener-based TEQ	127 / 127	0.0000038 - 0.0012	N/A	0.000050	0.000073	0.00011	neither	0.00017

*Statistics calculated by removing 2 samples in which 0 excess TEQ was calculated.

mg/kg = milligrams per kilogram.

N/A = Not applicable.

Note: Summary statistics include non-detects at one-half the detection limit.

Table 2-22

Concentrations of COPCs in Brown Bullhead, Largemouth Bass, and Pumpkinseed Fillets
Rising Pond

Contaminant	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)
PCBs								
PCB, TOTAL	46 / 46	0.76 - 13	N/A	2.3	3.6	4.9	lognormal	4.8
2,3,7,8-TCDD TEQs								
Dioxin Congener-based TEQ	3 / 30	0.00000047 - 0.00000056	0.00000032 - 0.0000010	0.00000042	0.00000052	0.00000089	neither	0.00000066
Furan Congener-based TEQ	20 / 30	0.0000028 - 0.000021	0.0000029 - 0.0000064	0.0000035	0.0000047	0.0000062	neither	0.0000090
Dioxin-like PCB Congener-based TEQ	31 / 31	0.000014 - 0.000094	N/A	0.000028	0.000043	0.000063	lognormal	0.000054

mg/kg = milligrams per kilogram.
N/A = Not applicable.
Note: Summary statistics include non-detects at one-half the detection limit.

Table 2-23

Concentrations of COPCs in Yellow Perch Fillets
Rising Pond

Contaminant	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)
PCBs								
PCB, Total	14 / 14	1.6 - 25	N/A	3.7	5.7	9.9	lognormal	14
2,3,7,8-TCDD TEQs								
Dioxin Congener-based TEQ	1 / 6	0.0000000052 - 0.0000000052	0.000000023 - 0.000000049	0.000000019	0.000000025	0.000000046	normal	0.000000042
Furan Congener-based TEQ	6 / 6	0.0000048 - 0.000017	N/A	0.0000056	0.0000081	0.000015	lognormal	0.000019
Dioxin-like PCB Congener-based TEQ	6 / 6	0.000023 - 0.00021	N/A	0.000026	0.000042	0.00012	lognormal	0.00028

mg/kg = milligrams per kilogram.

N/A = Not applicable.

Note: Summary statistics include non-detects at one-half the detection limit.

2.7.2.3 Connecticut

Statistical comparisons of the data indicated that in Connecticut, the West Cornwall and Bulls Bridge locations were not statistically different (equal variance t-test; $\alpha = 0.05$), nor were the Lake Lillinonah and Lake Zoar locations statistically different (Aspin-Welch unequal variance test; $\alpha = 0.05$) with respect to smallmouth bass tPCB concentrations. Because concentrations were not statistically different, the bass data from West Cornwall and Bulls Bridge and the bass data from Lake Lillinonah and Lake Zoar, respectively, were combined to provide data groupings with larger samples sizes. Brown trout data were collected from the West Cornwall location only.

Summary statistics for tPCBs in each of the Connecticut data sets, i.e., West Cornwall/Bulls Bridge Area smallmouth bass, West Cornwall Area brown trout, and Lake Lillinonah/Lake Zoar smallmouth bass, are presented in Table 2-24.

2.8 WATERFOWL COPC SELECTION AND DATA SUMMARY

This section presents the COPC selection and final data set determination as they pertain to the waterfowl consumption pathway.

2.8.1 COPC Selection Process

Because of the known releases at the site and high measured concentrations in site media, PCBs and dioxin/furan congeners were included as COPCs.

The data set used in the COPC selection process included 25 duck breast samples (5 mallard and 20 wood duck) from the PSA that were analyzed for a suite of Appendix IX compounds in addition to PCBs. Table 2-25 presents statistical summaries of all detected PCBs, TEQ, and other Appendix IX contaminants in these samples. The table includes frequency of detection, range of detected concentrations, range of sample quantitation limits, median, and interquartile ranges (i.e., 25th and 75th percentiles).

Table 2-24

Concentrations of PCBs and Lipids in Smallmouth Bass and Brown Trout Fillets
Connecticut

Contaminant	Frequency of Detection	Range of Detects (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)
Smallmouth Bass - West Cornwall/Bulls Bridge								
PCB, Total	40 / 40	0.26 - 2.0	N/A	0.63	0.81	1.3	lognormal	1.1
Percent Lipids	39 / 39	0.16 - 3.9	N/A	0.89	1.4	1.9	ND	ND
Brown Trout - West Cornwall								
PCB, Total	60 / 60	0.70 - 11	N/A	1.2	1.5	1.8	neither	2.9
Percent Lipids	60 / 60	0.29 7.3	N/A	1.4	2.6	4.3	ND	ND
Smallmouth Bass - Lake Lillinonah/Lake Zoar								
PCB, Total	40 / 40	0.11 - 2.9	N/A	0.33	0.55	0.82	lognormal	0.80
Percent Lipids	40 / 40	0.34 3.9	N/A	0.79	1.1	1.6	ND	ND

mg/kg = milligrams per kilogram.
N/A = Not applicable.
ND = Not determined.

Table 2-25

Duck Breast Pesticides, Metals, and Lipids Chemistry Summary
Reaches 5 and 6

Contaminant	Frequency of Detection GC/ECD	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)
PCBs						
PCB, Total	25 / 25	1.1 - 19	N/A	4.2	6.0	8.7
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	4 / 25	0.0000035 - 0.0000092	0.0000034 0.0000061	0.0000036	0.0000037	0.0000038
Furan Congener-based TEQ	24 / 25	0.0000038 - 0.000075	0.0000057 0.0000057	0.0000057	0.000010	0.000015
Dioxin-like PCB Congener-based TEQ	25 / 25	0.000062 - 0.0053	N/A	0.00026	0.00058	0.0013
APP IX PESTICIDES						
1,2,3,4-Tetrachlorobenzene	21 / 25	0.000085 - 0.0091	0.00017 - 0.0017	0.00041	0.0013	0.0019
1,2,3,5-Tetrachlorobenzene	14 / 25	0.00032 - 0.0039	0.0016 - 0.0017	0.00079	0.0016	0.0016
4,4'-DDD	22 / 25	0.00056 - 0.0077	0.0012 - 0.0017	0.0014	0.0017	0.0029
4,4'-DDE	25 / 25	0.0073 - 0.13	N/A	0.014	0.020	0.028
4,4'-DDT	2 / 25	0.000070 - 0.0068	0.000095 - 0.0017	0.0011	0.0016	0.0016
Aldrin	1 / 25	0.00013 - 0.00013	0.000095 - 0.0017	0.0011	0.0016	0.0016
Alpha-BHC	5 / 25	0.000072 - 0.00020	0.000095 - 0.0017	0.00058	0.0016	0.0016
Alpha-Chlordane	8 / 25	0.000080 - 0.00085	0.000090 - 0.0017	0.00034	0.0016	0.0016
Beta-BHC	1 / 25	0.00011 - 0.00011	0.000095 - 0.0017	0.0011	0.0016	0.0016
Chlorpyrifos	3 / 25	0.000064 - 0.00033	0.000025 - 0.0017	0.00099	0.0016	0.0016
Cis-Nonachlor	4 / 25	0.000060 - 0.0013	0.0000080 - 0.0017	0.000089	0.0016	0.0016
Delta-BHC	3 / 25	0.000026 - 0.000047	0.0000075 - 0.0017	0.00048	0.0016	0.0016
Dieldrin	1 / 25	0.017 - 0.017	0.000090 - 0.0017	0.0011	0.0016	0.0016
Endosulfan II	5 / 25	0.00073 - 0.0010	0.000090 - 0.0017	0.00082	0.0016	0.0016
Endrin	1 / 25	0.00021 - 0.00021	0.000090 - 0.0017	0.00099	0.0016	0.0016
Gamma BHC (Lindane)	1 / 25	0.000028 - 0.000028	0.000095 - 0.0017	0.0011	0.0016	0.0016
Gamma-Chlordane	1 / 25	0.00019 - 0.00019	0.000095 - 0.0017	0.0011	0.0016	0.0016
Heptachlor	2 / 25	0.000081 - 0.00023	0.000095 - 0.0017	0.0011	0.0016	0.0016
Heptachlor Epoxide	1 / 25	0.00019 - 0.00019	0.000095 - 0.0017	0.0011	0.0016	0.0016
Hexachlorobenzene	24 / 25	0.00013 - 0.0011	0.000017 - 0.000017	0.00023	0.00037	0.00059
Mirex	3 / 25	0.000047 - 0.00031	0.0000085 - 0.0017	0.00022	0.0016	0.0016
O,P'-DDD	24 / 25	0.0020 - 0.024	0.0012 - 0.0012	0.0078	0.011	0.015
O,P'-DDE	3 / 25	0.00037 - 0.00066	0.000090 - 0.0017	0.00091	0.0016	0.0016
O,P'-DDT	25 / 25	0.0067 - 0.19	N/A	0.021	0.030	0.054
Oxychlordane	13 / 25	0.00032 - 0.0029	0.000090 - 0.0017	0.00084	0.0011	0.0016
Pentachlorobenzene	25 / 25	0.000070 - 0.0073	N/A	0.00042	0.00090	0.0017
Trans-Nonachlor	11 / 25	0.00026 - 0.0018	0.000039 - 0.0017	0.00049	0.0012	0.0016
ORGANIC						
Percent Lipids (GC)	25 / 25	0.20 - 17	N/A	0.65	2.3	6.8
Percent Lipids (GC/MS)	25 / 25	0.80 - 30	N/A	2.0	5.9	13

mg/kg = milligrams per kilogram.
N/A = Not applicable.
Note: Summary statistics include non-detects at one-half the detection limit.

2.8.1.1 Frequency of Detection

The following contaminants were eliminated from evaluation because they were detected in less than 5% of the samples (i.e., 1 out of 25):

- Aldrin
- Beta-BHC
- Gamma-BHC (Lindane)
- Gamma-Chlordane
- Dieldrin
- Endrin
- Heptachlor Epoxide

2.8.1.2 Risk-Based Criteria

No RBCs are available for waterfowl. Fish RBCs represent very conservative screening risk values for waterfowl, because waterfowl consumption rates are lower than fish (see Section 4). Comparison of the fish RBCs with pesticide concentrations detected in waterfowl indicates that only the fish RBCs for 4,4'DDE, o,p'-DDD, and o,p'-DDT and dieldrin are exceeded in any sample, based on the GC/ECD data, as shown in Table 2-26. Thus, pesticides other than these DDTs and dieldrin are eliminated as COPCs by comparison with fish RBCs. Dieldrin was eliminated as a COPC because of its low frequency of detection.

2.8.1.3 Accounting for Analytical Interference

The Appendix IX pesticide concentrations listed in Table 2-25 are based on GC/ECD analytical methodology. However, analytical results for duck tissue, as for fish tissue, were affected by interference from high concentrations of PCBs. To determine whether the amount of interference is likely to be comparable for fish and ducks, the ratio of total pesticide and tPCB concentrations was calculated for each largemouth bass sample and each duck sample from the PSA. The total pesticide/tPCB ratio should be indicative of interference level, although it is possible that individual congeners are interfering with individual pesticides. As shown in Table 2-27, both the range and the central tendencies of these ratios for fish and ducks were similar. Based on this similarity, it is anticipated that the duck concentrations for pesticides are actually 5 to 100 times lower than reported in the GC/ECD analysis and listed in Table 2-25. In addition, the frequency of detection is likely to be lower.

Table 2-26

Comparison of Fish RBCs with Pesticide Concentrations Detected in Waterfowl

Appendix IX Pesticides	Max Concentration (mg/kg)	Fish RBC (mg/kg)	
1,2,3,4-Tetrachlorobenzene	0.0091	NA	---
1,2,3,5-Tetrachlorobenzene	0.0039	0.041	N
4,4'-DDD	0.0077	0.013	C
4,4'-DDE	0.13	0.0093	C
4,4'-DDT	0.0068	0.0093	C
Aldrin	0.00013	0.00019	C
Alpha-BHC	0.0002	0.00050	C
Alpha-Chlordane	0.00085	0.009	C
Beta-BHC	0.00011	0.0018	C
Chlorpyrifos	0.00033	0.41	N
Cis-Nonachlor	0.0013	NA	---
Delta-BHC	0.000047	NA	---
Dieldrin	0.017	0.00020	C
Endosulfan II	0.0010	0.81	N
Endrin	0.00021	0.041	N
Gamma BHC (Lindane)	0.000028	0.0024	C
Gamma-Chlordane	0.00019	0.0090	C
Heptachlor	0.00023	0.00070	C
Heptachlor Epoxide	0.00019	0.00035	C
Hexachlorobenzene	0.0011	0.0020	C
Mirex	0.00031	0.027	N
o,p'-DDD	0.024	0.013	C
o,p'-DDE	0.00066	0.0093	C
o,p'-DDT	0.19	0.0093	C
Oxychlordane	0.0029	NA	---
Pentachlorobenzene	0.0073	0.11	N
Trans-Nonachlor	0.0018	NA	---

Source: EPA Region 3 Risk-Based Concentration (RBC) Table, 2004.

C = Based on cancer target risk of 1E-06.

mg/kg = milligrams per kilogram.

N = Based on noncancer effects using a target hazard quotient of 0.1.

NA = Not available.

Table 2-27

Ratio of Total Pesticide/tPCB Concentrations in Ducks and Largemouth Bass, PSA

Parameter	Ducks	Largemouth Bass
Range	1.1%-2.8%	0.88%-2.8%
Arithmetic Mean	2.11%	1.55%
Geometric Mean	1.90%	1.49%

Adjusting the GC/ECD data for 4,4'DDE, o,p'-DDD, and o,p'-DDT using the ratio of means of GC/MS SIM and GC/ECD data obtained from fish tissue (Table 2-13) reduces the maximum concentrations detected for o,p'-DDD and o,p'-DDT to lower than the fish RBC. Based on this comparison, o,p'-DDD and o,p'-DDT were eliminated as COPCs. One of 25 samples had an (adjusted) concentration of 4,4'-DDE higher, by a factor of 3, than the conservative fish-based RBC. Based on the low frequency, low maximum exceedance of this highly conservative RBC, 4,4'-DDE was eliminated as a COPC.

2.8.1.4 Results of COPC Selection

Total PCBs and TEQ (PCB congener-based, dioxin congener-based, and furan congener-based TEQ) were retained as COPCs for the waterfowl consumption pathway.

2.8.2 Risk Assessment Data Summary

COPC selection was conducted using all of the waterfowl breast tissue data from the PSA. Summary statistics for mallards and wood ducks combined are presented in Table 2-28. Comparable statistics for the breast tissue samples from 20 wood ducks in the Threemile Pond reference area are also presented in the table.

Table 2-28

Total PCB Breast Tissue Summary Statistics for Duck Species

Species/Location	No. Samples	Range of Concentrations	25th Percentile	Median	Mean	75th Percentile
Mallard, Reaches 5 and 6	5	1.59 - 19.34	3.58	7.8	9.1	15.27
Wood Duck, Reaches 5 and 6	20	1.06 - 17.9	3.94	5.95	6.6	8.36
Wood Duck, Threemile Pond	20	0.004 - 3.21	0.01	0.21	0.58	0.63

*Total PCBs mg/kg wet weight.

Because PCBs are the major contaminant in the study area, tPCB concentrations in the two species were compared. First, normality was tested using the Shapiro-Wilks test ($\alpha = 0.05$). Subsequent statistical comparisons of the data indicate that within the PSA, mallard and wood duck breast were not significantly different (equal variance t-test; $\alpha = 0.05$). Statistical outputs are presented in Attachment C.6.

Because the tPCB concentrations in mallard and wood duck tissue were not statistically different, data from these species were combined to provide the waterfowl consumption data set. Summary statistics for the waterfowl consumption COPCs are presented in Table 2-29. The data set included breast tissue data from both mature and immature ducks. Ducks in the sample were collected in August/early September. Because immature ducks are harvestable by the opening of hunting season, it was considered appropriate to include them in the data set used to calculate the exposure point concentration even though the dietary preferences of immature ducks are different from those of adult ducks (except during adult duck breeding and egg laying) and reflect only site contamination. (Adult ducks that have spent the spring and summer rearing broods on the river also reflect primarily site-related exposures.) See Table 2-30 for age-specific tPCB concentrations.

Table 2-29

Concentrations of COPCs in Duck Breast
Reaches 5 and 6

Contaminant	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Range of Sample Quantitation Limits (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)
PCBs								
PCB, Total	25 / 25	1.1 - 19	N/A	4.2	6.0	8.7	lognormal	9.7
2,3,7,8-TCDD TEQs								
Dioxin Congener-based TEQ	4 / 25	0.0000035 - 0.0000092	0.0000034 0.0000061	0.0000036	0.0000037	0.0000038	neither	0.0000046
Furan Congener-based TEQ	24 / 25	0.0000038 - 0.000075	0.0000057 0.0000057	0.0000057	0.000010	0.000015	lognormal	0.000017
Dioxin-like PCB Congener-based TEQ	25 / 25	0.000062 - 0.0053	N/A	0.00026	0.00058	0.0013	lognormal	0.0019

mg/kg = milligrams per kilogram.

N/A = Not applicable.

Note: Summary statistics include non-detects at one-half the detection limit.

Table 2-30

Concentrations of tPCBs in Duck Breast by Age Class

Species/Location	Number of Samples*	Range of Detected Concentrations (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)
Reaches 5 and 6					
Age					
Immature	20	1.6 - 19	4.7	5.9	7.7
Mature	5	1.1 - 18	2.4	8.7	13

*Total PCBs detected in every sample.
mg/kg = milligrams per kilogram.

2.9 REFERENCES

ANS (The Academy of Natural Sciences of Philadelphia). 1990. *PCB Concentrations in Fishes from the Housatonic River, Connecticut in 1984, 1986, and 1988*. Division of Environmental Research, Report No. 89-30F, January 11, 1990.

ANS (The Academy of Natural Sciences of Philadelphia). 1991. *PCB Concentrations in Fishes from the Housatonic River, Connecticut in 1984 to 1990.* Division of Environmental Research, Report No. 91-20R, July 29, 1991.

ANS (The Academy of Natural Sciences of Philadelphia). 1993. *PCB Concentrations in Fishes from the Housatonic River, Connecticut in 1984 to 1992.* Division of Environmental Research.

ANS (The Academy of Natural Sciences of Philadelphia). 1995. *PCB Concentrations in Fishes from the Housatonic River, Connecticut in 1984 to 1994.* Division of Environmental Research, Report No. 95-3F, May 8, 1995.

ANS (The Academy of Natural Sciences of Philadelphia). 1997. *PCB Concentrations in Fishes from the Housatonic River, Connecticut in 1984 to 1996.* Division of Environmental Research.

ANS (The Academy of Natural Sciences of Philadelphia). 2001. *PCB Concentrations in Fishes from the Housatonic River, Connecticut, 1984-2000, and in Benthic Insects, 1978-2001.* Patrick Center for Environmental Research, Report No. 01-9-F. July 23, 2001

BBL (Blasland, Bouck & Lee, Inc.) and QEA (Quantitative Environmental Analysis, LLC). 2003. *Housatonic River – Rest of River RCRA Facility Investigation Report*. Prepared for General Electric Company.

Beck, Gerald J. 1982. *PCBs in Housatonic River Fish – Statistical Analyses*. January.

Bellrose, F.C. 1980. *Ducks, Geese, and Swans of North America.* Stackpole Books, Harrisburg, PA, USA.

Boon, J.P., J. Van der Meer, C.R. Allchin, R.J. Law, J. Klungsoyr, P.E.G. Leonards, H. Spliid, E. Storr-Hansen, C. Mckenzie, D.E. Wells. 1997. Concentration-dependent changes of PCB patterns in fish-eating mammals: Structural evidence for induction of cytochrome P-450. *Arch. Environ. Contam. Toxicol*. 33:298-311.

ChemRisk. 1994. *Methodology and Results of the Housatonic River Creel Survey*. Prepared for: General Electric Company. 25 March 1994.

Coles, James F. 1996. *Organochlorine Compounds and Trace Elements in Fish Tissue and Ancillary Data of the Connecticut, Housatonic, and Thames River Basins Study Unit, 1992-94.* USGS Open File Report 96-358, p26.

CTDHS (State of Connecticut Department of Health Services). 1979. *Housatonic River PCB Fish Log Book, 1979 Samples.*

CTDEP (Connecticut Department of Environmental Protection). 1988. *An Angler Survey and Economic Study of the Housatonic River Fishery Resource. Final Report*. Bureau of Fisheries, Department of Environmental Protection, State of Connecticut.

CTDEP (Connecticut Department of Environmental Protection). 1994. Letter to Mr. Richard Thibedeau, Massachusetts Department of Environmental Management from Michael J. Harder. 6 April 1994.

Ebert, E.S., S.H. Su, T.J. Barry, M.N. Gray, and N.W. Harrington. 1996. Estimated rates of fish consumption by anglers participating in the Connecticut Housatonic River Creel Survey. *North American Journal of Fisheries Management* 16:81-89.

EPA (U.S. Environmental Protection Agency). 1987. Superfund Data Quality Objectives for Remedial Response Activities, Development Process. Reproduced by U.S. Department of Commerce.

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final*.

EPA (U.S. Environmental Protection Agency). 1992. *Guidance for Data Useability in Risk Assessment (Part A) Final*. Office of Emergency and Remedial Response, Washington DC. PB92-963356.

United States of America, State of Connecticut and Commonwealth of Massachusetts, Plaintiffs vs. General Electric Company, Defendant. 1999. Consent Decree. October 1999.

EPA (U.S. Environmental Protection Agency). 2000. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories*, Volume I, Third Edition. November 2000.

EPA (U.S. Environmental Protection Agency). 2001. Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). www.epa.gov/superfund/programs/lead

EPA (U.S. Environmental Protection Agency). 2004a. *Region 3 Risk-Based Concentration Table*. April 2004.

EPA (U.S. Environmental Protection Agency). 2004b. ProUCL version 3.1. April 2004.

Gisslen, W. 1995. *Professional Cooking*, 3rd ed. John Wiley & Sons, Inc. 828 p.

Grice, D. and J.P. Rogers. 1965. *The Wood Duck in Massachusetts*. Massachusetts Division of Fisheries and Game. 96 pp.

Labensky, S. and A. Hause. 1995. *On Cooking: Techniques from Expert Chefs*. Prentice-Hall, Inc. 1080 p.

MassWildlife. 2004. *MassWildlife Migratory Bird Regulations for 2004-2005*.

MDEP (Massachusetts Department of Environmental Protection). 8 October 1981. PCB Data From MDEP Files for 1977 Fish.

MDPH (Massachusetts Department of Public Health). 1997. *Housatonic River Area PCB Exposure Assessment Study, Final Report.* Bureau of Environmental Health Assessment, Environmental Toxicology Unit. September 1997.

NCSS (Number Cruncher Statistical System). 2000. Published by NCSS. Dr. Jerry L. Hinztze. Kaysville, Utah.

Smith, Stephen B. and James F. Coles. 1997. *Endocrine Biomarkers, Organochlorine Pesticides, and Congener Specific Polychlorinated Biphenyls (PCBs) in Largemouth Bass From Woods Pond, Housatonic River, MA, Sept 1994 and May 1995*. U.S. Geological Survey.

Stewart Laboratories, Inc. 1982. *Housatonic River Study 1980 and 1982,* Volumes I and II.

Terres, John K. 1980. *The Audubon Society Encyclopedia of North American Birds*. Alfred A. Knopf, New York, NY. 1109 p.

Tillitt, D, D. Papoulias, and D. Buckler. 2003a. *Fish Reproductive Health Assessment in PCB Contaminated Regions of the Housatonic River, Massachusetts, USA: Investigations of Causal Linkages Between PCBs and Fish Health.* Final Report of Phase I Studies. Prepared for U.S. Fish and Wildlife Service, Concord, New Hampshire and U.S. Environmental Protection Agency, Boston, Massachusetts. July 2, 2003.

Tillitt, D, D. Papoulias, and D. Buckler. 2003b. *Fish Reproductive Health Assessment in PCB Contaminated Regions of the Housatonic River, Massachusetts, USA: Investigations of Causal Linkages Between PCBs and Fish Health.* Final Report of Phase II Studies. Prepared for U.S. Fish and Wildlife Service, Concord, New Hampshire and U.S. Environmental Protection Agency, Boston, Massachusetts. July 8, 2003.

Van den Berg, Martin, Linda Birnbaum, Albertus T.C. Bosveld, Bjorn Brunstrom, Philip Cook, Mark Feeley, John P. Giesy, Annika Hanberg, Ryuichi Hasegawa, Sean W. Kennedy, Timothy Kubiak, John Christian Larsen, F.X. Rolaf van Leeuwen, A.K. Djien Liem, Cynthia Nolt, Richard E. Peterson, Lorenz Poellinger, Stephen Safe, Dieter Schrenk, Donald Tillitt, Mats, Tysklind, Maged Younes, Fredrik Waern, and Tim Zacharewski. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs, for humans and wildlife. *Environmental Health Perspectives* 106(12):775-792.

WESTON (Roy F. Weston, Inc.). 1998, revised 2003. *Quality Assurance Project Plan*. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. October 1998, DCN GEP2-100598-AADE; May 2003, DCN GE-022803-ABLZ.

WESTON (Roy F. Weston, Inc.). 1999, revised 2003. *Quality Assurance Project Plan*, Volume III, Appendices C and D. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. January 1999, DCN GEP2-123098-AAET; October 1999, DCN GEP2-060499-AAIY; and May 2003, DCN GE-022803-ABLZ.

WESTON (Roy F. Weston, Inc.). 2000. *Supplemental Investigation Work Plan for the Lower Housatonic River*, Volumes I and II. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. DCN GEP2-020900-AAME.

WESTON (Weston Solutions, Inc.). 2004. *Ecological Risk Assessment for General Electric (GE)/Housatonic River Site, Rest of River*. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. DCN GE-100504-ACJS. November 12, 2004.

3. DOSE-RESPONSE ASSESSMENT

3.1 INTRODUCTION

The primary purpose of the dose-response assessment is to identify the toxicity values to use in the evaluation of potential human cancer risks and noncancer health effects. These toxicity values are combined with the average daily doses of COPCs to calculate potential cancer risks and noncancer health hazards in the risk characterization step.

EPA has developed toxicity values for cancer and noncancer effects. The toxicity values for cancer are known as cancer slope factors (CSFs), whereas toxicity values for noncancer effects associated with oral exposures are known as reference doses (RfDs).

CSFs are plausible upper-bound estimates of carcinogenic potency used to calculate cancer risk from exposure to carcinogens by relating estimates of lifetime average chemical intake to the incremental probability of an individual developing cancer over a lifetime (EPA, 1986a, 1999). Because the CSFs developed by EPA are plausible upper-bound estimates, EPA is reasonably confident that the actual cancer risks are likely to be less than the risks estimated with the upper-bound slope factor. It is not possible to estimate how much less, but risks to some individuals could be zero.

The chronic RfD represents an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA, 1989).

Historically, an important distinction between the cancer and noncancer toxicity values has been that CSFs were developed assuming a linear dose-response relationship at the low doses associated with environmental exposures in humans (EPA, 1986a), whereas noncancer reference doses were developed assuming that there was a threshold to the adverse effect. In other words, for a carcinogen, it was assumed that there is a finite risk of a carcinogenic response associated with all exposures, no matter how low. For a noncancer, threshold effect, it was assumed that there is a dose below which no adverse effects would be expected.

The different shapes of the cancer and noncancer dose-response relationships were based on data and inferences regarding toxic processes. As scientific knowledge of the carcinogenic process has increased, several different "modes of action" of cancer have been recognized. Although for many modes of action, such as those that include a reaction with DNA, linear extrapolations to low dose are appropriate, there may be some modes of action that are appropriately modeled using a threshold approach. EPA has recently published drafts of revised cancer risk assessment guidelines (EPA, 2003, 1999, 1996a) that reflect the mode of action differences. The carcinogens evaluated in this report have CSFs derived using linear extrapolations to low doses. The CSFs for PCBs and dioxin-like compounds used in this report have been evaluated and reviewed by EPA in the context of the revised cancer risk assessment guidelines and are consistent with these guidelines.

Cancer and noncancer toxicity values published in EPA databases and reports were used in the risk assessment. Toxicity values obtained from the Integrated Risk Information System (IRIS), EPA's consensus toxicity values (EPA, 2004), were used preferentially because these values have undergone extensive scientific peer review. For COPCs for which toxicity values are not published in IRIS, provisional values were obtained from the Health Effects Assessment Summary Tables (HEAST) (EPA, 1997).

The following sections describe the approach to calculating toxicity values and identify the toxicity values selected for use in this assessment. Section 3.2 describes the approach to evaluating cancer effects, and Section 3.3 describes the approach to evaluating noncancer health effects.

3.2 CARCINOGENIC EFFECTS

3.2.1 Cancer Potency

The CSF is used with exposure information to provide a conservative estimate of the likelihood that an individual will develop cancer as a result of lifetime exposure to a chemical. It is a plausible upper-bound estimate of carcinogenic potency used to calculate cancer risk from exposure to carcinogens by relating lifetime average contaminant intake to the incremental probability of an individual developing cancer over a lifetime. The oral CSFs used in this risk assessment are expressed as risk per unit dose, in units of incremental cancer risk per milligram of contaminant per kilogram of body weight per day $(mg/kg\text{-}d)^{-1}$. Cancer potency is directly proportional to the CSF value; the larger the CSF, the greater the cancer potency of the compound.

Two carcinogenic COPCs are considered in this assessment: tPCBs and 2,3,7,8-TCDD TEQ. The following two sections provide a discussion of some of the important toxicological issues associated with these COPCs. A more detailed discussion is provided in Section 4 of HHRA Volume I.

3.2.2 PCBs

PCBs are synthetic organic chemicals including 209 individual chlorinated biphenyl compounds, known as congeners. The manufacturing process of commercial PCB mixtures (e.g., Aroclors) produced approximately 175 of the possible 209 PCB congeners. During Aroclor production, small amounts of furans are also formed and are present in the commercial product at parts per million (ppm) concentrations (ATSDR, 2000; Erickson, 2001). Heating PCBs, either at high temperatures, or at lower temperatures for longer periods of time, also results in the formation of furans (Erickson, 2001).

Aroclor 1260 is the predominant Aroclor pattern detected in the Rest of River; a PCB pattern resembling Aroclor 1254 has also been detected, but at lower concentrations (WESTON, 2002). Aroclor 1260 is one of the most highly chlorinated of the commercial Aroclors, with an average chlorine content by weight of 60%; Aroclor 1254 has an average chlorine content by weight of 54%. There is considerable overlap in the individual congeners associated with these two Aroclors (Erickson, 2001). Toxicity data for multiple adverse effects, including cancer, are available for commercial mixtures of Aroclor 1260 and Aroclor 1254 (ATSDR, 2000; Cogliano, 1998; EPA, 2004). Individual PCB congeners also vary in their toxicity, both in their potency and their mechanism of action. Twelve congeners have dioxin-like activity in humans, as discussed in Section 3.2.3.

Following the release of commercial PCB mixtures into the environment, the original mixture may be altered as a result of environmental fate and transport processes such as partitioning, transformation, and bioaccumulation through the food chain. For example, environmental transport processes such as vaporization and dissolution do not act on all congeners equally, resulting in environmental concentrations of individual PCB congeners that may differ substantially from those present in the original commercial mixture. This process is known as weathering (Erickson, 2001; EPA, 1996b). Bioaccumulation and biomagnification through the foodchain can result in altered patterns of the original congeners, as well as metabolic by-products of congeners, notably hydroxyl or methylsulfonyl-PCB metabolites (James, 2001). These alterations in composition may alter the toxicity of the mixture, making it more or less toxic than the commercial product.

EPA has classified PCBs as a B2 or probable human carcinogen based on liver tumors found in rats exposed to a range of commercial PCB mixtures, and on suggestive evidence from human studies, referred to as epidemiological studies (EPA, 1996a, 2004; Safe, 1994). Although the IRIS profile has not yet been updated to provide a descriptor under draft revised cancer guidelines (EPA, 1999), EPA in 1996 (EPA, 1996b) reaffirmed the classification of PCBs as a probable human carcinogen. The 1996 PCB cancer reassessment was consistent with the 1996 proposed cancer guidelines (EPA, 1996b) and remains consistent with the 1999 Revised Carcinogen Guidelines (EPA, 1999). The 1999 Guidelines currently serve as EPA’s interim guidance to EPA risk assessors preparing cancer risk assessments (EPA, 2001).

To evaluate environmental mixtures, EPA recommends an approach to assess cancer risk associated with exposure to PCBs that accounts for different PCB mixtures typically found in environmental media (EPA, 2004). Studies to date suggest that more highly chlorinated, less volatile congeners are associated with greater cancer risk. These congeners tend to persist in the environment in soil and sediment and to bioaccumulate and biomagnify in biota. More volatile, less chlorinated congeners are more likely to be metabolized and eliminated than highly chlorinated congeners. If congener data are not available, the exposure pathway can be used to indicate how the potency of a mixture might have changed following release to the environment. EPA’s recommendations are summarized in Table 3-1 and described below.

To estimate risk from exposure to highly chlorinated congeners or exposure via pathways that include highly chlorinated congeners, EPA recommends using an upper-bound CSF of

Table 3-1

Tiers of CSF Estimates for Environmental Mixtures of Polychlorinated Biphenyls (PCBs)

Central Slope $(mg/kg\text{-}d)^{-1}$	Upper-Bound Slope $(mg/kg\text{-}d)^{-1}$	Criteria for Use
High Risk and Persistence		
1.0	2.0	Food chain exposure
		Sediment or soil ingestion
		Dust or aerosol inhalation
		Dermal exposure, if an absorption factor has been applied to reduce the external dose
		Presence of dioxin-like, tumor-promoting, or persistent congeners in other media
		Early life exposure (all pathways and mixtures)
Low Risk and Persistence		
0.3	0.4	Ingestion of water-soluble congeners
		Inhalation of volatilized congeners
		Dermal exposure, if no absorption factor has been applied to reduce the external dose
Lowest Risk and Persistence		
0.04	0.07	Congener or isomer analyses verify that congeners with more than four chlorines comprise less than 0.5% of tPCBs

Source: EPA, 1996b.

2.0 per mg/kg-d and a central estimate CSF of 1.0 per mg/kg-d. These CSFs are used for (1) food chain exposure; (2) sediment or soil ingestion; (3) dust or aerosol inhalation; (4) dermal exposure, if an absorption factor has been applied; (5) presence of dioxin-like, tumor-promoting, or persistent congeners; and (6) early life exposure (all pathways and mixtures).

To estimate risk from exposure to more volatile PCB congener mixtures that are less persistent in the environment, EPA recommends using an upper-bound CSF of 0.4 per mg/kg-d and a central estimate CSF of 0.3 per mg/kg-d. These CSFs are used for (1) ingestion of water-soluble congeners; (2) inhalation of evaporated congeners; and (3) dermal exposure, if no absorption factor has been applied.

If congener or isomer analyses verify that congeners with more than four chlorines comprise less than 0.5% of tPCBs, EPA (EPA, 2002) recommends use of an upper-bound CSF of 0.07 per mg/kg-d and a central estimate CSF of 0.04 per mg/kg-d.

The exposure pathways evaluated in this risk assessment meet the criteria for evaluating the exposure as a mixture of highly chlorinated PCBs. Thus, the high risk and persistence upper-bound CSF of 2.0 $(mg/kg\text{-}d)^{-1}$ and the central estimate CSF of 1.0 $(mg/kg\text{-}d)^{-1}$ were incorporated into the reasonable maximum exposure (RME) and the central tendency exposure (CTE) risk estimates, respectively.

3.2.3 Dioxins and Furans and Dioxin-Like PCBs

Like PCBs, PCDDs and PCDFs are commonly found as complex mixtures in environmental media and biological tissues. PCDDs include 75 compounds, and PCDFs include 135 compounds. All of these compounds are referred to as congeners. Humans are exposed to these contaminants as complex mixtures, which vary by source and medium of exposure, rather than as individual congeners.

The most frequently studied of the PCDD congeners is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), which is often simply referred to as dioxin. Seven PCDD, 10 PCDF, and 12 PCB congeners exhibit human toxicity similar to 2,3,7,8-TCDD. PCB congeners may exert toxic effects through the same mechanism of action as 2,3,7,8-TCDD, namely, binding to the aryl hydrocarbon receptor (AhR), a cellular protein, as an initial step. A toxic equivalence (TEQ) approach has been developed to estimate risk associated with 2,3,7,8-TCDD and other dioxin-like congeners (Van den Berg et al., 1998), which is described in Section 3.2.4.

Cancer risks associated with TEQ from 2,3,7,8-TCDD and other dioxin-like congeners were calculated using EPA's CSF for oral carcinogenicity of 2,3,7,8-TCDD of 1.5E+05 $(mg/kg\text{-}d)^{-1}$ (EPA, 1997). The CSF was derived from linearized multistage modeling of female liver cancer results from a 2-year feeding study of Sprague Dawley rats (EPA, 1985). EPA's Dioxin Reassessment provides a CSF for oral carcinogenicity of 2,3,7,8-TCDD of 1E+06 $(mg/kg\text{-}d)^{-1}$ (EPA, 2001. However, the Dioxin Reassessment has not been formally released, and it is being reviewed by the National Academy of Sciences (NAS). The Dioxin Reassessment, the NAS review, and the uncertainties associated with each of these CSFs are discussed in Section 4 of HHRA Volume I.

3.2.4 TEQ Approach in Cancer Risk Assessment

A TEQ approach was developed to estimate risk associated with 2,3,7,8-TCDD and other dioxin-like PCDD, PCDF, and PCB congeners (Van den Berg et al., 1998) and has been adopted for use at Superfund and RCRA sites (EPA, 1998). The approach applies only to aryl hydrocarbon receptor (AhR)-mediated effects, assuming a model of dose additivity among congeners. Congeners included in the TEQ approach satisfy the following criteria:

- They are structurally similar to PCDDs and PCDFs.
- They bind to the AhR.
- They elicit AhR-mediated biochemical and toxic responses.
- They are persistent and accumulate in the food chain (Van den Berg et al., 1998).

Binding to the AhR is an important criterion because most (if not all) biological effects of these congeners appear to be mediated by the AhR (Van den Berg et al., 1998).

3.2.4.1 Calculating TEQ

Each dioxin-like congener was assigned a toxic equivalency factor (TEF) to represent the fractional toxicity of the congener relative to 2,3,7,8-TCDD. Table 3-2 summarizes these TEFs,

Table 3-2

Toxicity Equivalency Factors (TEFs) for Dioxins and Furans and Dioxin-like PCBs

Compound	TEF
Chlorodibenzo-p-dioxins (CDDs)	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD 1,2,3,6,7,8-HxCDD 1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0001
Chlorodibenzofurans (CDFs)	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF 2,3,4,7,8-PeCDF	0.05 0.5
1,2,3,4,7,8-HxCDF 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0001
Dioxin-like PCBs	
PCB-77: 3,4,3’,4’-TeCB	0.0001
PCB-81: 3,4,4’5-TeCB	0.0001
PCB-105: 2,3,4,3’,4’-PeCB	0.0001
PCB-114: 2,3,4,5,4’-PeCB	0.0005
PCB-118: 2,4,5,3’,4’-PeCB	0.0001
PCB-123: 3,4,5,2’,4’-PeCB	0.0001
PCB-126: 3,4,5,3’,4’-PeCB	0.1
PCB-156: 2,3,4,5,3’,4’-HxCB	0.0005
PCB-157: 2,3,4,3’,4’,5’-HxCB	0.0005
PCB-167: 2,4,5,3’,4’,5’-HxCB	0.00001
PCB-169: 3,4,5,3’,4’,5’-HxCB	0.01
PCB-189: 2,3,4,5,3’,4’,5’-HpCB	0.0001

Source: Van den Berg et al., 1998.

which were developed based on contaminant structure, persistence, resistance to metabolism, and toxicological action (Van den Berg et al., 1998). The uncertainty associated with TEFs is discussed in the HHRA, Volume I, Section 4.2.2.3. TEFs indicate an order-of-magnitude estimate of a congener's toxicity relative to 2,3,7,8-TCDD, and they are used to transform concentrations of individual dioxin-like PCDD, PCDF, and PCB congeners into equivalent concentrations of 2,3,7,8-TCDD.

The TEF of each congener present in the mixture is multiplied by the respective congener concentration. The products are then summed to represent the 2,3,7,8-TCDD TEQ of the mixture, as determined by the equation:

$$TEQ = \sum_{n1}(PCDD_i \, x TEF_i) + \sum_{n2}(PCDF_i \, x TEF_i) + \sum_{n3}(PCB_i x TEF_i)$$

where:

TEQ = Toxic equivalence concentration

PCDD = Polychlorinated dibenzo-*p*-dioxin concentration

PCDF = Polychlorinated dibenzofuran concentration

PCB = Dioxin-like polychlorinated biphenyl concentration

TEF = Toxic equivalency factor

3.2.4.2 Estimating Total Cancer Risk from PCBs and TEQ

PCB cancer risk was quantified by multiplying tPCB doses by the PCB CSF; and TEQ cancer risk was quantified by multiplying TEQ doses from PCDD, PCDF, and dioxin-like PCB congeners by the CSF for 2,3,7,8-TCDD. Estimating total cancer risk from tPCBs and TEQ is not straightforward for several reasons:

- PCBs were released into the environment from the GE facility as Aroclor 1260 and, to a lesser extent, Aroclor 1254, as a result of construction and repair of electrical transformers.

- Aroclors are complex commercial mixtures that contain many individual PCB congeners, as well as a small component of chlorinated furans (Cogliano, 1998).

- Aroclors that have been subjected to fires or used in transformers, such as those released from the GE facility, are often enriched in chlorinated furans that are formed upon heating PCBs.

- The fate and transport properties of individual congeners differ, and PCB mixtures in the environment can differ significantly from the original commercial products.

- The cancer bioassays used to derive the PCB CSF were conducted using commercial Aroclors as test materials rather than the environmental PCB mixtures to which people are exposed.

Because of the potential differences between the commercial Aroclor mixtures that were tested and the PCB mixture in the environment, there is uncertainty associated with applying the PCB CSF to environmental mixtures. For example, if the relative proportion of carcinogenic PCB congeners is higher in the environmental mixture than in the Aroclor test material used in the cancer bioassays that form the basis of the PCB CSF, use of the PCB CSF alone might underestimate cancer risk from tPCBs.

It is possible that one or more of the 12 dioxin-like PCB congeners (and the furans that composed a small fraction of the Aroclor mixture) might be present in environmental mixtures in higher proportions than in the commercial Aroclors. These PCB congeners can be evaluated as TEQ using the toxic equivalence approach developed for chlorinated dioxins and furans. Although the carcinogenic potency of these PCB congeners (and the furans) is already accounted for in the PCB CSF to the extent that they were present in the Aroclor mixture tested in the animal bioassay(s), assessing risks for tPCBs may not capture the full extent of risks from dioxin-like PCBs. Environmental mixtures, particularly those found in the food chain (fish, for example), may have enhanced concentrations of these and other highly persistent congeners.

Although PCB cancer risk can be quantified as TEQ, this approach alone also may not fully account for PCB carcinogenicity because PCBs have been associated with carcinogenic mechanisms other than through dioxin-like effects. For example, the EPA Science Advisory Board (SAB) cited the van der Plas et al. (2000) study of rats exposed to Aroclor 1260, which suggests that most of the tumor promotion potential of PCB mixtures is attributable to the nondioxin-like fraction (EPA SAB, 2001). Because this fraction is not included in the TEQ calculation, van der Plas et al. (2000) concluded that the tumor promotion potential of PCBs might be underestimated by the TEQ approach alone.

To address the concern that dioxin-like PCBs in environmental mixtures may pose a health risk that is not predicted by the PCB CSF alone or as TEQ alone, the following approaches were considered for expressing total cancer risk.

Approach 1: Sum cancer risk from tPCBs and from TEQ, and describe the potential overestimate of total cancer risk that results. This approach has the advantage of comparability with the standard EPA approach of summing risks from different contaminants (EPA, 1986b). However, this approach may overestimate cancer risk to the extent that the commercial Aroclor test material contained TEQ from dioxin-like PCB congeners and chlorinated furans. This might be considered "double-counting" TEQ.

Approach 2: Sum tPCB cancer risk and TEQ cancer risk from all congeners after subtracting the amount of TEQ accounted for by the PCB CSF for commercial Aroclors. This approach has the advantage of correcting for the potential overestimate of cancer potency that is associated with "double-counting" TEQ. However, there is uncertainty associated with this approach because it requires characterizing the environmental mixture as a commercial Aroclor, and is further complicated because more than one Aroclor was released. Thus, this option has the disadvantage that there is uncertainty associated with quantifying the amount of TEQ that should be subtracted from the estimate of TEQ from dioxin-like PCB congeners.

Approach 3: Present cancer risk from tPCBs and TEQ separately, and describe the potential underestimate of total cancer risk that results from considering them individually. This approach has the advantage of fully presenting cancer risks from two toxicological evaluations, and avoids potential "double-counting" that may result from summing the two risk values. However, either individual risk estimate alone may not fully quantify the carcinogenic risk of the PCB, dioxin, and furan mixture at the site.

Although the best approach to evaluating total cancer risk would be to appropriately account for the potential enrichment of dioxin-like congeners in the environmental mixture, this approach has too much uncertainty to be adopted at this time.

Approach 3 is used in this risk assessment. Cancer risks from both tPCBs and TEQ are presented separately, and represent two toxicological evaluations of cancer risks from the environmental mixture. The cancer risks from these separate evaluations are not summed, and the potential underestimate of tPCB cancer risk as a result of the potential enrichment of persistent congeners, including dioxin-like PCB congeners, is discussed in the uncertainty analysis (Section 7) of this volume and in more detail in Section 4 of HHRA Volume I.

3.3 NONCANCER HEALTH EFFECTS

3.3.1 Evaluation of Noncancer Health Effects Using RfDs

RfDs are used to characterize noncancer health effects. EPA defines RfDs as:

> The chronic RfD represents an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA, 1989).

RfDs can be based on adverse effects, such as gross or microscopic organ damage, and physiological effects (reproductive dysfunction, immunotoxicity, or biochemical effects, e.g., altered enzyme system).

Adverse effects are not likely at doses below these toxicity values. The level of concern for a particular contaminant does not increase linearly as the RfD is approached or exceeded because these values are derived as benchmarks. Therefore, comparing these values with exposure estimates at the site provides an index of concern rather than a probability of an adverse effect occurring. RfDs are expressed as a dose in units of milligrams of contaminant per kilogram of body weight per day (mg/kg-d), and are inversely proportional to the toxic potency of the contaminant.

3.3.2 Noncancer Effects of PCBs

EPA's IRIS database (EPA, 2004) provides oral RfDs for two commercial PCB mixtures, Aroclor 1016 and Aroclor 1254:

- RfD for Aroclor 1254: 2E-05 mg/kg-d.
- RfD for Aroclor 1016: 7E-05 mg/kg-d.

The environmental mixture of PCBs at the site most closely resembles the commercial mixture Aroclor 1260 with minor contributions from Aroclor 1254 (WESTON, 2002). However, no RfD is available for Aroclor 1260 or environmental mixtures. With respect to chlorine content and environmental persistence, the environmental PCB mixture at the site more closely resembles Aroclor 1254 than Aroclor 1016. Therefore, the RfD of 0.00002 mg/kg-d (2E-05) was used in the assessment of noncancer health effects. The RfD for Aroclor 1254 is based on the lowest observed adverse effect level (LOAEL) for impaired immune function, distorted growth of fingernails and toenails, and inflamed Meibomian (eyelid) glands in studies conducted on rhesus monkeys.

In addition to the skin, eye, and immune system effects that form the basis of the RfD for Aroclor 1254, experimental animal studies have shown reproductive and developmental effects and toxic effects to the liver, gastrointestinal system, blood, and endocrine system. In epidemiological studies, PCB exposure has been associated with (1) disruption of reproductive function, (2) neurobehavioral and developmental deficits in newborns (with in utero exposure) that continue at least through school age, (3) systemic effects such as (self-reported) liver disease and diabetes, and (4) effects on the thyroid and thyroid hormone status, and (5) impaired immune function (ATSDR/EPA, 1999). These effects are discussed in Section 4 of HHRA Volume I, as are the uncertainties associated with the use of current reference doses for PCBs.

In updating the evaluation of PCB noncancer toxicity, EPA is considering recent studies, including those associated with adverse effects from in utero exposures (EPA, 2004). However, these studies are not yet incorporated into the RfD, and are not assessed quantitatively in this risk assessment.

3.3.3 Noncancer Effects of 2,3,7,8-TCDD TEQ

PCDDs, PCDFs, and other dioxin-like compounds have been shown in multiple animal species to be developmental, reproductive, immunological, and endocrinological hazards. There is no reason to expect, in general, that humans would not be similarly affected at some dose, and there is a growing body of data supporting this assumption. Occupational and industrial accident cohorts exposed at higher concentrations show correlations with exposure and a number of noncancer effects consistent with those seen in the animal studies (EPA, 2000).

An RfD for dioxin-like compounds has not been developed. Further, EPA (2000) concluded that a reference dose for dioxin calculated in the manner typical of the way EPA determines RfDs would result in a dose that is significantly lower than current average background doses. RfDs are used primarily to evaluate increments of exposure from specific sources when background exposures are low and insignificant, and background exposures for dioxin-like compounds are not insignificant.

This assessment quantifies noncancer effects using RfDs to calculate hazard quotients and hazard indices. Because an RfD has not been developed for PCDD/PCDFs, the potential for noncancer effects from exposure to dioxin-like compounds is not quantitatively evaluated in this assessment. The science associated with noncancer effects of dioxin is under review by the NAS. Section 4 of HHRA Volume I includes a discussion of the noncancer adverse health effects associated with dioxin and dioxin-like congeners. In addition, it provides perspective on the potential underestimation of noncancer health effects and a comparison of estimated site-related intake of TEQ to estimated background dietary intake.

3.4 REFERENCES

ATSDR (Agency for Toxic Substances and Disease Registry) and EPA (U.S. Environmental Protection Agency). 1999. Public Health Implications of Exposure to PCBs www.epagov/water/waterscience/fish advisories/rpts & chemical fact sheets/exposure to PCBs.

ATSDR (Agency for Toxic Substances and Disease Registry). 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs). Prepared by Syracuse Research Corporation, November 2000.

Cogliano, Vincent James. 1998. Assessing the cancer risk from environmental PCBs. *Environmental Health Perspectives* 106(6):317-323.

EPA (U.S. Environmental Protection Agency). 1985. Health Effects Assessment Document for Polychlorinated Dibenzo-p-Dioxins. Prepared by the Office of Health and Environ. Assess. Environ. Criteria and Assess. Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, DC. EPA/600/8-84/014F.

EPA (U.S. Environmental Protection Agency). 1986a. Guidelines for Carcinogen Risk Assessment, Federal Register 51(185): 33992-34003.

EPA (U.S. Environmental Protection Agency). 1986b. *Guidelines for the Health Risk Assessment of Chemical Mixtures.* Risk Assessment Forum. EPA/630/R-98/002.

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund-Volume I. Human Health Evaluation Manual (Part A).* Interim Final. U.S. Environmental Protection Agency, Washington, DC. EPA/540/1-89/002.

EPA (U.S. Environmental Protection Agency). 1996a. Proposed Guidelines for Carcinogen Risk Assessment, *Federal Register,* 61(79): 17960-18011. April 23, 1996.

EPA (U.S. Environmental Protection Agency). 1996b. *PCB's: Cancer Dose-Response Assessment and Application to Environmental Mixtures*. National Center for Environmental Assessment. Washington DC. EPA/600/P-96/001F. September 1996.

EPA (U.S. Environmental Protection Agency). 1997. *Health Effects Assessment Summary Tables* Office of Research and Development. July 1997.

EPA (U.S. Environmental Protection Agency). 1998. Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites. Memorandum from Timothy Fields, Jr., Acting Administrator, Office of Solid Waste and Emergency Response. 13 April 1998. OSWER Directive 9200.4-26.

EPA (U.S. Environmental Protection Agency). 1999. Guidelines for Carcinogen Risk Assessment. SAB Review Draft, July 1999. NCEA-F-0644.

EPA (U.S. Environmental Protection Agency). 2000. *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Part III: Integrated Summary and Risk Characterization for 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds*. SAB Review Draft, September 2000, EPA/600/P-00/001Bg.

EPA (U.S. Environmental Protection Agency). 2001. Notice of Opportunity to Provide Additional Information and Comment on Draft Revised Guidelines for Carcinogen Risk Assessment (July 1999), Federal Register 66:59593-39394.

EPA (U.S. Environmental Protection Agency). 2002. Region 9 Preliminary Remediation Goals.

EPA (U.S. Environmental Protection Agency). 2003. Draft Final Guidelines for Carcinogen Risk Assessment (External Review Draft, February 2003). NCEA-F-0644A. March 3, 2003. Risk Assessment Forum, Washington, DC.

EPA (U.S. Environmental Protection Agency). 2004. Integrated Risk Information System Database.

EPA SAB (Environmental Protection Agency Science Advisory Board). 2001. *Dioxin Reassessment - an SAB Review of the Office of Research and Development's Reassessment of Dioxin*. Review of the Revised Sections (Dose Response Modeling, Integrated Summary, Risk Characterization, and Toxicity Equivalency Factors) of the EPA's Reassessment of Dioxin by the Dioxin Reassessment Review Subcommittee of the EPA Science Advisory Board (SAB). EPA-SAB-EC-01-006, May 2001.

Erickson, M.D. 2001. Introduction: PCB Properties, Uses, Occurrence, and Regulatory History. In *PCBs: Recent Advances in Environmental Toxicology and Health Effects*. L. W. Robertson and L. G. Hansen (Eds.). University Press of Kentucky, Lexington, KY.

James, M.O. 2001. Polychlorinated Biphenyls: Metabolism and Metabolites. In *PCBs: Recent Advances in Environmental Toxicology and Health Effects*. L. W. Robertson and L. G. Hansen (Eds.). University Press of Kentucky, Lexington, KY.

Safe, Stephen. 1994. Polychlorinated biphenyls (PCBs); environmental impact, biochemical and toxic responses, and implications for risk assessment. *Critical Reviews in Toxicology* 242(2):87-149.

Van den Berg, Martin, Linda Birnbaum, Albertus T.C. Bosveld, Bjorn Brunstrom, Philip Cook, Mark Feeley, John P. Giesy, Annika Hanberg, Ryuichi Hasegawa, Sean W. Kennedy, Timothy Kubiak, John Christian Larsen, F.X. Rolaf van Leeuwen, A.K. Djien Liem, Cynthia Nolt, Richard E. Peterson, Lorenz Poellinger, Stephen Safe, Dieter Schrenk, Donald Tillitt, Mats, Tysklind, Maged Younes, Fredrik Waern, and Tim Zacharewski. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs, for humans and wildlife. *Environmental Health Perspectives* 106(12):775-792.

van der Plas, S.A., H. Sundberg, H. van den Berg, G. Scheu, P. Wester, S. Jensen, Ake Bergman, J. deBoer, J. H. Koeman, A. Brouwer. 2000. Contribution of Planar (0-1 Ortho) and Nonplanar (2-4 Ortho) Fractions of Aroclor 1260 to the Induction of Altered Hepatic Foci in Female Sprague Dawley Rats. *Toxicol Appl Pharm* 169: 255-268.

WESTON (Weston Solutions, Inc.). 2002. *Rest of River Site Investigation Data Report.* Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. August 2002. DCN GE-080202-ABDK.

4. EXPOSURE ASSESSMENT

4.1 INTRODUCTION

The objective of the fish and waterfowl consumption exposure assessment is to estimate the nature, extent, and magnitude of potential exposure of adults and children to COPCs in fish and waterfowl. The exposure assessment includes the following steps:

- Evaluating the exposure setting, including describing local land and water uses and identifying potentially exposed populations (Section 4.2).
- Developing the conceptual site model, including sources, release mechanisms, transport and receiving media, exposure media, exposure scenarios, exposure routes, and potentially exposed populations (Section 4.3).
- Calculating exposure point concentrations (EPCs) for each COPC for each of the exposure scenarios (Section 4.4).
- Identifying the exposure scenarios, models, and assumptions for fish consumption used to calculate the exposure doses, and calculating doses (Section 4.5).
- Identifying the exposure scenarios, models, and assumptions for waterfowl consumption used to calculate the exposure doses, and calculating doses (Section 4.6).

Both the reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios are presented to provide a range of exposure estimates from the point estimate approach (EPA, 1992a). The RME is a high-end or upper estimate of exposure that, when combined with toxicity information, leads directly to the RME estimate of risk defined by EPA guidance (1992a) as

> "… a plausible estimate of the individual risk for those persons at the upper end of the risk distribution. The intent of this description is to convey an estimate of risk in the upper range of the distribution, but to avoid estimates which are beyond the true distribution."

The RME, an estimate of the upper range of exposure in a population, is based on a combination of the upper and central estimates of exposure parameters representing the 90th percentile or greater of actual expected exposure (EPA, 1995).

The CTE is the central tendency (i.e., average) exposure, which uses average exposure parameters to calculate an average exposure to an individual. Both the RME and CTE analyses are presented for each exposure scenario.

To describe the range of exposures, both upper and central tendency descriptors are used to convey the variability in exposure levels and thus the risk experienced by individuals in the population. A quantitative evaluation of variability and incertitude, which together describe the uncertainty of exposure and risk, is provided in Section 6 using two probabilistic approaches: Monte Carlo simulation and probability bounds analysis. The probabilistic approaches also provide a range of upper or RME (90th to 99th percentile) estimates and a central estimate (50th percentile or median) of the risk (EPA, 2001).

4.2 EXPOSURE SETTING

The exposure setting for the evaluation of human health risks due to fish consumption is the Housatonic River from the confluence of the East and West Branches in Pittsfield, MA, downstream to its mouth in Stratford, CT. However, the quantitative risk assessment extends only from the confluence to Stevenson Dam (Lake Zoar) in Connecticut, as additional Superfund and other hazardous waste sites are known to contribute PCBs farther downstream.

In 1982, the Massachusetts Department of Public Health (MDPH) issued a consumption advisory for fish, frogs, and turtles for the Housatonic River. In addition, in 1999, MDPH issued a waterfowl consumption advisory from Pittsfield to Great Barrington due to PCB concentrations in wood ducks and mallards collected from the river by EPA. The consumption advisories recommend that the public not consume any fish, frogs, or turtles from the Housatonic River from Dalton to Sheffield (the border with Connecticut) and refrain from eating all mallards and wood ducks from the Housatonic River and its impoundments from Pittsfield south to Rising Pond in Great Barrington. These advisories remain in effect, and current consumption of fish, frogs, turtles, and ducks from the Housatonic River is assumed to be lower than levels that would be consumed in the absence of consumption advisories.

The State of Connecticut posted a fish consumption advisory for most of the Connecticut section of the river in 1977 as a result of the PCB contamination in the river sediment and fish tissue.

The advisory recommends more restrictive consumption for high-risk individuals (pregnant women, women planning to become pregnant within 1 year, and children under 6) than others, and differs for different locations on the river. The 2004 advisory is summarized as follows:

Location	Fish Species	High-Risk Groups	Low-Risk Groups
Housatonic River above Derby Dam (*except as listed below for lakes on Housatonic River*)	-Trout, Catfish, Eel, Carp	Do not eat	Do not eat
	-Bass, White Perch, Bullhead	Do not eat	One meal per 2 months
	Panfish (yellow perch, sunfish, etc.)	One meal per month	One meal per week
Lakes on Housatonic River: (Lillinonah, Zoar, Housatonic)	-Bass, White Perch, Bullhead	One meal per month	One meal per month
	-Other Species	No more than one fish meal per month	No more than one fish meal per week

As in Massachusetts, the existence of a consumption advisory may decrease current consumption from fish caught in Connecticut reaches of the Housatonic River.

The potentially exposed populations are anglers or members of their family who consume at least one meal per year from the Housatonic River or who may be exposed to contaminants from this fish consumption while in utero or via breast milk (nursing infants). Although members of non-angling families may also consume Housatonic River fish, it is assumed that this practice is less frequent than consumption by anglers and their families. The evaluation of the angling population results in the highest risk estimates, and provides a health-protective analysis for all potential consumers.

Exposures from the consumption of contaminated fish were evaluated for four separate areas based on the areas for which fish tissue data were available:

- The Primary Study Area (PSA) – from the confluence of the East and West Branches of the Housatonic River to Woods Pond Dam (Reaches 5 and 6).
- Rising Pond in Great Barrington, MA (Reach 8).
- West Cornwall and Bulls Bridge, CT (Reaches 11 and 12).
- Lake Lillinonah and Lake Zoar, CT (Reaches 14 and 15).

Primary Study Area (Reaches 5 and 6) – The approximately 11 miles from the confluence downstream to and including the Woods Pond impoundment. Table 4-1 presents the number and biomass of fish species likely to be consumed by recreational anglers in the PSA. Fish biomass was estimated to range from 10.7 g/m^2 near the confluence to 31.7 g/m^2 in the backwaters above Woods Pond (Woodlot, 2002). The amount of fish present in the river as quantified in the biomass study confirms that a sufficient abundance of species typically consumed by residents is present to support a recreational fishery.

Rising Pond (Reach 8) – An approximately 45-acre impoundment, which is the next major impoundment downstream from Woods Pond in Great Barrington, MA, from which fish were sampled as part of the Supplemental Investigation (SI).

West Cornwall and Bulls Bridge (Reaches 11 and 12) – A stretch of flowing water including a newly established (2003 season) bass management area and a trout management area (CTDEP, 2003). Both are currently managed as catch and release fisheries. Bulls Bridge (Reach 12/13 boundary) is located near the Schaghticoke tribal reservation in Kent, CT.

Lake Lillinonah and Lake Zoar (Reaches 14 and 15) – Lake Lillinonah is an impoundment created in 1955 by construction of the Shepaug Dam. There are two state-owned boat launches on the lake. According to the CTDEP (Jacobs and O'Donnell, 2002), fishing is "good" for largemouth bass, smallmouth bass, and carp; "fair to good" for yellow perch, white perch, and crappie; and "fair" for sunfish and catfish. Lake Zoar is an impoundment of the Housatonic River created by the Stevenson Dam in Monroe. There is a state-owned boat launch on the north end of the lake, and 4 miles of the lakeshore are located within state forests. Fishing is reported to be "fair" for bass, white perch, sunfish, eel, and catfish (Jacobs and O'Donnell, 2002).

Waterfowl - Exposures from the consumption of contaminated waterfowl were evaluated for one area, the lower portion of Reach 5 and Woods Pond, Reach 6, where data on COPC concentrations in waterfowl were available. The potentially exposed populations are hunters or members of their family who consume at least one meal per year of waterfowl that were inhabitants of the Housatonic River or who may be exposed to contaminants from this waterfowl consumption while in utero or via breast milk (nursing infants). Although members of non-

Table 4-1

Biomass Survey – Primary Study Area

	No. Fish Caught, Sum of Single Pass and Multipass Runs					
	5A	5B	5C	Backwaters	Woods Pond	Totals
Largemouth Bass	**52**	**70**	**115**	**36**	**76**	**349**
Smallmouth Bass	4	2	0	0	0	6
Yellow Perch	**97**	**439**	**324**	**116**	**183**	**1159**
Pike	11	26	15	8	29	89
Pickerel	5	63	45	1	2	116
Trout (brown and rainbow)	3	0	0	0	0	3
Bluegill/pumpkinseed	**135**	**328**	**805**	**284**	**1419**	**2971**
Brown bullhead	**0**	**0**	**13**	**32**	**97**	**142**

	Biomass Collected, g/m^2, Sum of Single Pass and Multipass Runs					
	5A	5B	5C	Backwaters	Woods Pond	Totals
Largemouth Bass	**5.19**	**6.86**	**10.27**	**5.73**	**4.18**	**32.23**
Smallmouth Bass	0.22	0.095	0	0	0	0.315
Yellow Perch	**2.6**	**8.441**	**6.23**	**8.75**	**4.55**	**30.571**
Pike	0.94	1.67	1.36	1.76	1.88	7.61
Pickerel	0.2	0.364	0.55	0.2	0.04	1.354
Trout (brown and rainbow)	0.17	0	0	0	0	0.17
Bluegill/pumpkinseed	**1.414**	**3.371**	**6.67**	**10.32**	**2.02**	**23.795**
Brown bullhead	**0**	**0**	**0.52**	**4.93**	**4.46**	**9.91**

Source: Woodlot, 2002.

Species in bold are those used in the risk assessment.

waterfowl hunting families may also consume birds bagged on the river or floodplain, it is assumed that this practice is less frequent than consumption by hunters and their families. The evaluation of the waterfowl hunting population results in the highest risk estimates, and provides a health-protective analysis for all potential consumers.

The minimum population of ducks subject to hunting can be estimated from the banding efforts conducted by the Massachusetts Department of Fisheries and Wildlife (MassWildlife) each year in Woods Pond and the backwater areas north of the pond to approximately the upstream limit of Reach 5C. The banding is conducted in late August, when the young-of-the-year birds have not yet fledged and the adults are molting and therefore also flightless. Thus, most banded birds were resident for that season.

The banding records indicate that MassWildlife banded an average of 56 ducks per year since 1992 (range = 16 to 116). This number can be considered the mean minimum number of ducks resident in the PSA over this period. Based on observations of the numbers of duck broods in the PSA made during the ecological characterization and other field activities conducted for the Rest of River study, it is conservatively estimated that less than half of the resident ducks are banded each year; therefore, the local population is at least double the numbers banded (Bob Roy, personal communication, 2003). Banding records further indicate that approximately 23% of the birds banded locally are also shot locally.

Geese were not banded by MassWildlife. However, based on observations of adults, pairs, broods, goslings, and nests during 1998 to 2000, there are approximately 10 to 20 pairs of geese and associated goslings utilizing the PSA and adjacent floodplains (WESTON, 2004, Appendix A). These geese are also hunted.

The attractiveness of both fishing and hunting opportunities associated with the river is exemplified by the amount of state land along the Housatonic River on which these activities are promoted, stocking activities, designation of fisheries, the numerous locations where the river is accessible to the public, and the number of fishing/hunting-related organizations in the area.

4.2.1 Fishing and Waterfowl Hunting Regulations

The number of fish and waterfowl a hunter/angler may take and potentially consume are limited to some extent by fishing and waterfowl hunting regulations. This section describes the limits established by fishing and waterfowl hunting regulations in Massachusetts and Connecticut. The consumption rates used in the exposure calculations (Sections 4.5.2.2 and 4.6.2.1) are consistent with these legal limits with the exception of fish consumption in areas that are currently designated as "catch and release only." The future potential consumption rate for these areas is estimated assuming that the "catch and release only" designation or fish consumption advisory based on contamination is no longer needed.

4.2.1.1 Fishing

In the Commonwealth of Massachusetts, fishing licenses are required for all persons 15 years of age and over (MassWildlife, 2004). The State of Connecticut requires fishing licenses for all persons 16 years of age and over (CTDEP, 2003). The license requirement for each state is for fishing inland waters. Massachusetts allows fishing year-round in the Housatonic River. Daily creel limits and minimum lengths for species for the Housatonic River are presented in Table 4-2. From the confluence of the East and West Branches to the Massachusetts/Connecticut line, the Housatonic River is currently restricted to the taking of one trout per day, minimum length of 20 inches (exclusive of catch and release areas). Lakes and ponds are open year-round for fishing in Connecticut. Rivers and streams are open from the third Saturday in April through the last day of February. Daily creel limits and minimum lengths for species in the inland waters (i.e., freshwater) of the Housatonic River (Massachusetts/Connecticut border to Merritt Parkway in Milford/Stratford), not specifically designated as management areas, are presented in Table 4-2.

In Connecticut, the Housatonic River contains trout, bass, and walleye management areas. The trout management areas (TMAs) are designated as catch and release, and are open year-round except in areas within 100 ft of tributaries that are closed to all fishing from June 15 to August 31. Normal statewide regulations apply to the bass management area (BMA; Stanley Tract Area); but the Bulls Bridge BMA, which is coincident with the TMA, shares the TMA

Table 4-2

Daily Creel Limits and Length Requirements

Species	Massachusetts[a]		Connecticut[b]	
	Daily Creel	Minimum Length (in.)	Daily Creel	Minimum Length (in.)
Brook, Brown, Rainbow, and Tiger Trout[c]	April 1 – September 10		3rd Saturday in April – Last day in February	
	8	None	5	None
	September 11 – March 31			
	3	None		
Chain Pickerel	January 1 – December 31		Lakes and Ponds	
	5	15	6	15
			Rivers and Streams	
			None	None
Largemouth and/or Smallmouth Bass (aggregate total)	5	12	Lakes and Ponds	
			6	12
			Rivers and Streams	
			6	None
Walleye	5	14	5	15
All other species	None	None	Not listed	Not listed
Panfish	Not listed	Not listed	None	None

[a] MassWildlife, 2004. Year-round unless otherwise specified.

[b] CTDEP, 2004.

[c] For Massachusetts, based on “Other Rivers and Brooks.” Special regulations currently in effect for Housatonic River from confluence to Connecticut (see text).

restrictions, i.e., it is a catch and release fishery. Lake Housatonic (Shelton-Derby-Monroe-Oxford-Seymour) is a bass and walleye management area open to fishing year-round.

In Lake Housatonic, the daily creel limit for large and smallmouth bass is 2, with a 16-inch (40.64-cm) minimum length. Walleye were stocked in 2001 and are expected to reach legal size (15 inches or 38.1 cm) in 2003-2004. Figure 4-1 shows the locations of these areas.

4.2.1.2 Waterfowl Hunting

The Commonwealth of Massachusetts requires hunting licenses for all persons 15 years of age and over (MassWildlife, 2004). Federal migratory bird regulations for the Berkshire Zone apply to the Housatonic River area. Regulations for waterfowl hunting during the 2004-2005 hunting season are presented in Table 4-3. Although the Massachusetts Division of Fisheries and Wildlife specifies that possession limits are twice the daily bag limits, it is essentially an unenforceable regulation given the ability to store meat for future consumption and the lack of a system for routinely checking household refrigerator and freezer contents. Based on the MDPH survey that included consumption of waterfowl (MDPH, 1997; 2001b; see Section 4.6.2.1), it is possible that some individuals possess more waterfowl than the regulations specify.

Site-specific information was not available for waterfowl species harvested from the Housatonic River. According to Ducks Unlimited (2000), during the 1999-2000 waterfowl seasons, nationally, mallards were the most commonly harvested duck species (35% of harvest), followed by green-winged teal (14%), gadwall (11%), wood ducks (10%), and blue-winged/cinnamon teal (7%). However, the difference in species availability and therefore harvesting may differ by flyway.

The following species of ducks and geese potentially occur within the study area:

- American black duck (*Anas rubripes*)
- Blue-winged teal (*Anas discors*)
- Canada goose (*Branta canadensis*)
- Common goldeneye (*Bucephala clangula*)
- Common merganser (*Mergus merganser*)
- Green-winged teal (*Anas crecca*)
- Hooded merganser (*Lophodytes cucullatus*)
- Mallard (*Anas platyrhynchos*)

Table 4-3

Waterfowl Hunting Regulations 2004-2005 Summary

Season	Dates	Bag	Possession
Ducks[a]	12 Oct. – 25 Dec.	6[b]	12[b] (no canvasback)
American Coot	Same as ducks	15	30
Mergansers[c]	Same as ducks	5[b]	10[b]
Regular Goose	23 Oct. – 27 Nov. 10 Dec. – 25 Dec.	3	6
Early Canada Goose	7 Sept. – 25 Sept.	5	10
Snow and Blue Goose	Same as ducks	15	30
Falconry (Ducks and Coot only)	6 Oct. – 7 Feb.	3[b]	6[b]
Youth Waterfowl Hunt	9 Oct. and 11 Oct.	For ages 12 – 15. May take ducks, coots, mergansers, and geese.	

[a] The daily bag may contain no more than:

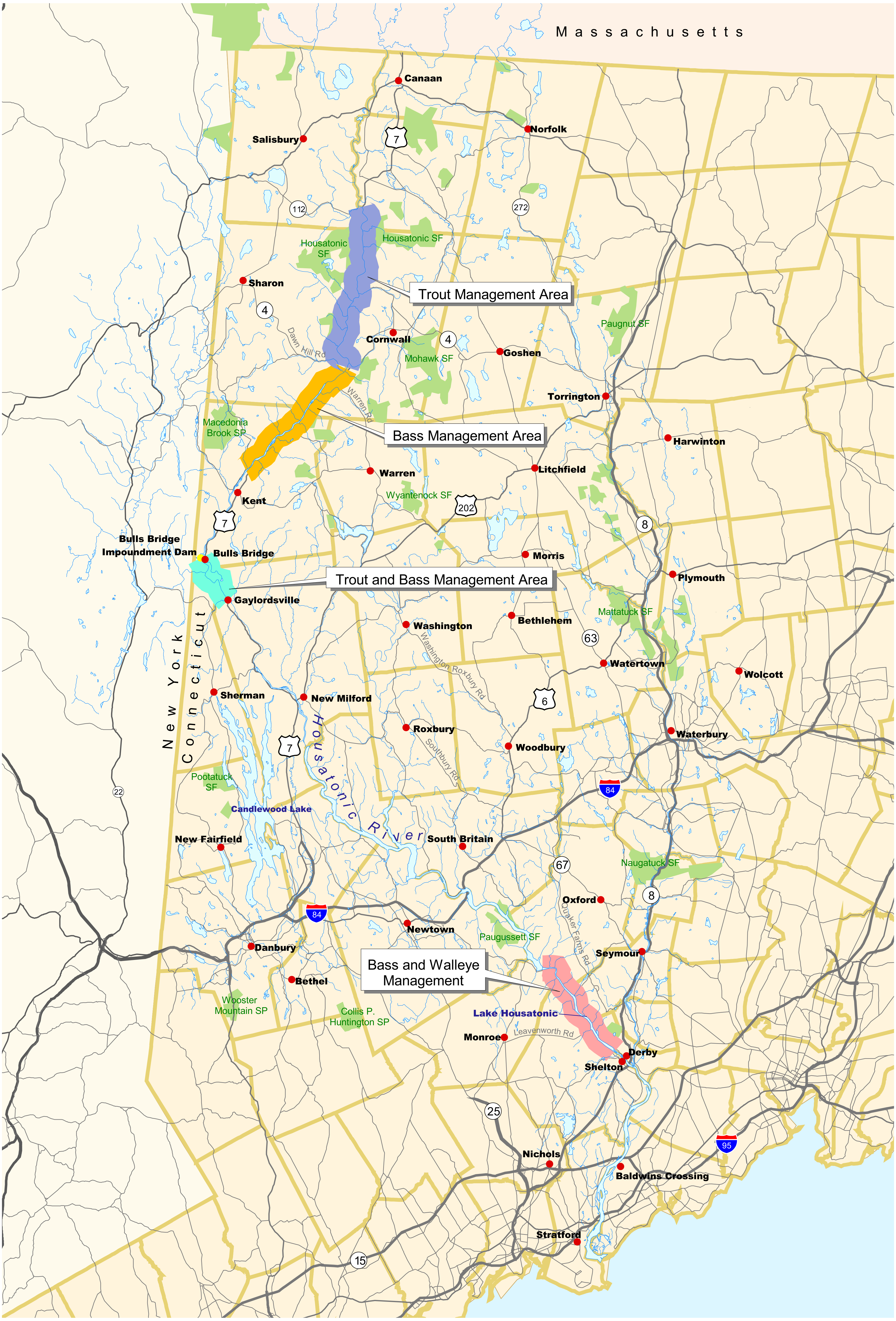
Mallard	4 (only 2 female)	Canvasback	1	Pintail	1
Scaup	3	Fulvous whistling	1	Harlequin	none
Wood duck	2	Mottled	1	Hooded Merganser	1
Redhead	2	Black duck	1	All other duck species	4

Possession limits are double the daily bag.

[b] Singly or in the aggregate.

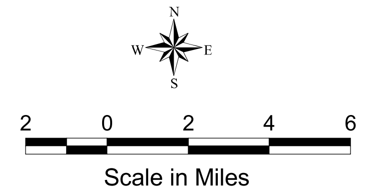
[c] Daily bag of mergansers may not include more than one hooded merganser; no more than two hooded in possession.

Source: MassWildlife, 2004.



LEGEND:

● Towns	🟪 Trout Management Area
● Dams	🟦 Trout and Bass Management Area
╱╲ Rivers (Housatonic River Basin)	🟧 Bass Management Area
╱╲ Primary Road with Limited Access	🟥 Bass and Walleye Management Area
╱╲ Primary Road	🟩 State Parks
╱╲ Secondary and Connecting Road	



Scale in Miles

Fish and Waterfowl Consumption Risk Assessment
Housatonic River Project
Pittsfield, Massachusetts

FIGURE 4-1
STATE OF CONNECTICUT HOUSATONIC RIVER FISH MANAGEMENT AREAS

O:\gepitt\aprs\ct_fishmanage.apr | layout - fish zones 4-1 | o:\gepitt\epsfiles\plots\in\fw4-1.eps | 3:27 PM, 4/9/2003 |

- Ring-necked duck (*Aythya collaris*)
- Snow goose (*Chen caerulescens*)
- Wood duck (*Aix sponsa*)

Of these species, all but the snow goose and ring-necked duck were observed during the ecological characterization (WESTON, 2004, Appendix A). Canada geese, mallards, and wood ducks were observed breeding and rearing young in the PSA. Broods were observed most commonly in the backwater channels and wetlands between New Lenox Road and Woods Pond. Wood duck broods also were observed in the main channel of the river between Holmes Road and New Lenox Road. Similarly, Canada goose broods were observed in the river channel, backwaters, Woods Pond, and on residential lawns. Green-winged teal, common goldeneye, and common merganser were only observed during migration (WESTON, 2004).

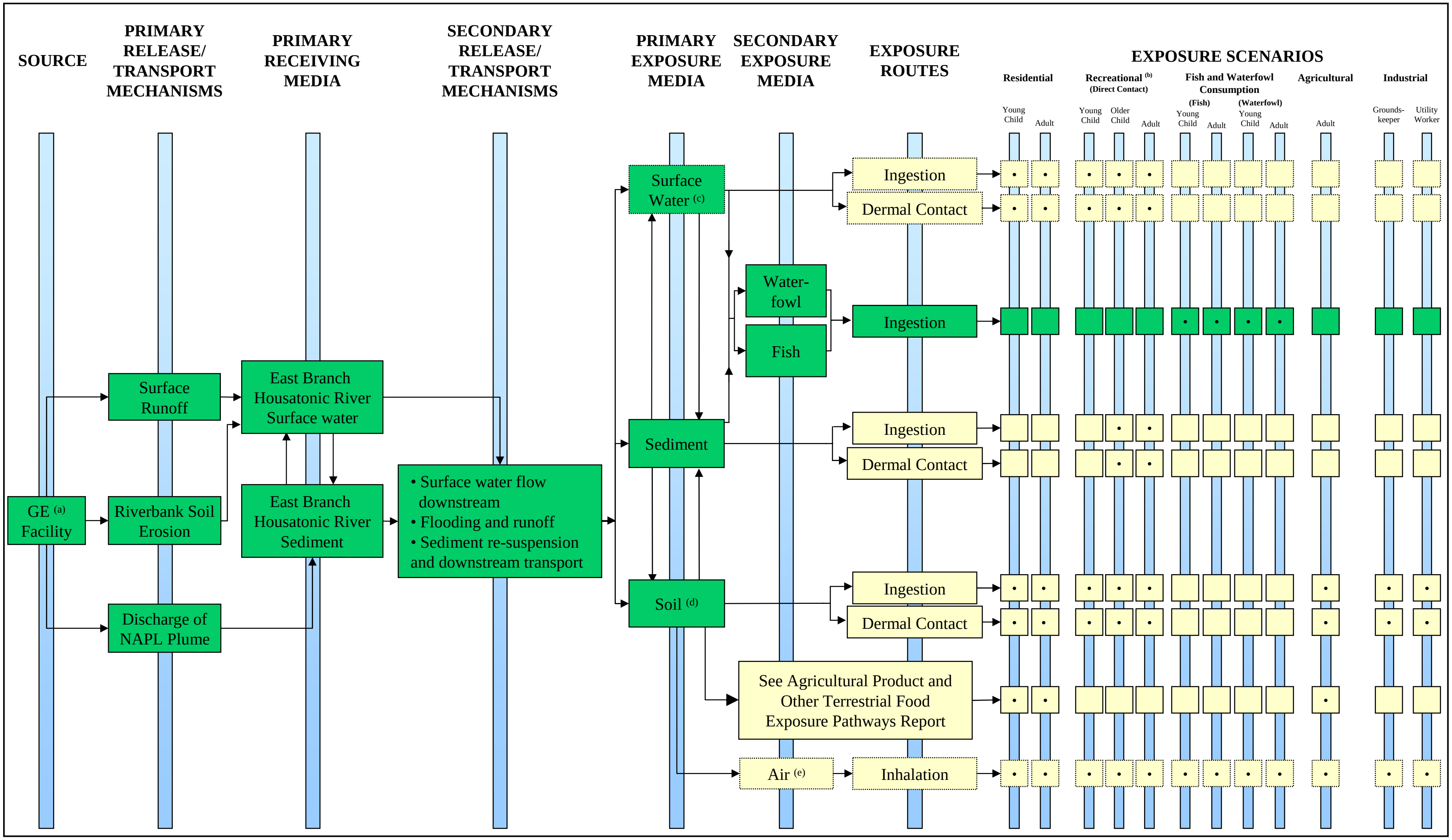
All of the species listed above are legal to hunt in accordance with the Massachusetts Migratory Bird Regulations for 2004-2005 (MassWildlife, 2004).

4.3 CONCEPTUAL SITE MODEL AND EXPOSURE SCENARIOS

A conceptual site model describes the contaminant sources, release mechanisms, transport and receiving media, exposure media, exposure routes, and potentially exposed populations. One objective of the conceptual site model is to identify complete and incomplete exposure pathways. A complete exposure pathway has all of the above-listed components, whereas an incomplete pathway is missing one or more of these components. Figure 4-2 illustrates the conceptual site model that was developed for the Housatonic River risk assessment, with the fish and waterfowl consumption exposure pathways highlighted. Each component of the conceptual site model related to consumption of fish and waterfowl is examined in detail below. Other components of the conceptual site model are discussed in HHRA Volume I, Section 2.

4.3.1 Sources of Contamination, Release, and Transport Mechanisms, and Receiving Media

Migration of contaminated sediment in the Housatonic River has resulted in contamination of floodplain soil downstream from the site. Sediment contamination has resulted from surface water runoff from contaminated source areas, migration of nonaqueous phase liquids (NAPLs),



• = Complete exposure pathway

☐ = Incomplete exposure pathway

⬚ = Not evaluated quantitatively.

🟩 = Pathways of concern.

NAPL = nonaqueous phase liquid.

(a) = Includes all facility-related sources such as site soils, Unkamet Brook, Silver Lake, former oxbows, fill areas, etc.

(b) = There are seven variations of the recreational scenario, including: general recreation, ATV/dirt and mountain biker, marathon canoeist, recreational canoeist, angler, waterfowl hunter, and sediment exposure. The scenario selected will depend on the medium and exposure area of concern being evaluated.

(c) = Chemical concentrations in surface water were compared to conservative, site-specific screening risk based concentrations (SRBCs) as an initial screening step. Results of the screening process indicated chemical concentrations in surface water below levels of human health concern. Thus, direct contact to surface water was not evaluated quantitatively.

(d) = Includes floodplain and riverbank soil.

(e) = Air sampling conducted at various points along the Lower River resulted in low concentrations of PCBs. An additional sampling and screening level risk assessment was performed. Results of the screening process indicated chemical concentrations in air below levels of human health concern. Thus, inhalation of air was not evaluated quantitatively.

Figure 4-2
Conceptual Site Model
Fish and Waterfowl
Consumption Risk Assessment

General Electric/Housatonic River Site
Rest of River

MK01|O:\20123001.096\HHRA_FNL_FW\FW_FNL_4_fig4-2.ppt direct discharge of PCBs from outfalls and the GE Facility Building 68 tank implosion, and inundation/erosion of contaminated floodplain.

Current or past contaminant sources for the Housatonic River include the following:

- Former oxbows of the Housatonic River that have been filled with materials, including some hazardous materials.
- NAPLs and soil contaminated with hazardous substances, including PCBs, volatile organic compounds (VOCs), metals, and semivolatile organic compounds as a result of spills from a number of aboveground storage tanks, underground storage tanks, and process pipelines currently or formerly located on GE property.
- Unkamet Brook Landfill and contaminated soil and sediment on the banks or in Unkamet Brook.
- PCB-contaminated soil used as fill material.
- Former waste stabilization basin.
- Silver Lake.
- Stormwater and wastewater discharges.
- Contaminated groundwater discharge to the river.
- Contaminated soil and sediment on the banks or in the river itself.

Additional information regarding source areas in and releases from the GE facility can be found in the *Source Area Characterization Report* (WESTON, 1998).

4.3.2 Secondary Release and Transport Mechanisms

The contaminant release and transport processes affecting the fate and effect of PCBs within the Housatonic River and its floodplain are interrelated and complex. The following discrete, but interrelated, PCB transport pathways have been identified:

- Sediment contamination with ongoing transport of solids and associated PCBs.
- Erosion and downstream transport of contaminated bank soil. Bank contamination has occurred as a consequence of historical cut and fill operations that used fill material contaminated with PCBs, as well as PCB spills and NAPL seeps.

- Surface water contamination from flux of soluble PCBs from contaminated sediment, and resuspension of contaminated sediment particles.
- Floodplain soil and riverbank soil contamination via deposition of suspended river sediment during flood events.
- Erosion of contaminated floodplain soil (surface and subsurface) during flood events, and subsequent deposition as contaminated river sediment.
- Bioaccumulation, biomagnification, and cycling of PCBs within the terrestrial and aquatic food chains exposed to contaminated soil, surface water, and sediment, through diffusion across the epidermis or gill membrane of aquatic species, consumption of contaminated food items, or sediment/soil/surface water directly.

4.3.3 Primary Exposure Media

Anglers and hunters and their families may be exposed to COPCs through consumption of fish and waterfowl, respectively. Thus, fish and waterfowl are considered the primary exposure media. In Section 2, Hazard Identification, the data available for use in this assessment are presented in detail, along with information regarding species consumption preferences for fish.

4.3.3.1 Fish

The fish species and sample characteristics for each geographic area evaluated are summarized by area as follows:

- PSA – Brown bullhead, largemouth bass, sunfish, and yellow perch, skinned and trimmed fillet. (Largemouth bass ≥12 inches [30.45 cm] only.)
- Reach 8 (Rising Pond) – Brown bullhead, largemouth bass, pumpkinseed (sunfish), and yellow perch, skinned and trimmed fillet. (Largemouth bass ≥12 inches [30.45 cm] only.)
- Reaches 11 and 12 (West Cornwall and Bulls Bridge, CT) – Smallmouth bass, skin-on fillet.
- Reach 11 (West Cornwall, CT) – Brown trout, skin and scales on fillet.
- Reaches 14 and 15 (Lake Lillinonah and Lake Zoar, CT) – Smallmouth bass, skin-on fillet.

4.3.3.2 Waterfowl

The waterfowl consumption risk assessment was based on samples of mallard and wood duck skin-on breasts from the PSA. The birds were captured prior to migration, and thus were considered to be resident waterfowl.

PCBs bioconcentrate and bioaccumulate in Housatonic River waterfowl that ingest contaminated water, river sediment, floodplain soil, and dietary items. Thus, COPC concentrations detected in mallards and wood ducks are considered representative of the concentrations that would be detected in other resident species with similar life histories and diets that are also hunted in the area, such as Canada goose (see also Section 2.2.1.2). The concentrations in species that are more highly exposed to COPCs, such as fish-eating ducks, would be expected to be higher, but these species are generally less preferred by hunters.

Both mallards and wood ducks are considered year-round inhabitants of the Housatonic River area (HRA) (WESTON, 2004, Appendix A). Mallards are dabbling ducks, while wood ducks are perching ducks. The diet is similar in that the young eat invertebrates almost exclusively, while more- mature individuals eat primarily plants and lesser quantities of invertebrates. Both terrestrial and aquatic invertebrates are ingested. These ducks, particularly mallards, may eat winter crops or unharvested crops in agricultural areas during the winter. As noted in Section 2.8.2, statistical tests indicated no significant difference in the distribution of tPCB concentrations between species, and the data for mallards and wood duck were pooled. These concentrations were considered representative of the concentrations in the dabbling ducks (Subfamily Anatinae).

Waterfowl in the Family Rallidae (rail), geese (Subfamily Anserinae), diving ducks (Subfamily Anthyinae), and mergansers (Subfamily Merginae) may be hunted (based on availability) in the HRA as well. All of these are potentially edible; however, only the Canada goose is typically considered desirable for eating.

Canada geese have been observed in the Housatonic River throughout the spring, summer, fall, and winter, and are year-round inhabitants of the area. Based on observations of adults, pairs, broods, goslings, and nests during 1998 to 2000, there are approximately 10 to 20 pairs of geese and associated goslings utilizing the PSA and adjacent floodplain.

Canada goose broods were observed in the river channel, backwaters, Woods Pond, and floodplain including agricultural fields and residential lawns during 1998 to 2000. Canada goose adults and goslings have been observed foraging in the river channel, backwaters, and adjacent uplands (WESTON, 2004). Canada geese feed on invertebrates in the river and backwaters as young goslings, and shift to feeding on macrophytes and emergent plants in and near the river as older goslings. The vegetation and invertebrates ingested by the geese have been observed to be at times coated with sediment from the river after flood events. Similarly, geese feed on roots and tubers of submerged aquatic plants, which would include the consumption of sediment during their foraging (Terres, 1980). Canada geese have a strong site fidelity to nesting territory, and the young remain with the parents until the second year, when the young may form nonbreeding groups (Bellrose, 1980; Ehrlich et al., 1988; Terres, 1980). The geese begin to nest at age 3 when they may attempt nesting at a location near their natal site or travel to another location (Bellrose, 1980; Ehrlich et al., 1988). The resident geese can continue to ingest contaminated sediment for multiple years if they remain in the area and nest as adults. Because the river occasionally becomes inaccessible in winter because of ice cover, Canada geese from the Housatonic River potentially feed in adjacent contaminated agricultural fields, golf courses, and parks.

4.3.4 Exposed Populations

4.3.4.1 Anglers

Recreational anglers and their families (including exposure while in utero and while nursing) have been identified as the population with the highest potential exposure for the consumption of fish. EPA has made efforts to identify populations that engage in subsistence fishing in both the Massachusetts and Connecticut reaches of the Housatonic River (including discussions with appropriate state personnel), and has found no evidence that a subsistence population exists at this time.

EPA held discussions with representatives of the Schaghticoke Tribal Nation, which obtained federal acknowledgment (pending appeal) in January 2004. EPA asked the members about the species preferred and consumed from the river. Tribal members responded that they currently practice catch-and-release fishing because of the warnings on fish consumption. In the absence of such warnings, consumption would resume. In addition, the residential population of the reservation may increase. The current reservation spans about 400 acres, and legal efforts are underway that could expand the reservation by more than an additional 2,000 acres. The current moratorium on building at the reservation is expected to be lifted in the future. The tribe has a housing authority that plans to construct housing, possibly for elder members, in the future.

In addition to the bass, trout, bullhead, and perch that were identified as preferred species in the MDPH survey (see Section 2.4), tribal members listed the following fish and invertebrate species as desirable: American eel, bullhead, carp, yellow perch, crayfish, and, to a lesser extent, chain pickerel. The preferred method for preparation is pan frying, although a long-held tribal practice is to prepare the fish by removing the head, wrapping the fish in mud, then foil, and slow-cooking. To account for the potential increase in fishing on the Schaghticoke Reservation and a potential return to traditional fish preparation practices, the impact of these changes on risk are evaluated in the uncertainty analysis (Section 7.2.2). The impact of consumption of species other than bass and trout (the two species evaluated in Connecticut reaches) is also discussed in the uncertainty analysis.

Balcom et al. (1999), in a report prepared for the Office of Long Island Sound Programs of CTDEP, quantified fish consumption rates throughout the state. Nine populations were specifically identified, including sport fishing and cultural/subsistence families; and minority (including Southeast Asian) and limited income families (these subpopulations are not mutually exclusive). Although the focus was on saltwater anglers, freshwater anglers were also included in the survey. A total of 2,354 individuals (1,048 households) were included in the study, which was conducted in 1996 and 1997.

A comparison of meal size of caught fish indicated that the adult sport-fishing population had a slightly larger mean meal size (7.3 oz) than minority (7.1 oz), limited income (7.1 oz), and Southeast Asian (7.0) adult populations. The sport-fishing population also had a higher mean number of meals per year of caught fish (seafood) (10) than minority (9), limited income (9.8), and Southeast Asian (8.8) populations. At the highest end of the meal frequency distribution, the sport-fishing population had a maximum of 156 meals/year of caught fish, whereas the maximum meals/year of caught fish for minority, limited income, and Southeast Asian populations were 104, 156, and 78, respectively. These results strongly suggest that consumption rates based on sport-fishing (i.e., recreational) anglers are higher than those of other populations in Connecticut. The survey did not identify subsistence angling.

Three potentially exposed populations that may be particularly sensitive to adverse effects of PCBs (ATSDR, 2000) were considered in this risk assessment: fetuses (in utero exposure), nursing infants (breast milk exposure), and young children (ages 1 to 6 years). It was assumed that some recreational anglers share fish with other household members, including young children. The child receptor is evaluated quantitatively by integrating exposure from fish consumption as a child with exposure as an adult for cancer risks, and separately for noncancer hazards. Risks to nursing infants cannot be quantified at this time as chronic (long-term) reference doses and other toxicological factors in the published literature are not applicable to short-duration exposures, such as those for nursing infants. However, estimates of PCB concentrations in breast milk of mothers who consume Housatonic River fish are presented in HHRA Volume I, Section 10, and compared to PCB concentrations in breast milk measured in several populations. Similarly, risks from in utero exposure cannot be evaluated quantitatively at this time because of limited dose-response information. The potential for these risks represents a significant uncertainty with respect to toxicity (see Section 7).

For the point estimate exposure assessment, both high-end (RME) and average (CTE) exposure scenarios were evaluated. Different exposure assumptions were used for the two scenarios, and are described in Section 4.5. The probabilistic assessment provides a range of exposures that may result from different angling and consumption habits.

4.3.4.2 Hunters

Recreational hunters and their families (including exposure while in utero and while nursing) have been identified as the population with the highest potential exposure for the consumption of waterfowl. As for consumption of fish, three potentially exposed populations that may be particularly sensitive to adverse effects of PCBs (ATSDR, 2000) were considered also in this risk assessment: fetuses (in utero exposure), nursing infants (breast milk exposure), and young children. For this risk assessment, it was assumed that hunters consume the waterfowl that they harvest and some share the harvest with their families, including young children.

As with fish consumption, both upper (RME) and average (CTE) exposure scenarios were evaluated in the point estimate approach using exposure assumptions described in Section 4.6. The probabilistic assessment provides a range of exposures that may result from different hunting and consumption habits. The child receptor was evaluated quantitatively by integrating exposure from waterfowl consumption as a child with exposure as an adult for cancer risks, and individually for noncancer hazards. Estimates of PCB concentrations in breast milk of mothers who consume Housatonic River waterfowl and/or fish are presented in HHRA Volume I, Section 10, and compared to PCB concentrations in breast milk measured in several populations. However, currently there is insufficient toxicological information to quantify risk from breast milk exposure. Similarly, risks from in utero exposure cannot be evaluated quantitatively at this time because of limited dose-response information. The potential for these risks represents a significant uncertainty with respect to toxicity (see Section 7).

4.4 EXPOSURE POINT CONCENTRATION CALCULATION METHOD

The EPCs calculated in this risk assessment were scenario-specific and contaminant-specific. Consistent with EPA guidance (EPA, 1992b; EPA, 2002a), EPCs were calculated for each data set for each exposure area based on the 95% UCL of the mean of the concentration data. The equations that were used for the calculation were selected based upon the shape of the underlying distribution of the concentration data.

The UCLs for data with normal and lognormal distributions were computed using the Student's t and Land's *H* method, respectively. The software program ProUCL (EPA, 2002b) was used to test for normality and lognormality and to compute the UCL for normal and lognormal data. As noted in Section 2, site data were tested for normality using the Shapiro-Wilks test (alpha = 0.05) for sample sizes <50 and Lilliefors Test Statistic (alpha = 0.05) for samples ≥50. For data sets that were neither normally nor lognormally distributed, the Hall's modified bootstrap method was used. The modified bootstrap calculation was implemented using a software program developed for this site. The documentation and code for the program, along with coverage rates of the Hall's bootstrap method under certain assumptions about the underlying distribution of concentrations, are provided in Attachment 4 of HHRA, Volume I.

The equations for each of the UCL calculation methods are presented below.

Normal Distribution

$$UCL = \overline{X} + t\,(s/\sqrt{n}\,)$$

Where:

UCL = 95% UCL of the arithmetic mean,

$\overline{X}$ = the arithmetic mean of the data, $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$,

s = the standard deviation of the data, $s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}$,

t = the 95th percentile of Student's t distribution with $n-1$ degrees of freedom,

n = the number of samples.

In principle, the Student formulation is correct when the sample size is small, as long as the concentrations are normally distributed. The method is robust to non-normality if sample size is sufficiently large. But for moderate or small *n*, this method of computing the UCL can be incorrect if the underlying data are not normally distributed. Therefore it is important to test the data for normality.

Lognormal Distribution

$$UCL = \exp\left(\overline{\ln X} + s_{\ln}^2/2 + Hs_{\ln}/\sqrt{n-1}\right)$$

Where:

UCL = 95% UCL of the arithmetic mean,

$\overline{\ln X}$ = the mean of the log-transformed data, $\overline{\ln X} = \frac{1}{n}\sum_{i=1}^{n}\ln(X_i)$,

$s_{\ln}$ = the associated standard deviation, $s_{\ln} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\ln(X_i) - \overline{\ln X}\right)^2}$,

H = H-statistic associated with $s_{\ln}$ and n (Land, 1975; Gilbert, 1987 Table A12),

n = the number of samples

The Land formulation is known to be sensitive to deviations from lognormality. The formula may commonly yield estimated UCLs substantially larger than necessary when distributions are not truly lognormal if variance or skewness is large (Gilbert, 1987). Because the Land method is sensitive to violations of the assumption of lognormality, it is important to test this assumption.

Hall's Bootstrap

$$UCL = \overline{X} + W s$$

Where:

UCL = 95% UCL of the arithmetic mean,

$\overline{X}$ = the arithmetic mean of the data, $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$,

s = the standard deviation of the data, $s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}$,

W = Hall's modifier, $W = \frac{3}{k}\left(\left(1 + k\left(Q_{0.05} - \frac{k}{6n}\right)\right)^{1/3} - 1\right)$,

k = the sample skewness, $k = \frac{1}{ns^3}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^3$,

n = the number of samples

$Q_{0.05}$ = the 5th percentile of the distribution of values $Q = w + \frac{kw^2}{3} + \frac{k^2w^3}{27} + \frac{k}{6n}$.

The Q values were computed for bootstrap samples of size n where $W = (\overline{X}_b - \overline{X})/s_b$, $\overline{X}_b$ is the arithmetic mean of the bootstrap sample, and s_b is the associated standard deviation.

If the 95% UCL concentration exceeded the maximum detected concentration for a contaminant, the maximum detected concentration was used as the EPC. The fish and waterfowl EPCs are presented in Sections 4.5.1 and 4.6.1, respectively.

4.5 FISH

4.5.1 Exposure Point Concentrations

The data sets for the PSA and Rising Pond included four fish species: brown bullhead, largemouth bass, sunfish (bluegill and pumpkinseed), and yellow perch. Quantitative information related to the species consumption preferences of local residents was used to evaluate the potential combination of the data from these four species to obtain a single EPC representative of fish consumption from this area. A qualitative discussion of species preference is provided in Section 2.4.1.1.1 as part of the data selection process. The following studies, previously described for the qualitative analysis, were reviewed to obtain quantitative estimates:

- Freshwater fish species consumption preferences in the Housatonic River area (MDPH, 1997).
- Species caught in the Housatonic River in Massachusetts (ChemRisk, 1994).
- Species harvested in the Housatonic River in Connecticut (CTDEP, 1988; Ebert et al. 1996).

Additional data that are relevant for the Housatonic River area, but not specific for the Housatonic River, were also examined for the quantitative evaluation:

- Species that Massachusetts residents fish for in Massachusetts (USFWS, 1998a; 2001).
- Meals consumed per species from streams and rivers in New York (EPA, 1999).
- Weight consumed, on a species basis, from freshwater sources in Maine (ChemRisk, 1992).

The criteria to select the study to provide the quantitative data for species preference were:

- Similarity of the population to Housatonic River anglers.
- Data to derive quantitative estimates of meals/species consumed.
- Data for all species in the Housatonic River risk assessment data set.
- The size and quality of the study.

Based on these criteria, the MDPH study (used to determine the qualitative species preference information) was selected as the basis for calculating the relative frequency of consumption of each species. The MDPH study is site-specific, contains information for each fish species, and can be used to quantify preference of species consumption using the assumption that the frequency of respondents listing a species as one of the three most frequently consumed reflects the relative amounts of species actually consumed.

The data used to develop relative weighting (preference) of species consumed for the Massachusetts reaches are provided in Table 4-4. In the Exposure Prevalence phase of the study, approximately half the respondents in the "all respondents" group and in the group who had consumed fish from the Housatonic River expressed a preference for perch and bass. Approximately 15% of the respondents considered bullhead to be one of their top three fish preferences and fewer than 2% of the respondents preferred sunfish. The preferences are somewhat different for the respondents in the volunteer phase of the survey, with notably fewer individuals preferring bass and more preferring bullhead.

Table 4-4

Percentage of Individuals Noting Species Consumed Most Frequently

Species	Percent of Individuals who Consumed the Species (exposure prevalence study/volunteer study)	
	All Respondents	**Housatonic River Anglers**
Bass	50.3/23.8	46.2/11.1
Bullhead	12.5/20	15.4/44.4
Sunfish	1.7/2.9	1.9/0
Perch	49.7/47.6	57.7/55.6

Based on MDPH, 1997. The exposure prevalence study and the volunteer study are described in Section 4.5.2.2.1.

Data from Connecticut (CTDEP, 1988) indicate that, in terms of target species, anglers devoted 37% of their fishing effort to trout, 27% of their effort to bass (both largemouth and smallmouth), and 36% of their effort to panfish/gamefish (which includes perch and sunfish). However, a different pattern was observed for harvested fish at the time of the Connecticut creel survey: 29% white perch, 25% yellow perch, 17% sunfish, and 9% smallmouth bass (Ebert et al., 1996). The trout were caught primarily in the trout management area, which is designated catch and release only, and thus would have been illegal to harvest. There was a fish consumption advisory in place at the time of this creel survey.

Species preference weighting was not incorporated into the EPCs in the Connecticut reaches because only smallmouth bass data were available for three of the locations. Both smallmouth bass and brown trout data were available for one location, and these were evaluated separately.

Fish EPCs for each of the evaluated areas are presented in Tables 4-5 through 4-7.

4.5.1.1 Primary Study Area (Reaches 5 and 6)

As discussed in Section 2.7.2.1, the tPCB concentrations in perch were not statistically different from those measured in sunfish. Similarly, largemouth bass concentrations were not statistically different from those found in brown bullhead. Therefore, the data were combined into two groups rather than four to provide larger sample sizes (i.e., a more robust data set for calculating statistics).

In the MDPH survey, respondents indicated an approximately equal preference for bass/bullhead and perch/sunfish. Therefore, the concentration data for these data groups, i.e., bass/bullhead and perch/sunfish, were given equal weight to calculate EPCs in the PSA.

Table 4-5

Fish Tissue Exposure Point Concentrations
Reaches 5 and 6

Contaminant	Brown Bullhead-Largemouth Bass			Sunfish-Yellow Perch			Combined[a] Fish EPC (mg/kg)
	Maximum Detected Concentration (mg/kg)	95% UCL (mg/kg)	EPC (mg/kg)	Maximum Detected Concentration (mg/kg)	95% UCL (mg/kg)	EPC (mg/kg)	
PCBs							
PCB, TOTAL	151	18	18	76	9.4	9.4	14
2,3,7,8 TCDD TEQs[b]							
Dioxin Congener-based TEQ	0.0000073	0.0000042	0.0000042	0.0000027	0.0000011	0.0000011	0.0000027
Furan Congener-based TEQ	0.000042	0.000012	0.000012	0.000034	0.0000071	0.0000071	0.0000096
Dioxin-like PCB Congener-based TEQ	0.0036	0.00038	0.00038	0.0012	0.00017	0.00017	0.00028
METALS							
Mercury[c]	0.72	0.61	0.61	NA	NA	NA	0.61

[a] The combined fish exposure point concentration was calculated by summing one-half of the brown bullhead/largemouth bass EPC and one-half the sunfish/yellow perch EPC.

[b] TEQs were calculated using one-half the sample quantitation limit (SQL) for congeners detected within the data set but not within the sample.

[c] Mercury was not analyzed for in sunfish and yellow perch; therefore, the EPC based on the brown bullhead and largemouth bass data was used as the combined EPC.

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

NA = not analyzed.

UCL = upper confidence limit.

Table 4-6

Fish Tissue Exposure Point Concentrations
Rising Pond

	Brown Bullhead-Largemouth Bass-Pumpkinseed			Yellow Perch			
Contaminant	**Maximum Detected Concentration (mg/kg)**	**95% UCL (mg/kg)**	**EPC (mg/kg)**	**Maximum Detected Concentration (mg/kg)**	**95% UCL (mg/kg)**	**EPC (mg/kg)**	**Combined[a] Fish EPC (mg/kg)**
PCBs							
PCB, TOTAL	13	4.8	4.8	25	14	14	9.4
2,3,7,8 TCDD TEQs[b]							
Dioxin Congener-based TEQ	0.00000056	0.00000066	0.00000056	0.0000000052	4.2	0.0000000052	0.00000028
Furan Congener-based TEQ	0.000021	0.0000090	0.0000090	0.000017	0.000019	0.000017	0.000013
Dioxin-like PCB Congener-based TEQ	0.000094	0.000054	0.000054	0.00021	0.00028	0.00021	0.00013

[a] The combined fish exposure point concentration was calculated by summing one-half of the brown bullhead/largemouth bass/pumpkinseed EPC and one-half the yellow perch EPC.

[b] TEQs were calculated using one-half the sample quantitation limit (SQL) for congeners detected within the data set but not within the sample.

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

NA = not analyzed.

UCL = upper-confidence limit.

Table 4-7

Fish Tissue tPCB Exposure Point Concentrations
Connecticut

Species/Location	Maximum Detected Concentration (mg/kg)	95% UCL (mg/kg)	EPC (mg/kg)
Smallmouth Bass—West Cornwall / Bulls Bridge	2.0	1.1	1.1
Brown Trout—West Cornwall	11	2.9	2.9
Smallmouth Bass—Lake Lillinonah / Lake Zoar	2.9	0.80	0.80

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

UCL = upper confidence limit.

4.5.1.2 Rising Pond

As discussed in Section 2.7.2.2, and for the PSA, the tPCB concentrations were compared statistically among the species. Concentrations in bass were not different from those found in sunfish and brown bullhead. Because concentrations of these species were not statistically different, data for these species were combined to provide a larger sample size (i.e., more-robust data set), while perch were considered as a separate data set.

As noted in the discussion for the PSA, in the MDPH survey, respondents indicated a similar preference for bass/bullhead and perch/sunfish. Because sunfish comprise a small portion of the species preference (0 to 3%), grouping the data as bass/bullhead/sunfish versus perch yields an approximately even distribution among the two categories. Therefore, the concentration data for these two data groups, i.e., bass/bullhead/sunfish and perch, were given equal weight to calculate EPCs.

4.5.2 Exposure Models and Parameters

The exposure model used to calculate average daily doses of each COPC from the consumption of fish and the parameter values used in the model are described in the following sections.

4.5.2.1 Exposure Model

Average daily doses (ADDs) of COPCs were calculated for each receptor based on two different averaging times. ADDs averaged over the exposure duration were used to evaluate noncancer health effects. These averages are arithmetically identical to a yearly average, although they are assumed to be similar over the entire exposure duration. Lifetime average daily doses (LADDs), in which the doses are averaged over a 70-year lifetime, were used to evaluate potential cancer risk. ADDs and LADDs are expressed as administered doses in milligrams of contaminant per kilogram of body weight per day (mg/kg-d).

The reasonable maximum exposure (RME) and central tendency exposure (CTE) fish consumption point estimate LADDs and ADDs were calculated for cancer risk and noncancer effects for an adult angler and a child household member using the formulas and parameter values presented in Tables 4-8 through 4-10. Consistent with the approach described in EPA guidance (EPA, 1989a), the RME exposure included a mix of upper and average values from exposure parameter distributions to arrive at an upper-bound risk estimate. The CTE exposure used average values for exposure parameters and, thus, yielded estimates of average risk. The rationale for selecting the exposure parameters are described in the following sections.

4.5.2.2 Fish Consumption Rate

The following three studies detailing fish catch for the Housatonic River were evaluated as a basis for fish consumption rates:

- The PCB Exposure Assessment Study conducted by the Massachusetts Department of Public Health in 1995/1996 (MDPH, 1997).
- A creel survey conducted by ChemRisk/GE in 1992 (ChemRisk, 1994).
- A creel survey conducted by the Connecticut Department of Environmental Protection from 1984 to 1986 (CTDEP, 1988). This study formed the basis for a paper on ingestion rates (Ebert et al., 1996).

The design and demographics of these studies are described in Section 2.4.2.

Fish consumption advisories were in place during all of these studies, which may lead to an underestimate of fish consumption rates in the absence of advisories. Because of this, the following study was also reviewed for use in deriving the fish ingestion rate:

- Maine Angler Survey (Ebert et al., 1993; ChemRisk, 1992).

4.5.2.2.1 MDPH PCB Exposure Study

This study consisted of interviews of Housatonic Area residents to obtain information about activities that may result in contact with site-related contaminants, including the fishing habits of area residents. Since the 1995/1996 study, MDPH has screened additional residents on an ongoing basis. Updated statistics were compiled by MDPH in August and September 2001 (MDPH, 2001a and 2001b). A summary of this study is presented in Section 2.4.2.1.1.

Table 4-8

Age-Adjusted Cancer Dose Calculation for the Consumption of Fish

$$\text{Fish Consumption Dose (mg/kg-d)} = \frac{EPC_{fish} \text{ x } (1 - LOSS) \text{ x } FI \text{ x } EF \text{ x } CF \text{ x } IRF_{adj}}{AT}$$

Where:			RME	CTE	Reference
EPC_{fish}	=	Exposure point concentration of contaminant in fish (mg/kg).	Exposure area-specific		
LOSS	=	Cooking loss (unitless).	0 (25% in calculation)*	25%	Various, see text.
FI	=	Fraction ingested from contaminated source (unitless).	0.97	0.5	See text
EF	=	Exposure frequency (ds/year).	365	365	Standard value when using average daily ingestion rates
CF	=	Conversion factor (kg/g).	0.001	0.001	---
IRF_{adj}	=	Age-adjusted fish consumption factor, see Table 4-9 (g-year/kg-d).	26 (MA and CT bass) 9.9 (CT trout)	3.8 (MA and CT bass) 1.8 (CT trout)	See Table 4-9
AT	=	Averaging time (d).	25,550	25,550	EPA, 1989a

* The CTE cooking loss (25%) is used in the RME calculation to obtain a combination of upper and central tendency exposure parameters that provides health protective, but not unrealistic, estimates of potential exposure.

Table 4-9

Calculation of Age-Adjusted Fish Consumption Factor

$$IRF_{adj}\ \text{(g-year/kg-d)} = \frac{ED_c \times IRF_c}{BW_c} + \frac{ED_a \times IRF_a}{BW_a}$$

Where:	RME	CTE	Reference
IRF_{adj} = Age-adjusted fish consumption factor (g-year/kg-d).	26 (MA and CT bass) 9.9 (CT trout)	3.8 (MA and CT bass) 1.8 (CT trout)	Calculated
ED_c = Child exposure duration (years).	6	6	EPA, 1989a
ED_a = Adult exposure duration (years).	44	17	MDPH, 2001a
IRF_c = Child fish consumption rate (g/d).	16 (MA and CT bass) 6 (CT trout)	4.3 (MA and CT bass) 2 (CT trout)	See text
IRF_a = Adult fish consumption rate (g/d).	31 (MA and CT bass) 12 (CT trout)	8.7 (MA and CT bass) 4 (CT trout)	Ebert et al., 1993; see text
BW_c = Child body weight (kg).	15	15	EPA, 1989a
BW_a = Adult body weight (kg).	70	70	EPA, 1989a

Table 4-10

Noncancer Dose Calculation for the Consumption of Fish

$$\text{Fish Consumption Dose (mg/kg-d)} = \frac{EPC_{fish} \times (1 - LOSS) \times IRF \times EF \times FI \times ED \times CF}{BW \times AT}$$

Where:			**RME**	**CTE**	**Reference**
EPC_{fish}	=	Exposure point concentration of contaminant in fish (mg/kg).	Exposure area-specific		
LOSS	=	Cooking loss (unitless).	0 (25% in calculation)*	25%	see text
IRF	=	Fish consumption rate (g/d).	31 (adult; MA and CT bass) 12 (adult; CT trout) 16 (child; MA and CT bass) 6 (child; CT trout)	8.7 (adult; MA and CT bass) 4 (adult; CT trout) 4.3 (child; MA and CT bass) 2 (child; CT trout)	Ebert et al., 1993 (adult) See text (child)
EF	=	Exposure frequency (d/year).	365	365	Standard value when using average daily ingestion rates
FI	=	Fraction ingested from contaminated source (unitless).	.97	0.5	See text
ED	=	Exposure duration (years).	44 (adult) 6 (child)	17 (adult) 6 (child)	MDPH, 2001a (adult) EPA, 1989a (child)
CF	=	Conversion factor (kg/g).	0.001	0.001	---
BW	=	Body weight (kg).	70 (adult) 15 (child)	70 (adult) 15 (child)	EPA, 1989a
AT	=	Averaging time (d).	16,060 (adult) 2,190 (child)	6,205 (adult) 2,190 (child)	EPA, 1989a

* The CTE cooking loss (25%) is used in the RME calculation to obtain a combination of upper and central tendency exposure parameters that provides health protective, but not unrealistic, estimates of potential exposure.

As part of the MDPH study, information on the frequency of fish consumption from any freshwater source was collected. A total of 527 of the 1,529 residents (35%) in the Exposure Prevalence Study reported ever eating freshwater fish from any source. Of this fish-eating population, approximately 75% (304 residents) reported that freshwater fish consumed were self-caught or caught by friends or family members. A total of 52 residents reported ever eating fish from the Housatonic River. For those who reported eating freshwater fish, 167 (32%) reported eating fish one to four times per month, and 135 (26%) reported eating fish one to two times per week, and five reported eating fish at least three times per week. There were no significant differences in fishing activity among different age groups. Male residents were found to fish more frequently in the Housatonic River than female residents.

In the Volunteer Study, 105 of the 158 residents (67%) surveyed reported eating freshwater fish from any source. Of these fish-eating respondents, 88 (84%) reported that fish consumed were self-caught or caught by friends or family members. A total of 28 of the 158 residents (17.8%) had fished in the Housatonic River, and 9 of the 28 residents (32%) had eaten fish from the Housatonic River at least once. The reported frequency of consumption of those who ate freshwater fish from any source was 33 participants who ate one to four meals per month, and 12 participants who ate one to two meals per week.

4.5.2.2.2 ChemRisk Massachusetts Creel Survey

This creel survey was conducted by ChemRisk in 1992 at two locations in the Massachusetts portion of the Housatonic River: Newell Street Bridge to the Woods Pond Dam (Location 1) and Woods Pond Dam to the Connecticut Border (Location 2). A total of 62 creel survey days were completed on the river, and 85 anglers were interviewed. Twenty percent of the anglers in Location 1 and 33% of the anglers in Location 2 reported that they had fished those reaches of the river more than once a week. On average, the anglers fished 5 months per year. Of the 85 anglers interviewed, 57 had caught fish, and 1 had retained at least some of the catch. This study was conducted after MPDH issued a fish consumption advisory. A summary of this study is presented in Section 2.4.2.1.2.

4.5.2.2.3 Connecticut Housatonic River Creel Survey

This creel survey was conducted by the CTDEP from 1984 to 1986 at six locations from the Massachusetts border to the Stevenson Dam (Lake Zoar). The data collected by CTDEP were also analyzed by Ebert and colleagues (Ebert et al., 1996). The median frequency of trips to the Housatonic River was 10 per year (Ebert et al., 1996). Twenty-three (1.5%) of the 1,515 respondents indicated that all of their fishing was in the Housatonic River, and 150 respondents (9.9%) reported that at least 95% of their fishing trips were to the Housatonic River. A summary of this study is presented in Section 2.4.2.1.3.

The data did not indicate any subpopulations of Housatonic River anglers that consumed considerably more fish than others. Of the 202 anglers who provided both harvest and trip frequency data, 109 indicated they usually consumed their catch, 53 reported they usually did not consume their catch, and 40 did not report their consumption practice.

The data from the CTDEP survey were reanalyzed by Ebert et al. (1996) to determine fish consumption rates. Total edible mass of fish per trip was estimated based on species-specific length information and the number of fish harvested per trip, both of which were provided in the survey forms, and the assumption that 30% of the fish is edible (i.e., consumers do not eat the head, viscera, or bones). The total mass of fish potentially ingested per angler per year was obtained by multiplying the edible mass/trip by the number of trips per year. Daily ingestion rates were obtained by dividing the edible mass of fish harvested each year by 365 days per year to obtain a daily ingestion rate assuming only the angler consumed the fish. This fish consumption rate was further adjusted based on one of two assumptions: two adults in a household shared fish or households averaged 2.5 persons, and they shared the fish equally. Results were reported for multiple percentiles, thus providing a distribution of ingestion rates.

Ebert et al. estimated that the total edible mass of fish obtained by individual anglers averaged 120 g/trip, with a median of 19 g/trip, and a 95th percentile of 770 g/trip. The daily consumption rate, assuming only the angler consumed the fish, yielded an arithmetic mean of 6.7 g/person-d, a median of 0.45 g/person-d, and a 95th percentile of 32 g/person-d. If two adults per household shared the fish equally, the consumption rates would be half those of the angler-only rates.

In a study conducted after the Ebert et al. analysis, Balcom et al. (1999) surveyed sport-fishing families as part of a larger study of fish consumption rates in Connecticut. Balcom et al. reported that the average household size of sport-fishing families was 1.5, compared to 2.1 for the general population, 3.4 for limited-income families, and 3.5 for minority families. If family members shared equally in the catch, then the 95th percentile of the daily fish consumption rate would be 21.3 g/d. However, fish consumption advisories were in place during this survey, which would have depressed consumption rates (Connelly et al., 1992).

The Ebert et al. (1996) study was considered as the basis of the fish consumption rate because of its site specificity and the size of the study. However, the creel survey was conducted while a fish consumption advisory was in place, potentially giving a low bias to the consumption rates. In addition, the underlying data for the study are no longer available, thus limiting its usefulness for the probabilistic analysis.

4.5.2.2.4 Maine Angler Survey

Ebert et al. (1993; additional data published in ChemRisk, 1992) estimated adult consumption rates of recreationally caught freshwater fish in Maine based on data from a statewide mail survey of licensed resident anglers. In Maine, less than 1% of riverine environments were subject to fish consumption advisories at the time of the survey, and thus the consumption rates calculated from this study were not potentially biased low.

The Maine Angler Survey was a 1-year recall study based on a 19-page survey mailed to 2,500 individuals holding residential or complementary fishing licenses in Maine in 1989. All categories of licenses were sampled (fishing; fishing and hunting; fishing and archery; servicemen combination; supersport; over 70—fishing and combination; disabled veterans—fishing and combination; paraplegics—fishing and combination; blind—fishing; mental disability—fishing; and Indian—combination). Every 75th license holder was selected from the list, for a total of approximately 3,000 names.

The survey was tested on 50 individuals, and revised based on telephone interviews and returned surveys. On 16 October 1990, 2,500 (revised) surveys were mailed out, corresponding to the end of the open-water fishing season. Approximately 70% (1,612) of the delivered surveys were completed and returned.

Respondents were asked to recall the frequency of fishing trips during the 1989-1990 ice-fishing season and the 1990 open water season, the number of species caught during both seasons, the number taken from flowing water and standing water, the number of fish consumed by species, the number of fish consumed that were caught by other anglers, and fish preparation and cooking methods. Anglers were also asked about the average length of each fish species that was consumed, a value that could be converted to mass ingested.

Seventy-eight percent (1,251 respondents) indicated they fished (open-water or ice) the previous year, and approximately 7% of the respondents indicated they did not fish but consumed freshwater fish caught by other anglers. Approximately 44% and 82% of the respondents indicated they had ice fished and open-water fished, respectively. Nearly 93% of the open-water anglers fished ponds or lakes and 66% fished streams or rivers. Twenty-three percent of the respondents did not consume freshwater fish.

Calculation of Fish Consumption Rates (ChemRisk, 1992; Ebert et al., 1993)

The approach for calculating fish consumption rates in this study was as follows:

- For each household, Ebert et al. (1993) calculated the total mass of freshwater fish consumed in the household that was caught by members of the household or obtained as gifts (separate calculations were done for ice fishing, open water-flowing, and open water-standing).
- Individual consumption rates were calculated by dividing the total household mass consumed by the number of freshwater fish consumers in the household. No distinction was made between males and females or children and adults.
- The fish mass consumed was calculated from the responses to the questions regarding length and number of fish consumed (see below). These data were combined with a species-specific relationship between fish length and mass, and the percent edible portion of fish (assuming only fillets were consumed).
- The consumable portion of the fish was assumed to be 30% for all species except landlocked salmon (40%) and smelt (78%). The 30% value was based on studies of smallmouth bass in Maine and EPA default values (EPA, 1989b).

The Maine Angler Survey included questions regarding the species and number of freshwater fish caught by the respondent (with separate questions for ice and open-water season) and the disposition of the fish. One portion of a question asked for the number and average length of the fish consumed by the respondent and/or household member (for each of 14 named species and "other"). The bullets below summarize the questions that formed the basis for the calculation of total mass consumed per household:

- How many fish of each of 14 named species had the respondent caught during ice fishing season and eaten? What was the length of these fish? (Q11)
- How many fish of each of 14 named species had the respondent caught during open water fishing season and eaten? (Q23)
- How many of these fish were from flowing waters and how many from standing waters? What was the average length of these fish? (Q24)
- How many of each of 14 named species caught by other members of the household during ice fishing and open water season were eaten by the respondent and/or other family members (also average length)? (Q29)
- How many of each of 14 named species caught by non-household members during open water fishing season were eaten by the respondent and/or other family members (also length)? (Q31)
- Please describe the age and sex of each household member and indicate whether they eat freshwater fish caught in Maine. (Q32)

To calculate fish mass consumed in each respondent's household, the average lengths provided in response to questions 11, 23, 24, 29, and 31 for the species consumed were converted to fish mass using the following relationship:

$$W = CL^n$$

Where:

W = the mass of the whole fish
C = species-specific constant
L = length of whole fish
n = species-specific constant, generally around 3, but depends on shape of fish

Parameter values (n) were obtained from regressions of fish caught in Maine (unpublished data from Maine Inland Fisheries and Wildlife) and literature values.

Using this methodology, Ebert et al. calculated the consumption rate of fish for each of three consumption patterns:

- All household fish consumers eat an equal share of consumed fish.
- Only adults in the household consume fish.
- Only the angler consumes fish.

Table 4-11 presents the fish consumption rates calculated by Ebert et al. based on these three consumption pattern scenarios. Fish ingestion rates are variable across the population, and the table provides the estimates for the median (50th percentile), and several higher percentiles including the 90th and 95th percentile of the distribution of consumption rates. It also presents the arithmetic mean, which is slightly above the 75th percentile, indicating a skewed distribution for consumption. The data indicate that consumption of fish from rivers and streams comprises approximately half of the total consumption of freshwater fish (all waters). In addition, the consumption rates based on only the angler ingesting fish are approximately 2.5 times greater than the consumption rates that assume household members equally share the fish. The upper range of fish consumption rates based on angler-only consumption from all waters are 32 and 57 grams/d for the 90th and 95th percentile, respectively. Central tendency consumption rates for these anglers are 5 and 15 grams/d for the median and mean, respectively.

Uncertainties and Potential Biases of the Results

As with any study, there are multiple uncertainties and potential biases associated with the results. These uncertainties and biases can be due to inherent problems with surveys and the subsequent calculations based on the survey data. The following potential biases have been identified by various reviewers of this study, and/or the study authors.

- Accounting for nonrespondents (64% response rate): The study authors argue that it is more likely that the nonrespondents were non-anglers or low-frequency anglers (i.e., fishing is less important to them and thus they are less likely to respond) and their omission results in a high bias to the ingestion rate.

- Format and level of detail of the questionnaire led to lack of its completion. This would lead to a low bias. The study authors state that this is not a problem because of similarity of species preference in response to early and late questions in the survey and to responses in previous surveys (ChemRisk, 1996).

Table 4-11

Consumption Rates of Recreationally Caught Freshwater Fish in Maine

Percentile	Consumption Rate (g/d)					
	All Household Consumers Share		Only Adult Consumers Share		Anglers Only (No Sharing)	
	All Waters	Streams/ Rivers	All Waters	Streams/ Rivers	All Waters	Streams/ Rivers
50th	2.0	0.99	2.3	1.2	5.0	2.5
66th	4.0	1.8	4.4	2.0	9.1	4.1
75th	5.8	2.5	6.6	3.0	13	6.1
90th	13	6.1	16	6.5	32	14
95th	26	12	28	20	57	27
Arithmetic mean	6.4	3.7	7.5	4.5	15	8.9

Source: Ebert et al., 1993. (Table 4)

- Fish consumption rates could be overestimated due to survey biases; participants responding to self-report surveys with 6-month to 1-year recall periods tend to over-report their actual participation in activities (Ebert et al., 1993; citing a study by Westat, 1989).

- Fish ingestion rates may be underestimated because the calculation of mass consumed was based on average fish length data, but the fish length-weight relationship is known to be nonlinear. Large fish would lead to more mass consumed than calculated. ChemRisk (1996) acknowledges this effect, but maintains that it will be small based on calculations of this effect using data on fish length variability.

- Freshwater fishing and consumption may be biased low because of the availability of salt water fishing (ChemRisk, 1992). The fact that less than 1% of Maine's freshwater bodies were subject to consumption advisories at the time of the survey would tend to mitigate this low bias to some degree.

- Consumption rates are likely to be underestimated for some individuals (such as adult males) because they were calculated by dividing household consumption by the number of consumers in a household. Since approximately 80% of the survey respondents were male, and typical meal sizes for adult males are larger than for adult women and for children, it is likely that consumption rates for this population are likely to be underestimated.

EPA Approach to Calculating Consumption Rate Based on Data from the Maine Angler Survey

The Maine Angler Survey represents a large and well-conducted study on which to base recreationally caught fish consumption rates. To determine its applicability to Housatonic River anglers and fish consumers, the demographics of the population of the Maine angler survey were compared with the demographics available for anglers and fish consumers in the Housatonic River area of Massachusetts and Connecticut. Tables 4-12 through 4-15 compare the survey designs and the available demographics in Ebert et al. (1993) to those available for fish consumers or anglers in Massachusetts and Connecticut.

This comparison includes gender, age, ethnicity, income, and education to the degree that this information was available. Overall, the demographics of the populations in these studies are comparable.

Statistics regarding gender were not provided in the Ebert et al. (1993; ChemRisk, 1992). The mean age of participants was 44, compared with 39 in the CTDEP, 1988 study. Mean age was not given in the other studies, but was estimated by summing the product of the midpoint of the age range and the percentage of respondents within that range. Based on these assumptions, the average age of the anglers from other studies (MDPH exposure prevalence and volunteer, and Massachusetts and Connecticut anglers [USFWS study]) ranges from 37 to 40. The ethnicity of the participants in the MDPH and CTDEP study was not noted, although, according to the U.S. Census Bureau, in 2000 the population of Berkshire County was 95% White (www.quickfacts.census.gov). The subjects of the Ebert et al. study were 88% White, non-Hispanic, while the USFWS subjects were 89% and 93% White in the Massachusetts and Connecticut studies, respectively. Annual household income between the CTDEP and Ebert et al. studies are fairly similar, approximately $29,000 versus approximately $31,000, respectively. MDPH did not report income. Annual household income from Ebert is lower than in the USFWS studies (average annual income > $50,000), but the difference may be partially attributable to the difference in the study years (1990 versus 1996). Average education level also appears to be lower in the Ebert study versus the USFWS studies (high school graduate versus some college). MDPH and CTDEP did not collect information on education levels.

Table 4-12

Summary of Massachusetts, Connecticut, and Maine Angler Survey Designs

Category	Massachusetts (MDPH, 1997)		Connecticut (CTDEP, 1988[a])	Maine (Ebert et al., 1993[b])	Massachusetts (USFWS, 1998a)	Connecticut (USFWS, 1998b)
	Exposure Prevalence	Volunteer				
Study Dates	1995	1996	1984 to 1986	1990	1996	1996
Geographic Area	Residences within 0.5-mile radius of the Housatonic River from Lanesborough and Dalton to the CT border.	---	Housatonic River: Six locations from Massachusetts border to Stevenson Dam (Lake Zoar, CT)	Maine	Massachusetts	Connecticut
Study Type	Household screening questionnaire, via phone	Household screening questionnaire, via phone	Angler survey	Mail survey	Three phone survey interviews conducted at 4-month intervals	Three phone survey interviews conducted at 4-month intervals
Sample Selection	Stratified systematic cluster sampling scheme	---	Roving census combined with a stratified design	Random selection of approximately 3,000 Maine residents from 225,000 fishing license holders	Individuals at least 16 years old who were identified as likely anglers during the screening phase	Individuals at least 16 years old who were identified as likely anglers during the screening phase
Population	Households in Pittsfield Households from the rest of the HRA communities	117 individuals from Pittsfield 41 individuals from the rest of the HRA communities	Housatonic River anglers in CT	2,500 Maine freshwater anglers	Massachusetts Residents – Sportsmen (anglers and hunters)	Connecticut Residents – Sportsmen (anglers and hunters)
Sample Size (contactable)	783 households representing 1820 individuals	158	1,598	2,303	601	680
Response Rates (%)	84	100	95	64	80	85

Table 4-12

Summary of Massachusetts, Connecticut, and Maine Angler Survey Designs (Continued)

Category	Massachusetts (MDPH, 1997)		Connecticut (CTDEP, 1988[a])	Maine (Ebert et al., 1993[b])	Massachusetts (USFWS, 1998a)	Connecticut (USFWS, 1998b)
	Exposure Prevalence	Volunteer				
Total Participants	1,529	158	1,515	1,612	479 used to estimate responses for a population of 601,000 anglers	581 used to estimate responses for a population of 364,000 anglers

[a]As presented in Ebert et al., 1996.

[b]As presented in ChemRisk, 1992.

Table 4-13

Comparison of Massachusetts, Connecticut, and Maine Angler Survey Demographics – Gender and Age

Demographic	Massachusetts (MDPH, 1997)		Connecticut (CTDEP, 1988[a])	Maine (Ebert et al., 1993[b])	Massachusetts (USFWS, 1998a[c])	Connecticut (USFWS, 1998b[c])
	Exposure Prevalence	Volunteer				
Sex:						
Male	724 (47%)	76 (48%)	1424 (94%)	---	440 (73%)	292 (80%)
Female	805 (53%)	82 (52%)	30 (2%)	---	160 (27%)	72 (20%)
Unknown	---	---	61 (4%)	---	---	---
Age:						
0-19	402 (26%)	---	61 (4%)	---	---	---
20-39	380 (25%)	---	742 (49%)	---	---	---
40-59	432 (28%)	---	439 (29%)	---	---	---
0-59	1214 (79%)	107 (68%)	1242 (82%)	---	---	---
60+	315 (21%)	51 (32%)	152 (10%)	---	---	---
65+	---	---	---	---	36 (6%)	34 (9%)
Unknown	---	---	121 (8 %)	---	---	---
16-17	---	---	---	---	30 (5%)	---
18-24	---	---	---	---	80 (13%)	37 (10%)
25-34	---	---	---	---	131 (22%)	80 (22%)
35-44	---	---	---	---	198 (33%)	109 (30%)
45-54	---	---	---	---	85 (14%)	67 (18%)
55-64	---	---	---	---	41 (7%)	28 (8%)
Average	---	---	39[d]	44	---	---

[a] As presented in Ebert et al., 1996, unless otherwise noted.

[b] As presented in ChemRisk, 1992.

[c] Estimated values. Numbers in thousands.

[d] CTDEP, 1988.

Table 4-14

Comparison of Massachusetts, Connecticut, and Maine Angler Survey Demographics – Ethnicity

Demographic	Massachusetts (MDPH, 1997)		Connecticut (CTDEP, 1988[a])	Maine (Ebert et al., 1993[b])	Massachusetts (USFWS, 1998a[c])	Connecticut (USFWS, 1998b[c])
	Exposure Prevalence	Volunteer				
Ethnicity (% of sample)						
White	---	---	---	---	537 (89%)	338 (93%)
White, Non Hispanic	---	---	---	1412 (88%)	---	---
Hispanic	---	---	---	3 (0.19%)	---	---
Native American	---	---	---	148 (9.2)	---	---
Asian/Pacific Islander	---	---	---	2 (0.12%)	---	---
Black	---	---	---	1 (0.062%)	47 (8%)	12 (3%)
Other	---	---	---	3 (0.19%)	---	---
Not Reported	---	---	---	36 (2.2%)	---	---

[a] As presented in Ebert et al., 1996, unless otherwise noted.

[b] As presented in ChemRisk, 1992.

[c] Estimated values. Numbers in thousands.

Table 4-15

Comparison of Massachusetts, Connecticut, and Maine Angler Survey Demographics – Income and Education

Demographic	Massachusetts (MDPH, 1997)		Connecticut (CTDEP, 1988[a])	Maine (Ebert et al., 1993[b])	Massachusetts (USFWS, 1998a[c])	Connecticut (USFWS, 1998b[c])
	Exposure Prevalence	Volunteer				
Annual household income:						
≤$9,999	---	---	106 (7%)	173 (11%)	---	---
$10,000-$19,999	---	---	182 (12%)	323 (20%)	---	22 (6%)
$20,000-$29,999	---	---	333 (22%)	319 (20%)	37 (6%)	21 (6%)
$30,000-$39,999	---	---	227 (15%)	256 (16%)	61 (10%)	36 (10%)
$40,000-$49,999	---	---	106 (7%)	198 (12%)	68 (11%)	25 (7%)
≥$50,000	---	---	166 (11%)	220 (14%)	288 (48%)	200 (51%)
$50,000-$74,999	---	---	---	---	140 (23%)	86 (20%)
≥$75,000	---	---	---	---	148 (25%)	114 (31%)
≥$100,000	---	---	12 (0.8%)	20 (1.2%)	---	---
Unknown	---	---	394 (26%)	---	124 (21%)	58 (16%)
Average	---	---	$29,144[d]	$31,125	---	---
Education:						
9 to 11 years	---	---	---	---	53 (9%)	26 (7%)
12 years	---	---	---	---	196 (33%)	117 (32%)
1 to 3 years college	---	---	---	---	122 (20%)	86 (24%)
4 years college or more	---	---	---	---	227 (38%)	127 (35%)
Average	---	---	---	High School Graduate	---	---

[a] As presented in Ebert et al., 1996, unless otherwise noted.

[b] As presented in ChemRisk, 1992.

[c] Estimated values. Numbers in thousands.

[d] CTDEP, 1988.

Overall, it was concluded that the angler population in Maine is sufficiently similar to the angler population in the Housatonic River area that these data provide a reasonable basis for determining consumption rates.

Recalculation of Consumption Rates Based On Raw Data

Consumption data for each individual angler, as well as the number of fish consumers in each angler's household, was provided to EPA by the authors of the Maine Angler Survey report (Ebert et al., 1993; ChemRisk, 1992). Consumption data were provided separately for rivers and streams, lakes and ponds, ice fishing, "other" (for those who did not consume self-caught fish), total consumption rate, and percent of total due to other (i.e., fish consumed by respondent that was obtained from others). EPA sorted these data by the number of fish consumers in each household, and selected the subset of data for which there was only one consumer in the household.

Eighty-seven of the respondents reported that there was only one fish consumer in their household (they did not share their catch with members of their household) and that they eat only what they catch. An additional 51 respondents reported they did not share their catch with household members, and consumed fish caught by others in addition to (or instead of) themselves. Based on fish consumption from all waters, the following statistics were derived for all non-sharing respondents (138) and those who eat only their catch (87).

Statistic	All Nonsharing, Who Only Eat Their Catch, All Waters (n=87) (g/d)	All Nonsharing, All Waters (n=138) (g/d)
Median (50th percentile)	3.4	2.9
Mean	8.5	8.9
90th percentile	18.7	21.5
95th percentile	31.4	31.1

This analysis of consuming anglers is based on only those who reported that they do not share their catch (9% of all respondents), thus an overestimation of consumption rates for this group is unlikely. The 95th percentile is appropriate to use for the RME point estimate of consumption rates, representing the midpoint of the upper exposure range (90 to 99%), and is consistent with EPA guidance for the use of 95% as the point of departure for determining an RME value. For both subsets of nonsharing anglers, the 95th percentile consumption rate is 31 g/d for consumption from all waters (rivers, streams, lakes, ponds, and ice fishing).

Ebert et al. (1993) calculated consumption rates for rivers and streams as well as "all waters." The "all waters" consumption rate is considered appropriate for fish species evaluated in the Housatonic River, except trout, for the following reasons:

1. Each of the four areas of the Housatonic River evaluated has reaches that are flowing and reaches that are standing (lakes and ponds). The areas (and the risk assessment) are structured on the basis that the majority of a person's fish consumption from the Housatonic River originates in these areas for the RME. To the extent that anglers consume fish from other areas of the Housatonic River, the risk should be fractionated among areas, not summed. (The fraction of the total recreationally caught freshwater fish consumption that originates in the Housatonic River is considered in the variable FI, described in Section 4.5.2.4).

2. Anglers may fish in multiple locations and seasons, with different characteristics of standing/flowing water in each area evaluated. Data collected in the Maine Angler Survey indicate that, on average, a recreational angler travels 30 miles to fish. The areas evaluated for this assessment have lengths that are less than 30 miles, determined either in river miles or by road. The distances below are in river miles:

    - Reach 5: 10.12 miles
    - Reach 6: 0.57 miles
    - Reach 7: 18.47 miles
    - Reach 8: 0.70 miles
    - Reach 9: 23.9 miles
    - Reach 10: 7.4 miles
    - Reach 11: 11.5 miles
    - Reach 12: 13.1 miles
    - Reach 13: 10.9 miles
    - Reach 14: 12.5 miles
    - Reach 15: 10.2 miles

3. The fish species that are most likely to be consumed by anglers are bass, perch, trout, and bullhead. To a lesser extent, sunfish such as bluegill or pumpkinseed may also be consumed. Bass, perch, bullhead, and sunfish may be caught in either flowing or standing waters, as shown in Table 4-1, which provides biomass data obtained during the ecological characterization of the PSA. In contrast, the trout are primarily in flowing waters.

For the consumption of bass, perch, bullhead, and sunfish, the distribution of consumption rates from all waters is the most appropriate basis for the exposure assessment. This analysis supports an RME consumption rate for fish other than trout of 31 g/d, which corresponds to fifty 8-oz meals/year. The central tendency exposure (CTE) consumption rate is represented by the average of the means of the two subsets (the one-consumer households who eat only what they catch, and those households that eat gift fish as well). This rate, 8.7 g/d, corresponds to fourteen 8-oz meals/year.

For the consumption of trout, the distribution of consumption rates from rivers and streams is most appropriate for the exposure assessment. The following table provides the statistics for anglers who report only one consumer in their household, based on consumption from rivers and streams.

Statistic	**All Nonsharing, Rivers and Streams (n=63) (g/d)**	**All Nonsharing, Who Only Eat Their Catch, Rivers and Streams (n=47) (g/d)**
Median (50th percentile)	2.0	1.8
Mean	6.1	4.2
90th percentile	11.6	8.8
95th percentile	22.5	11.7

This analysis supports an RME consumption rate for trout of 12 g/d, which corresponds to nineteen 8-oz meals/year and CTE consumption rate of 4 g/d, which corresponds to six 8-oz meals/year.

4.5.2.2.5 Consistency of Fish Consumption Rates with Other Sources of Data

The use of 31 g/d, or fifty 8-oz meals per year, for an RME fish consumption rate is consistent with the studies conducted in Massachusetts and Connecticut, including the MDPH survey (MDPH, 1997) and the Connecticut Creel Survey (Ebert et al., 1996). It is also consistent with the Maine Angler consumption rates reported by Ebert et al. (1993), if the correction is made for nonequal sharing of fish. The CTE value of 8.7 g/d, or fourteen 8-oz meals/yr, is also consistent with these studies.

MDPH Exposure Assessment Study

As discussed in Section 4.5.2.2.1, MDPH asked respondents about their frequency of fish consumption from any freshwater source. These data are summarized in Table 4-16 in terms of meals/year.

Table 4-16

Frequency of Fish Consumption (meals/year)

Statistical Parameter	Value
Mean	23.52
Standard Deviation	30.27
Sample Size	741
Maximum	208
Minimum	1
Median	12
95th Percentile	104
Third Quartile (75th percentile)	36
First Quartile (25th percentile)	2

Individuals who responded to the survey question for eating fish in number of times per life were assigned a frequency of 1 time/year. Eighteen individuals with unknown frequencies were not included in the summary.

Source: MDPH, 2001a.

The values for meals/year in this table reflect both recreationally caught and purchased fish meals. If, as indicated in the Exposure Prevalence phase of the MDPH study, 75% of the meals are recreationally caught, then the mean number of recreationally caught meals is estimated to be 18. This is close to the CTE estimate based on the Maine Angler Survey of 14 meals assuming 8-oz meals (or 16 meals/year assuming 7-oz meals). The 95th percentile of the distribution of recreationally caught meals is 78 meals/year. This is somewhat higher than the 50 meals/year (8-oz meals) derived from the Maine Angler Survey.

Connecticut Creel Survey

As discussed in Section 4.5.2.2.3, Ebert et al. calculated consumption rates based on a creel survey conducted in Connecticut from 1984 to 1986. Estimates of the 95th percentile of fish consumption ranged from 21.3 g/day to 32 g/day, depending upon assumptions of sharing within a family (and using specific family size for recreational anglers, rather than the statewide average). The 21.3 g/d rate is likely biased low, because a consumption advisory was in place, and it is based on the assumption of equal sharing. The 32 g/d may be biased high because there is likely some sharing of the catch, and concurrently biased low because the consumption advisory in place when the survey was conducted; it is not known how these biases may offset one another. This value is consistent with the 31-g/d estimate of the 95th percentile consumption rate derived from the Maine Angler Survey data.

Estimates of the arithmetic mean consumption rate in the Connecticut creel survey ranged from 4.5 to 6.7 g/d, depending upon assumptions of sharing within families (using an estimate of 1.5 for family size of angling families). These values are lower than the 8.7 g/d value derived from the Maine Angler Survey. Again, there is a low bias because of the consumption advisory.

Maine Angler Survey (Ebert, 1993) - Correcting for Nonequal Sharing

With regard to the majority of respondents who reported sharing their catch, the Maine Angler Survey assumed equal sharing of fish among all household consumers. However, males (roughly 80% of respondents) generally consume larger portions than females and children. This is demonstrated by the following consumption rates for male and female adults for freshwater and estuarine fish (all fish, not just those recreationally caught), which are published in the *Exposure Factors Handbook* (EPA, 1997):

Distribution of Consumption Rates Between Males and Females

Mean of distribution	male: 98.1 g/d	female: 74.7 g/d	Ratio: 1.3
90th percentile of distribution	male: 246.9 g/d	female: 181.1 g/d	Ratio: 1.4
95th percentile of distribution	male: 325.5 g/d	female: 239.6 g/d	Ratio: 1.4

If one assumes sharing of fish among two (one male/one female) adult household members only, and adjusting for nonequal sharing among males and females based on a 1.3 ratio, the 95th percentile of the distribution for adult male consumers is approximately 32 g/day. This value is derived by apportioning the 57 g/d (95th percentile of fish mass consumed per household, based on all households reported in the Maine Angler Survey) between an adult male and adult female consumer with a male/female ratio of 1.3. This yields an RME (male) of 32 g/d and an RME (female) of 25 g/d. Because 80% of anglers are male, the RMEs are weight-averaged, resulting in an overall sharing method RME of about 31 g/d.

4.5.2.2.6 Child Consumption Rate

A child consumption rate for sport-caught freshwater fish was not available from the surveys conducted on the Housatonic River or from the Maine Angler Survey. Instead, consumption rates for children and adults from other studies were used to calculate a ratio of the child to adult fish consumption rates. This fraction was then used with the adult ingestion rate to calculate an ingestion rate for a child (age 1 to 6). This approach assumes that the ratio of the amount of fish consumed by children and adults is similar between a study population (e.g., fish consumers in the United States) and the population of sportfish consumers in the Housatonic River area. The EPA document, *Estimated Per Capita Fish Consumption in the United States* (2002c), presents per capita estimates of daily average fish consumption. The report is based on data from the U.S. Department of Agriculture (USDA) 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII). Individual consumption rates are based on the U.S. population and the subpopulation of fish consumers in the United States by various age groups. Ingestion estimates are presented for "as prepared" and "uncooked" fish. In addition, estimates are presented for various fish and habitat types. The fish types include finfish, shellfish, and finfish/shellfish combined. The habitat types include freshwater/estuarine, marine, and all habitats.

Ingestion rates based on consumers only and "uncooked" fish were used because the ingestion rates for adults are based on these characteristics. Because the Housatonic River is a freshwater habitat with finfish, use of rates based on freshwater/estuarine finfish would have been preferable, but were not available. Therefore, rates based on the freshwater/estuarine finfish/ shellfish combination were used.

The age ranges for the adult ingestion rates are the same as used in the risk assessment, individuals age 18 and older. For the child, ingestion rates are available for individuals between 3 and 17 years and are grouped by different age categories that include ages 3 to 5, ages 6 to 10, ages 11 to 15, and ages 16 to 17. Because it most closely represented the assumed age of the child (1 to 6 years), the ingestion rates based on the 3- to 5-year-old age group were used.

Ingestion rates are presented for a number of statistics including the mean, the median (50th percentile), the 90th percentile, the 95th percentile, and the 99th percentile. Table 4-17 presents the ingestion rates based on the statistics for children (3 to 5 years) and adults (> 18 years old).

Table 4-17

Consumption Estimates for Children (3 to 5 years) and Adults (>18 years) Based on Freshwater/Estuarine Finfish and Shellfish

Statistic	Consumption Estimate (g/d)		Ratio of "3 to 5 years" to ">18 years"
	3 to 5 years[a]	> 18 years[b]	
Mean	40	81	0.49
Median (50th percentile)	23	47	0.49
90th percentile	95	200	0.48

[a]Table 5 of Section 5.2.1.1 (EPA, 2002c).

[b]Table 4 of Section 5.2.1.1 (EPA, 2002c).

The ratios of the child and adult ingestion rates are also presented. The child ingestion rates ranged from 23 to 95 g/d. The adult ingestion rates ranged from 47 to 200 g/d. The ratios of the child and adult ingestion rates ranged from 0.48 to 0.49 depending on the statistic, with the higher ratios at the center of the distribution.

One-half the adult ingestion rate was selected as a reasonable estimate of the child ingestion rate. For fish consumption in Massachusetts and bass consumption in Connecticut, the child ingestion rate is 16 g/d and 4.3 g/d for the RME and CTE, respectively. For trout consumption, the child ingestion rate is 6 and 2 g/d for the RME and CTE, respectively.

These values are supported by several surveys of fish consumption that have information on child consumption rates, meal sizes, and consumption patterns.

Balcom et al. (1999) conducted a population-based fish consumption survey in Connecticut that included both fresh and salt water fish consumption (including from the Housatonic River). The survey is described more fully in Section 4.3.4.1. They reported children's (ages 0 to 5) meal sizes of 2.7 oz for purchased fish and 3.9 oz for sport-caught fish. The sport-caught meal size is very close to child meal size used in this risk assessment, which was derived by an entirely different method, as described above.

Beehler et al. (2002) studied sport fish consumption patterns in families of anglers participating in the New York Angler State Angler Cohort Study. This prospective epidemiological study of anglers residing in 16 counties in upstate New York began in 1991. Anglers and partners who noted in 1991 that they had at least one child were contacted again in 1997-98 to respond to a survey regarding their children. Fish consumption patterns and the factors that contributed to variability were determined for first-born children aged 5 to 10 years (only first-born children were evaluated to eliminate statistical dependency among children sampled from the same household). Beehler et al. reported that a small fraction (5%) of children began consuming sport fish at age 1, and this fraction increased to above 40% by age 4. The median number of meals consumed were two to three per year, with a range up to 49 meals/year (based on only those who consume sport-caught fish). This median and range were applicable for each year of age between 1 and 10. These data are also reasonably consistent with the consumption frequencies reported in the MDPH Exposure Prevalence Study for children under age 12 consuming fish from rivers. Based on a sample size of 10, the median consumption frequency was 8.5 meals/year and the maximum was 52 meals/year (MDPH, 2002).

An analysis of the factors that contribute to the variance of child consumption rates indicated that a child's consumption pattern can be predicted from his/her parents' consumption pattern (Beehler et al., 2002). This observation supports the assumption used in this HHRA that the fish species and cooking methods used by the parents are also applicable to the child.

4.5.2.2.7 Summary

Fish consumption rates used in point estimate exposure assessments for all exposure areas and receptors are presented in Table 4-18.

Table 4-18

Fish Consumption Rates

Receptor/Area	Fish Consumption Rate (g/d)	
	RME	**CTE**
Adult		
PSA, Rising Pond, and CT smallmouth bass	31	8.7
CT trout	12	4
Child (1 to 6 years old)		
PSA, Rising Pond, and CT smallmouth bass	16	4.3
CT trout	6	2

4.5.2.3 Cooking Loss

Lipophilic compounds such as PCBs, dioxins, and furans accumulate in the fatty parts of fish. Some loss of these compounds may occur during cooking (Sherer et al., 1993; Sherer & Price, 1993). The exposure model used in this assessment incorporated a cooking loss term to estimate concentrations in fish as-consumed after cooking. The range of values for the percent of PCB and other contaminants lost during cooking was calculated based on literature data on cooking loss for each cooking method, and the relative frequency of each cooking method for consumers of Housatonic River fish.

Several reviews describing the methodologies and losses of PCBs due to cooking method have been published (Wilson et al., 1998; Zabik and Zabik, 1999; EPA, 2000). Four additional reports were published after the initial review for this risk assessment was completed. These newer papers address many of the difficulties in methodology identified for earlier work. In addition, congener-specific and tPCB cooking loss were reported in the recent papers.

Nineteen studies published since 1973 were identified that examined the loss of PCBs from fish fillets during food preparation and cooking. Experimental results range considerably, both between various cooking methods and within the same method. Cooking losses, expressed as percent loss based on tPCB or PCB-congener mass before and after cooking, range from 0% (or slight net gains, Moya et al., 1998; Skea et al., 1979) to as high as 74% (Skea et al., 1979). Most of the reported losses range between 10% and 40%. The four more recent studies are summarized below.

Moya et al. (1998) studied the effects of preparation and cooking on concentrations of PCBs in fillets of winter flounder. The methods used in this study were robust and detailed, and the number of samples analyzed allowed for statistical analysis of the data. As a result, this paper provides the most defensible estimates for PCB loss from cooking. Fish were filleted, fillets were divided into sections to eliminate potential bias, and the sections were cooked by deep-fat frying, pan frying with butter, and broiling. The resulting tissue was analyzed for 17 PCB congeners as well as tPCBs, and the post-cooking PCB concentrations were compared to precooked, wet-weight PCB concentrations. Statistical analyses were conducted to evaluate the differences of cooking treatment and fillet section on cooking loss of tPCB. A second analysis examined the effects of cooking on individual congeners.

Moya et al. reported that only the differences in cooking treatment (and not section or fillet effects) were statistically significant. The tPCB concentrations decreased 47% when fillet sections were deep fat fried. There was also a significant reduction of specific congener concentrations, ranging from 42% to 74% for deep fat frying. However, there were no statistically significant differences in tPCB concentrations between fillets that were broiled or pan fried and the uncooked samples. Moya et al. (1998) reported a significant increase in congeners PCB-105, PCB-118, PCB-138, and PCB-206 in the pan fried and broiled fillets, although this result does not necessarily represent a net gain in tPCBs. Cooking losses for coplanar congeners PCB-126 and PCB-169 were not determined. The percent loss of PCBs through deep fat frying is consistent with other reports, such as Skea et al. (1979). This loss is probably due to a combination of factors, such as high temperature and percent lipid in the fillet.

Salama et al. (1998) examined the effects of cooking method on tPCB concentrations in North Atlantic bluefish. This group filleted the fish (n=6) and subjected each fish to one of the following methods of cooking: smoking, microwaving, charbroiling (with and without skin), pan frying, and baking. One of the two fillets from each fish was analyzed raw. After cooking and extraction, tPCB concentrations were determined. When the data were adjusted for weight loss during cooking, all treatments indicated a loss of PCBs. Percent loss was reported as 27% for pan frying, 37% for charbroiling with the skin on, 47% broiling with the skin off, 39% for baking, 60% for microwaving, and 65% for smoking. Statistical significance of the percent losses between cooking method or with skin off/on was not determined.

Schecter et al. (1998) evaluated cooking loss of dioxins, dibenzofurans, and coplanar PCBs in broiled catfish. New York State farm-grown catfish fillets with skin attached were purchased from a supermarket. Half of the samples were broiled thoroughly, the other half remained raw. It is unclear whether the skin was removed prior to cooking. The authors report the mean, minimum, and maximum measured concentrations of PCDD, PCDF, and coplanar PCB congeners for the uncooked and the cooked samples as well as the changes in wet weight and percent lipid. They reported a 36% decrease in weight and a 39.5% decrease in percent lipid. The percent decrease in weight is similar to that reported by Moya et al. (1998) for deep-fried fillets. The authors report a 32% loss in total coplanar PCBs following broiling.

Wang and Harrad (2000) presented the results of a pilot study in which they examined the effect of skinning and pan-frying salmon and trout on PCB concentrations on a congener-specific basis. The description of the sample preparation and cooking was not detailed. The authors reported that they adjusted PCB concentrations for weight loss during cooking. Only changes in concentration, and not absolute concentrations, before and after pan frying the fillets were presented. Statistical significance was not reported. The results demonstrate no difference between salmon with or without skin or trout with or without skin. Percent losses of selected congeners were presented and the percent loss of tPCB, determined as the sum of congeners, was 30% for salmon and 25% for trout. It is unclear which congeners were selected for this analysis. Of the congeners reported, congeners PCB-52 and lower had a greater percent loss due to cooking than congeners PCB-101 and higher. This pattern is consistent with the hypothesis that some cooking loss is due to volatilization.

Data from the 10 studies from which cooking losses could be estimated are summarized in Table 4-19. This table presents results for all species of fish, including those species with higher lipid content than Housatonic River fish. The table also combines results of studies with skin-on fillets and skin-off fillets.

Wilson et al. (1998) reported weak relationships between the percent reduction in PCBs and fillet lipid content for baking ($p = 0.025$; $r^2 = 0.16$) and for broiling ($p = 0.046$; $r^2 = 0.25$). For fish from Housatonic River Reaches 5 through 9, lipid concentrations ranged from 0.004 to 7.6% (mean 0.9%; n = 260); in Connecticut lipid concentrations ranged from 0.16 to 7.34% (mean 2.05%; n = 140). These ranges in lipid concentrations indicate that the fish for which site-specific data were available are relatively "lean" fish, i.e., they did not have high concentrations of lipids in their muscle tissue (i.e., fillet). Based on the correlation between cooking loss and lipid content, cooking loss data for salmon, bluefish, and carp (which tend to be fattier fish, i.e., have a higher lipid content) may overestimate the cooking loss for Housatonic River fish. However, any overestimate of cooking loss is expected to be small because of the weakness of the correlation and its association with only some of the cooking methods typically used by consumers in the HRA.

Several studies included samples with both skin-on and skin-off fillets in parallel tests. However, Zabik et al. (1995b) specifically tested the effect of skin removal on cooking loss. They analyzed Chinook salmon that were baked and charbroiled as well as carp that were pan fried and deep fried. Wilson et al. (1998) subjected the Zabik et al. (1995b) results to statistical tests (t-test) to compare the results. They observed no significant effect of skin removal (i.e., skin-on versus skin-off fillets) on percent tPCB lost during cooking. However, there was a reduction in tPCB mass with skin removal.

The upper-value cooking loss was determined to be zero based on the studies by Moya et al. (1998) and Skea et al. 1979 as well as the large variability in study results. Additional support for an upper-value loss of zero is that individual preferences, such as consuming pan drippings, might result in consumption of PCBs reported in studies as "lost" from the fish during cooking (Zabik, 1982). In addition, several papers hypothesize that the mechanism of "loss" during high-temperature cooking is volatilization of PCBs (Armbruster et al., 1989; Wang and Harrad, 2000), some of which may be inhaled following their release into indoor air. While the upper value for the cooking loss parameter is zero, the average, or CTE, value for cooking loss was utilized in the calculation of the average daily dose for both the RME and CTE receptors in order to obtain a mix of upper and average values from exposure parameter distributions to arrive at an upper-bound risk estimate (EPA, 1989).

Table 4-19

Loss (percent) of PCBs in Fish Species by Cooking Method

	Baking (% Loss)	Reference	Broiling (% Loss)	Reference	Pan Frying (% Loss)	Reference	Deep Fat Frying (% Loss)	Reference
	5	Smith et al., 1973	0	Skea, et al., 1979	46	Puffer & Gossett, 1983	74	Skea et al., 1979
	16	Skea, et al., 1979	53	Zabik et al., 1979	7.5	Armbruster, 1989	31	Zabik, et al., 1982
	34	Zabik et al., 1979	7.5	Armbruster, 1989	35	Zabik et al., 1995a	35	Zabik et al., 1995a
	7.5	Armbruster, 1989	24	Zabik et al., 1996	31	Zabik et al., 1996	32	Zabik et al., 1995b
	27	Trotter et al., 1989	12	Armbruster, 1987	15	Armbruster, 1987	47	Moya et al., 1998
	20	Armbruster, 1987	16	Zabik et al., 1996	27	Salama et al., 1998		
	35	Zabik et al., 1995a	47	Salama et al., 1998	0	Moya et al., 1998		
	22	Zabik et al., 1996	0	Moya et al., 1998	27	Wang et al., 2000		
	13	Zabik et al., 1996						
	39	Salama et al., 1998						
	18	Schechter et al., 1998						
Median Loss	**20**		**14**		**27**		**35**	
Mean Loss	**22**		**20**		**24**		**44**	

*Represents arithmetic mean of all data.

The central tendency cooking loss for each cooking method, as indicated by the arithmetic mean and the median of the data for all species, is shown in Table 4-19. The arithmetic mean cooking loss is 22% for baking fish, 20% for broiling, 24% for pan frying, and 44% for deep-fat frying. The median loss is 20% for baking fish, 14% for broiling, 27% for pan frying, and 35% for deep-fat frying.

The results from the Maine Angler Survey were used as the basis for determining fish cooking method preferences. This is the most suitable study due to similarity in demographics, fish species, and cultural habits of the survey participants and Housatonic River area residents. The preferred cooking methods are presented as a percentage of meals cooked using each method, as shown in Table 4-20. The data indicate that the preferred methods for cooking are frying (62%), baking (18%), and broiling (16%). This survey did not distinguish between pan frying and deep-fat frying. However, a study of child anglers in upstate New York found that, for the children who consume freshwater fish, 40% of the fish are prepared by pan-frying (skin-on) (Knuth and Connelly, 1998). By combining the findings of these two studies, it was estimated that 40% of the fish are cooked by pan frying and 20% are cooked by deep-fat frying.

An overall cooking loss was calculated by combining the data on cooking loss for a specific cooking method with estimates of the percentage of meals cooked using each method, as presented in Table 4-21. The mean composite cooking loss was calculated as 27% and the median composite cooking loss as 25%. Based on these data, a composite cooking loss of 25% was selected for the CTE. This cooking loss is applicable to both skin-on and skin-off fillets.

These same cooking loss values (RME receptor = 0, CTE receptor = 25%) were used for dioxins/furans (i.e., 2,3,7,8-TCDD TEQ), based on the chemical similarities, and the same range of losses observed in the PCB congener data. A summary of fish cooking loss values used in the risk assessment is presented in Table 4-22.

4.5.2.4 Fraction Ingested

Fraction ingested (FI) refers to the fraction of the sport-caught fish consumed by recreational anglers that is from the Housatonic River. The values for fraction ingested are determined as those that would be appropriate in the absence of a fish advisory.

Table 4-20

Percentage of Fish Meals Prepared By Specific Cooking Methods

Cooking Method	%
Baking	17.9
Boiling	0.2
Broiling	16.4
Frying (pan and deep-fat)	62.1
Poaching	0.9
Microwaving	0.9
Raw	0.6
Soup	2

Source: ChemRisk, 1995.

Table 4-21

Percent PCB Loss for Preferred Cooking Methods

Cooking Method	Preferred Method (fraction of meals cooked)	Percent PCB Loss (mean)	Weighted Fraction of Cooking Loss (mean)	Percent PCB Loss (median)	Weighted Fraction Cooking Loss (median)
Baking	0.2	22	4	20	4
Broiling	0.2	20	4	14	3
Pan Frying	0.4	24	10	27	11
Deep-Fat Frying	0.2	44	9	35	7
Composite Cooking Loss (mean)*			27		
Composite Cooking Loss (median)*					25

* The composite cooking loss was calculated by multiplying, for each cooking method, the percent loss by the fraction of meals cooked to obtain the weighted fraction, and adding the weighted fractions for each cooking method.

Table 4-22

Fish Contaminant Cooking Loss Values Summary

	Percent Cooking loss	
Contaminant	RME*	CTE
PCBs	0%	25%
2,3,7,8-TCDD TEQ	0%	25%

*The RME value is the more conservative estimate for the cooking loss parameter. However, the CTE cooking loss was used to calculate the ADD for both RME and CTE receptors.

Several published reports provide information regarding the fraction ingested. The most applicable site-specific data are based on a creel survey of Housatonic River anglers in Connecticut from the Massachusetts border to Stevenson Dam (downstream end of Lake Zoar) that was conducted from 1984 to 1986 (Ebert et al., 1996; Barry, 1988). With respect to a preference for fishing the Housatonic River, Ebert et al. (1996) reported “Twenty three respondents (1.5%) indicated that all their angler effort was spent fishing the Housatonic, and 150 respondents (9.9%) reported that at least 95% of their fishing trips were to that river.” The median value was 30% of total fishing trips were taken to the Housatonic. It should be noted that a fish consumption advisory due to PCBs was in place during the period when the survey was performed. Data from the Maine Angler Survey (Ebert et al., 1993) are consistent with the data obtained in Connecticut. In a summary statement, the authors state that “over 80% of Maine’s resident anglers fish two or more bodies of water each year, approximately 50% fish three or more, and nearly 40% fish four or more.” An alternate way of stating this is that nearly 20% of Maine’s resident anglers fish only one body of water.

Data from the Connecticut creel survey were used to calculate the FI for the 90th to 99th percentile of the distribution, which covers the range considered by EPA to be the RME range (EPA, 2001). The top 1.5 percentile is an FI = 1. The next 9.9% (88.6 to 98.5 percentile) has an FI “greater than 95%,” which is interpreted as 97%. Thus, the majority of the RME range, including the commonly used 95th percentile, has an FI = 0.97. Based on this analysis, an FI of 0.97 was selected for the RME.

The median value of FI from the Housatonic River creel survey is 0.3. However, this value is biased low for the CTE for two reasons. First, the presence of the fish advisory likely decreased the number of trips and the preference for the Housatonic River (Connelly et al., 1992). Second, the underlying distribution of trip frequencies to the Housatonic River was not available, but most likely the average trip frequency is higher than the median frequency, as distributions contributing to exposure are frequently skewed. The Maine Angler Survey indicates that approximately 80% of anglers fish from two or more water bodies. Assuming that anglers fish equally from each of two water bodies results in a FI of 0.5.

A full distribution of the FI that fit all data from the Housatonic River and the Maine Angler Survey was constructed for use in the probabilistic assessment (Section 6.6.1). The mean of this constructed distribution was 0.5. Although derived differently, this value was the same used as the CTE FI.

4.5.2.5 Exposure Frequency

The consumption rates were calculated as average daily consumption rates averaged over a year. Thus, an exposure frequency of 365 d/year was used for both the RME and CTE scenarios.

4.5.2.6 Exposure Duration

Residence time in a single residence is typically used in risk assessments to estimate exposure duration. However, such estimates are not necessarily the best indicator of exposure duration for fish consumption, since individuals may move into a nearby residence and continue to consume fish caught from the same location, or an individual may choose to stop angling irrespective of the location of their home.

The questionnaire used for the MDPH *PCB Exposure Assessment Study* included questions asking participants to provide estimates of the frequency and total number of years they consumed freshwater fish species they had designated in the previous question (MDPH, 2001a). This information, along with the number of years living in the Housatonic River area for the entire population of survey respondents, is presented in Table 4-23. Table 4-24 presents the number of years consuming freshwater fish for children under 12.

Table 4-23

Years Consuming Fish and Residency Length

Statistic	Years Consuming Fish			Residency	
	Overall	Rivers	Housatonic River	At Current Residence	In Housatonic River Area
Sample Size	705	174	84	1,882	1,882
Minimum	1	1	1	0	0
Maximum	82	75	75	80	95
Mean	22.50	24.99	28.63	14.75	31.48
Std. Dev.	17.39	18.02	20.34	14.75	22.47
1st Quartile	10	10	11	3	12
Median	20	20.5	25	10	29
3rd Quartile	33	35	45	22	48
90th Percentile	50	50	60	36	65
95th Percentile	60	60	65	45	73

Source: MDPH, 2001a.

Table 4-24

Number of Years Consuming Fish – Children Under 12 Years Old

Statistic	Number of Years Consuming Fish		
	Overall	Ever Eaten Fish From Rivers	Ever Eaten Fish from the Housatonic River
Mean	3.93	3.88	4
Std. Dev.	2.32	2.1	---
Sample Size	33	8	1
Maximum	11	8	4
Minimum	1	1	4
Median	3	4	4
95th Percentile	8	8	4
75th Percentile	5	4.5	4
25th Percentile	2	2.5	4

Source: MDPH, 2002.

The sample size for the MDPH survey, which includes both the Exposure Prevalence Study and the ongoing survey, is 1,882 individuals. For the 705 individuals who reported having ever consumed freshwater fish, the mean duration of consumption is 22.5 years, the 90th percentile is 50 years, and the 95th percentile is 60 years. The mean and 90th percentile values were selected as the ED for the CTE and RME, respectively. The upper end of the distribution, appropriate for the RME, ranges from the 90th to the 99th percentile. Although the 95th percentile, the midpoint of the upper end range, is often used for the RME value, the 90th percentile was selected in this case because of the lack of specificity of the data regarding the length of time consuming fish from the Housatonic River, and the potential bias for overestimating exposure duration that it imposes. Exposure duration could also be based on the subsets of the study population who ever consumed freshwater fish from rivers, or had ever fished the Housatonic River. As shown in Table 4-23, the use of an ED based on those who had ever fished the Housatonic River would have resulted in a longer ED.

The survey results for the time residing in the area are consistent with the time consuming freshwater fish. For each of the percentiles examined, the number of years living in the Housatonic River area is higher than the number of years consuming freshwater fish (Table 4-23). Although the exposure durations were based on Massachusetts residents, the same exposure durations were assumed for the locations in Connecticut. A summary of the exposure duration values used in this assessment is presented in Table 4-25.

Table 4-25

Fish Exposure Duration Values Summary

Effect/Receptor/Evaluation Area	**Exposure Duration (years)**	
	RME	**CTE**
Cancer Risk	50	23
Noncancer Effects		
Adult	44	17
Child	6	6

4.5.2.7 Body Weight

For each location, an average body weight of 70 kg was used for the adult and an average body weight of 15 kg was used for a 1- to 6-year-old child (EPA, 1989a).

4.5.2.8 Averaging Time (AT)

A 70-year lifetime averaging time (25,550 d) was used for calculating cancer risks in all calculations (EPA, 1989a). For noncancer hazards, the averaging time is based on the exposure duration, in units of days. For the child, the AT for noncancer was 2,190 d, which is 6 years times 365 days per year. The resulting averaging times for adults were calculated as the exposure duration of 50 years minus 6 years exposure as a child, or 16,060 d, for the RME and 17 years (ED = 23 minus 6 years exposure as a child) or 6,205 d for the CTE. Noncancer averaging times for each receptor are presented in Table 4-26.

Table 4-26

Fish Consumption Noncancer Averaging Time Summary

Receptor	Averaging Time (d)	
	RME	**CTE**
Adult	16,060	6,205
Child	2,190	2,190

4.5.3 ADD Calculations

Using the exposure model and the exposure parameter values presented in Section 4.5.2, ADDs were calculated for each exposure area, receptor, and scenario. These ADDs are presented in Tables 4-27 through 4-36.

Table 4-27

Summary of Fish Ingestion Cancer Doses
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RME Cancer Dose (mg/kg-d)	CTE Cancer Dose (mg/kg-d)
PCBs			
PCB, TOTAL	14	0.0038	0.00029
2,3,7,8-TCDD TEQs			
Dioxin Congener-based TEQ	0.0000027	0.00000000073	0.000000000055
Furan Congener-based TEQ	0.0000096	0.0000000026	0.00000000020
Dioxin-like PCB Congener-based TEQ	0.00028	0.000000075	0.0000000057
METALS			
Mercury	0.61	0.00016	0.000013

CTE = central tendency exposure.

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

RME = reasonable maximum exposure.

Table 4-28

Summary of Fish Ingestion Noncancer Doses
Reaches 5 and 6

		RME Noncancer Dose		CTE Noncancer Dose	
Contaminant	**EPC (mg/kg)**	**Child (mg/kg-d)**	**Adult (mg/kg-d)**	**Child (mg/kg-d)**	**Adult (mg/kg-d)**
PCBs					
PCB, TOTAL	14	0.011	0.0045	0.0015	0.00065
2,3,7,8-TCDD TEQs					
Dioxin Congener-based TEQ	0.0000027	0.0000000021	0.00000000087	0.00000000029	0.00000000013
Furan Congener-based TEQ	0.0000096	0.0000000074	0.0000000031	0.0000000010	0.00000000045
Dioxin-like PCB Congener-based TEQ	0.00028	0.00000022	0.000000090	0.000000030	0.000000013
METALS					
Mercury	0.61	0.00047	0.00020	0.000066	0.000028

CTE = central tendency exposure.

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

RME = reasonable maximum exposure.

Table 4-29

Summary of Fish Ingestion Cancer Doses
Rising Pond

Contaminant	EPC (mg/kg)	RME Cancer Dose (mg/kg-d)	CTE Cancer Dose (mg/kg-d)
PCBs			
PCB, TOTAL	9.4	0.0025	0.00019
2,3,7,8-TCDD TEQs			
Dioxin Congener-based TEQ	0.00000028	0.000000000075	0.0000000000057
Furan Congener-based TEQ	0.000013	0.0000000035	0.00000000027
Dioxin-like PCB Congener-based TEQ	0.00013	0.000000035	0.0000000027

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-30

Summary of Fish Ingestion Noncancer Doses
Rising Pond

Contaminant	EPC (mg/kg)	RME Noncancer Dose		CTE Noncancer Dose	
		Child (mg/kg-d)	Adult (mg/kg-d)	Child (mg/kg-d)	Adult (mg/kg-d)
PCBs					
PCB, TOTAL	9.4	0.0073	0.0030	0.0010	0.00044
2,3,7,8-TCDD TEQs					
Dioxin Congener-based TEQ	0.00000028	0.00000000022	0.000000000090	0.000000000030	0.000000000013
Furan Congener-based TEQ	0.000013	0.000000010	0.0000000042	0.0000000014	0.00000000061
Dioxin-like PCB Congener-based TEQ	0.00013	0.00000010	0.000000042	0.000000014	0.0000000061

CTE = central tendency exposure.

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

RME = reasonable maximum exposure.

Table 4-31

Summary of the Smallmouth Bass Ingestion Cancer Doses
West Cornwall and Bulls Bridge Area - Connecticut

Chemical	EPC (mg/kg)	RME Cancer Dose (mg/kg-d)	CTE Cancer Dose (mg/kg-d)
PCBs			
PCB, TOTAL	1.1	0.00030	0.000023

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-32

Summary of Smallmouth Bass Ingestion Noncancer Doses
West Cornwall and Bulls Bridge Area - Connecticut

Chemical	EPC (mg/kg)	RME Noncancer Dose Child (mg/kg-d)	RME Noncancer Dose Adult (mg/kg-d)	CTE Noncancer Dose Child (mg/kg-d)	CTE Noncancer Dose Adult (mg/kg-d)
PCBs					
PCB, TOTAL	1.1	0.00085	0.00035	0.00012	0.000051

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-33

Summary of the Brown Trout Ingestion Cancer Doses
West Cornwall, Connecticut

Chemical	EPC (mg/kg)	RME Cancer Dose (mg/kg-d)	CTE Cancer Dose (mg/kg-d)
PCBs			
PCB, TOTAL	2.9	0.00030	0.000028

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-34

Summary of Brown Trout Ingestion Noncancer Doses
West Cornwall, Connecticut

Chemical	EPC (mg/kg)	RME Noncancer Dose		CTE Noncancer Dose	
		Child (mg/kg-d)	Adult (mg/kg-d)	Child (mg/kg-d)	Adult (mg/kg-d)
PCBs					
PCB, TOTAL	2.9	0.00084	0.00036	0.00015	0.000062

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-35

Summary of the Smallmouth Bass Ingestion Cancer Doses
Lake Lillinonah and Lake Zoar Area - Connecticut

Chemical	EPC (mg/kg)	RME Cancer Dose (mg/kg-d)	CTE Cancer Dose (mg/kg-d)
PCBs			
PCB, TOTAL	0.80	0.00022	0.000016

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-36

Summary of Smallmouth Bass Ingestion Noncancer Doses
Lake Lillinonah and Lake Zoar Area - Connecticut

Chemical	EPC (mg/kg)	RME Noncancer Dose		CTE Noncancer Dose	
		Child (mg/kg-d)	Adult (mg/kg-d)	Child (mg/kg-d)	Adult (mg/kg-d)
PCBs					
PCB, TOTAL	0.80	0.00062	0.00026	0.000086	0.000037

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

4.6 WATERFOWL

4.6.1 Exposure Point Concentrations

EPCs for COPCs for the waterfowl data set were calculated as noted in Section 4.4 and are presented in Table 4-37.

4.6.2 Exposure Models and Parameters

The reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were evaluated for an adult recreational hunter and child household member who consume at least one meal of waterfowl each year. The waterfowl consumption point estimates were calculated for cancer risk and noncancer effects using the formulas and parameter values presented in Tables 4-38 through 4-40. The rationale for selecting the exposure parameters is described in the following sections.

4.6.2.1 Consumption Rate

No studies were identified that reported waterfowl consumption rates or per-meal portion sizes. Instead, waterfowl consumption rates were calculated indirectly through estimates of hunting frequency, frequency of consumption of waterfowl, and portion sizes for other fowl. The consumption rate for waterfowl was calculated on an annual basis using the following equation:

$$Average\ Daily\ Ingestion\ Rate\ (g/day) = \frac{Meal\ Size\ (g/meal) \times Meal\ Frequency\ (meals/year)}{365\ days/year}$$

4.6.2.1.1 Meal Frequency

As discussed in Section 4.5.2.2.1, the questionnaire used for the MDPH *PCB Exposure Assessment Study* (MDPH, 1997) asked participants if they had hunted within the Housatonic River area, whether the prey was used for food, types of prey usually eaten, and frequency of meals from bagged animals. The study was conducted prior to the issuance of the waterfowl consumption advisory. Questions regarding meal frequency were asked on a prey basis, and therefore are reflective of the waterfowl consumption in the Housatonic River area. The raw data provided by MDPH in August 2001 (2001b) (including ducks, geese, and unspecified waterfowl) are presented in Table 4-41.

Table 4-37

Duck Breast Tissue Exposure Point Concentrations
Reaches 5 and 6

Contaminant	Maximum Detected Concentration (mg/kg)	95% UCL (mg/kg)	EPC (mg/kg)
PCBs			
PCB, TOTAL	19	9.7	9.7
2,3,7,8-TCDD TEQs [a,b]			
Dioxin Congener-based TEQ	0.0000092	0.0000046	0.0000046
Furan Congener-based TEQ	0.000075	0.000017	0.000017
Dioxin-like PCB Congener-based TEQ	0.0053	0.0019	0.0019

[a] TEQs were calculated using one-half the sample quantitation limit (SQL) for congeners detected within the data set but not within the sample.

[b] Dioxin-like PCB TEQs were calculated assuming that the congeners with TEFs reported in a doublet (i.e., PCB-123 as PCB-149/123) and a triplet (i.e, PCB-157 as PCB-201/157/173) composed 100% of the concentration. Had 0% been assumed, the EPC concentrations would not vary for the dioxin-like PCB congener-based TEQ because PCB-123 and PCB-157 contributed minimally to the total TEQ concentration.

EPC = exposure point concentration.

mg/kg = milligrams per kilogram.

UCL = upper-confidence limit.

Table 4-38

Age-Adjusted Cancer Dose Calculation for the Consumption of Waterfowl

$$\text{Waterfowl Consumption Dose (mg/kg-d)} = \frac{EPC_{waterfowl} \text{ x } (1 - LOSS) \text{ x } FI \text{ x } EF \text{ x } CF \text{ x } IRWF_{adj}}{AT}$$

Where:			**RME**	**CTE**	**Reference**
$EPC_{waterfowl}$	=	Exposure point concentration of contaminant in waterfowl (mg/kg).	Chemical-specific		
LOSS	=	Cooking loss (unitless).	0	0	Amundson, 1984
FI	=	Fraction ingested from contaminated source (unitless).	1	1	Professional judgment based on HRA-specific survey data
EF	=	Exposure frequency (d/year).	365	365	Standard value when using average daily ingestion rates
CF	=	Conversion factor (kg/g).	0.001	0.001	---
$IRWF_{adj}$	=	Age-adjusted waterfowl consumption factor, see Table 4-39 (g-year/kg-d).	4.1	1.1	See Table 4-39
AT	=	Averaging time (d).	25,550	25,550	EPA, 1989a

Table 4-39

Calculation of Age-Adjusted Waterfowl Consumption Factor

$$IRWF_{adj}\ (\text{g-year/kg-d}) = \frac{ED_c \times IRWF_c}{BW_c} + \frac{ED_a \times IRWF_a}{BW_a}$$

Where:			**RME**	**CTE**	**Reference**
$IRWF_{adj}$	=	Age-adjusted waterfowl consumption factor (g-year/kg-d).	4.1	1.1	Calculated
ED_c	=	Child exposure duration (years).	6	6	EPA, 1989a
ED_a	=	Adult exposure duration (years).	44	17	MDPH, 2001a
$IRWF_c$	=	Child waterfowl consumption rate (g/d).	2.5	1.2	See text
$IRWF_a$	=	Adult waterfowl consumption rate (g/d).	5	2.4	See text
BW_c	=	Child body weight (kg).	15	15	EPA, 1989a
BW_a	=	Adult body weight (kg).	70	70	EPA, 1989a

Table 4-40

Noncancer Dose Calculation for the Consumption of Waterfowl

$$\text{Waterfowl Consumption Dose (mg/kg-d)} = \frac{EPC_{waterfowl} \times (1 - LOSS) \times IRWF \times EF \times FI \times ED \times CF}{BW \times AT}$$

Where:			RME	CTE	Reference
$EPC_{waterfowl}$	=	Exposure point concentration of contaminant in waterfowl (mg/kg).	Chemical-specific		
LOSS	=	Cooking loss (unitless).	0	0	Amundson, 1984
IRWF	=	Waterfowl consumption rate (g/d).	5 (adult) 2.5 (child)	2.4 (adult) 1.2 (child)	Pao et al., 1982 (adult) See text (child)
EF	=	Exposure frequency (d/year).	365	365	Standard value when using average daily ingestion rates
FI	=	Fraction ingested from contaminated source (unitless).	1	1	Professional judgment; based on HRA-specific survey data
ED	=	Exposure duration (years).	44 (adult) 6 (child)	17 (adult) 6 (child)	MDPH, 2001a (adult) EPA, 1989a (child)
CF	=	Conversion factor (kg/g).	0.001	0.001	---
BW	=	Body weight (kg).	70 (adult) 15 (child)	70 (adult) 15 (child)	EPA, 1989a
AT	=	Averaging time (d).	16,060 (adult) 2,190 (child)	6,205 (adult) 2,190 (child)	EPA, 1989a

Table 4-41

Waterfowl Meal Frequencies for Individuals Reporting Hunting Birds from the HRA

Individual Response	Species	Frequency (meals/year)
1	Duck	2/lifetime
2	Duck	1
3	Duck	1
4	Duck	1
5	Duck	1
6	Duck	1
7	Duck	1
8	Goose	1
9	Goose	1
10	Goose	1
11	Duck	2
12	Duck	2
13	Duck	2
14	Duck	3
15	Waterfowl, unspecified	3
16	Waterfowl, unspecified	3
17	Waterfowl, unspecified	4
18	Duck	5
19	Duck	6
20	Duck	6
21	Waterfowl, unspecified	6
22	Duck	10
23	Puddle Duck	12
24	Goose	52
25	Duck	104

Source: MDPH, 2001b.

Waterfowl consumers were defined as the individuals who eat at least one waterfowl meal per year. The highest reported consumption rate from the MDPH survey was implausible based on the length of a hunting season and bag limits, if a meal consisted of a duck breast. Although this meal frequency was plausible if the meal was based on duck sausages that were frozen and stored in the freezer, the meal size would be much smaller than that assumed for a duck breast (see below). Because of the implausibility of the EF for the assumed meals of duck breast, this value was omitted from the distribution on which the summary statistics were calculated. Summary statistics of the data used to estimate waterfowl consumption rates are presented in Table 4-42. The 90th percentile of meal frequencies of 11 meals/year, and the mean value of 5.4 meals/year were selected for the RME and CTE, respectively.

The assumption used in the selection of this meal frequency was that all of these meals would be of waterfowl that had been resident in the PSA. Assuming that one duck provides a single meal (Section 4.6.2.1.2), this is equivalent to an annual bag from the PSA resident duck and goose population of 11 birds for the RME hunter and 5 or 6 birds for the CTE hunter.

This rate is well within the legal bag limit for waterfowl. The waterfowl hunting regulations for 2004-2005 (Table 4-3) allowed 6 ducks in a daily bag and 12 in possession, 5 Canada geese in the daily bag and 10 in possession from the early season, and 3 Canada geese in the daily bag and 6 in possession from the regular season. The early Canada goose season and the early portions of the regular season occur before the start of migration of the resident birds, and some geese and mallards were observed to be year-round residents of the PSA. In addition, the estimated population and annual production of ducks in the Housatonic River PSA, based on observations of waterfowl broods and duck capture and banding work conducted in the PSA during the course of this study, are adequate to support these meal frequencies (Section 4.2).

Table 4-42

Waterfowl Meal Frequency Summary Statistics

Statistic	Exposure Frequency (meals/year)
Sample Size	23
Minimum	1
Maximum	52
Mean	5.4
Std. Dev.	10.6
25th Percentile	1
Median	2
75th Percentile	6
90th Percentile	11
95th Percentile	44

Note: Both the two ducks/lifetime and 104 meals/year were removed from the data set to obtain these statistics for the reasons described in the text.

4.6.2.1.2 Adult Meal Size

Meal size was based on data on poultry consumption reported in Pao et al. (1982). The 50th percentile consumption rate, 112 g/meal, for poultry consumption (category includes chicken, turkey, Cornish game hen, duck, dove, squab, pigeon, quail, partridge, goose, and pheasant) was used as the basis for the adult RME and CTE. This consumption rate is for as-consumed meat (i.e., cooked meat). Because the site-specific concentration data are based on uncooked waterfowl breast tissue, it was necessary to convert the grams/meal consumption rate to a raw meat basis. Assuming a 32% cooking weight loss (mean loss for chicken and turkey; EPA, 1997), a raw meat adult meal size of 165 g/meal was calculated [112 g/meal ÷ (1-0.32)].

The meal size for waterfowl (112 g cooked, equivalent to 165 g uncooked) is smaller than the 227-g (8-oz) meal size for fish. The waterfowl value was based on published data for poultry consumption (Pao et al., 1982). For fish, meal sizes of caught fish are larger than meal sizes of purchased fish (Balcom et al., 1999). If a similar phenomena occurs for waterfowl, then the meal size may be underestimated to some extent. However, the meal size is generally consistent with the average size of the ducks collected for this study in the Housatonic River PSA and reference areas (approximately 90 g per sample, consisting of a half breast with skin [uncooked]), and assumes that a meal would consist of the entire breast. A higher value would also be inconsistent with a single duck sometimes providing two meals (Cameron and Jones, 1983; Beard, 1972) for consumers of wild waterfowl. Although these assumptions result in a meal size that is approximately 30% smaller than for recreationally caught fish, it is appropriately reflective of the portion size available from a wild duck. However, it may be biased low when considering meals from a wild goose.

4.6.2.1.3 Child Consumption Rate

No data regarding waterfowl meal sizes for children were identified. Instead, poultry consumption rates for children and adults from other studies were used to calculate a ratio of the child to adult poultry consumption rates. This fraction was then used with the adult consumption rate to calculate the consumption rate for a child (age 1 to 6). This approach assumes that the ratio of the amount of poultry consumed by children and adults is similar between a study population (e.g., poultry consumers in the United States) and the population of waterfowl consumers in the Housatonic River area. The *Exposure Factors Handbook* (EPA, 1997) presents per capita estimates of daily average poultry consumption. Data presented in the Handbook are from the 1989-1991 U.S. Department of Agriculture's (USDA) Continuing Survey of Food Intakes by Individuals (CSFII). Individual consumption rates are based on the U.S. population and the subpopulation of poultry consumers in the United States by various age groups. Ingestion estimates are presented for "as consumed" poultry.

For the adult, per capita intake rates are available for individuals ages 20 and over, and are grouped by different age categories that include ages 20 to 39, 40 to 69, and 70 and over. The adult per capita intake rates used in the comparison are based on the 20 to 39 and 40 to 69 years age groups. For the child, consumption rates are available for individuals between 1 and 19 years and are grouped by different age categories that include ages 1 to 2, ages 3 to 5, ages 6 to 11, and ages 12 to 19. Because they most closely represented the assumed age of the child (1 to 6 years), the intake rates based on the 3- to 5-year age group were used in this comparison.

The per capita intakes are presented in the *Exposure Factors Handbook* in units of grams of poultry per kilogram of body weight per day (g/kg-d). To compare child and adult consumption rates in units of g/d, the per capita intake rates were multiplied by the appropriate child and adult body weights. The body weight for the 3- to 5-years age group was assumed to be 17 kg (the 50th percentile body weight values for male and female children aged 3 through 5 years; EPA, 1997). The standard adult body weight of 70 kg was used.

Consumption rates are presented for a number of statistics including the mean, the median (50th percentile), the 90th percentile, the 95th percentile, and the 99th percentile. Table 4-43 presents the per capita intakes and the estimated consumption rates based on the statistics for children (3 to 5 years) and adults (20 to 39 and 40 to 69 years old). The ratios of the child and adult consumption rates are also presented. The child consumption rates ranged from 10.4 to 85 g/d. The consumption rates for the adult ages 20 to 39 and 40 to 69 years ranged from 23.1 to 189 g/d and 20.3 to 168 g/d, respectively. The ratios of the child and adult ingestion rates ranged from 0.45 to 0.56 depending on the statistic and the age groups being compared, with the highest ratios associated with comparisons with the 40- to 69-years age group. Based on this range of ratios, one-half the adult consumption rate was selected as a reasonable estimate of the child consumption rate.

Table 4-43

Poultry Consumption Estimates for Children (3 to 5 years) and Adults (20 to 39 and 40 to 69 years)

Statistic	**Per Capita Intake (g/kg-d)**			**Consumption Estimate[a] (g/d)**			**Ratio of “3 to 5 years” to “20 to 39 years”**	**Ratio of “3 to 5 years” to “40 to 69 years”**
	3 to 5 years[b]	**20 to 39 years[b]**	**40 to 69 years[b]**	**3 to 5 years**	**20 to 39 years**	**40 to 69 years**		
Mean	1.1	0.53	0.48	18.7	37.1	33.6	0.50	0.56
Median (50th percentile)	0.61	0.33	0.29	10.4	23.1	20.3	0.45	0.51
90th percentile	2.7	1.4	1.2	45.9	98	84	0.47	0.55

[a] Consumption estimates were estimated by multiplying the per capita intake by the appropriate body weight. For the child, the body weight was assumed to be 17 kg (average of mean BW for boys and girls ages 3, 4, and 5; Table 7-3, EPA, 1997). The adult body weight was assumed to be 70 kg.

[b] Table 11-5 of the *Exposure Factors Handbook* (EPA, 1997).

4.6.2.1.4 Summary

The adult average daily consumption rates for waterfowl were calculated by multiplying the meal frequency and meal size. The child average daily consumption rates were calculated by multiplying the adult rate by 0.5. These values are presented in Table 4-44.

Table 4-44

Summary of Selected Waterfowl Average Daily Consumption Rates

Receptor	Average Daily Consumption Rate (g/d)	
	RME	CTE
Adult	5	2.4
Child (1 to 6 years old)	2.5	1.2

EPA does not have a waterfowl-specific default consumption rate. The Lower Fox River risk assessment considered waterfowl consumption (WDNR, 1999). This assessment assumed an adult meal size of 110 g/meal (average meal size after cooking from Pao et al., 1982) for both the RME and CTE scenarios, and a meal frequency of 12 meals/year and 6 meals/year (based on Amundson, 1984) for the RME and CTE scenarios, respectively. The Saginaw River Area risk assessment (EPA, 1992c) also used the 110 g/meal for the consumption rate for the RME scenario, but used 85 g/meal for the CTE scenario (cited in EPA, 1992c as University of Georgia Extension Service, personal communication, 1991). The meal frequency was 16 meals/year (site-specific) and 3 meals/year (no rationale given) for the RME and CTE scenarios, respectively.

4.6.2.2 Cooking Loss

Lipophilic compounds, such as PCBs, dioxins, and furans, accumulate in the fatty parts of meat. As with fish, it is assumed that some loss of these compounds can occur during cooking when the fat cooks off or through direct volatilization during the cooking process (Sherer et al., 1993). The amount of loss may vary depending on cooking methods and times, lipid content and distribution in the meat, whether the meat was trimmed, and whether the skin was left on or removed.

A number of studies were reviewed on contaminant losses from poultry during cooking, with a focus on PCBs and dioxins/furans. The review showed that cooking loss is reported inconsistently in the literature, with some reporting loss on a mass basis, and others on a wet weight, % solids, or lipid basis. To derive cooking loss for waterfowl, only those cooking loss data reported or that could be converted to a mass basis were used. The advantage of reporting loss on a mass basis is that it can be used to directly estimate the impact of cooking loss on contaminant intake (Sherer and Price, 1993).

Only one paper (Amundson, 1984) was relevant (i.e., contained data for skin-on, raw tissue samples) for estimating cooking losses from the site-specific data. Amundson (1984) reported no significant loss of PCBs in cooking geese. Therefore, it was assumed in this assessment that cooking duck would not result in a decrease in PCB concentrations. Furthermore, the study indicated that there are factors concerning the preparation of geese that would be relevant to the site-specific assumptions used in this assessment, including the following:

- Meat is commonly prepared with skin on, and some consumers eat skin. PCB concentrations are generally higher in fatty portions of the bird such as the skin.
- Gravy is sometimes made from pan drippings (i.e., melted fat). Pan drippings may contain the highest concentrations of PCBs.

Therefore, it was assumed for both the RME and CTE that the cooking loss was equal to 0%, or no loss, based on the assumption that the whole breast could be cooked, and that the pan drippings would be used in making gravy or sauce.

4.6.2.3 Fraction Ingested

The fraction ingested (FI) term represents the fraction of waterfowl that were taken from the Housatonic River or surrounding area. The FI was assumed to be 1.0 for both the RME and the CTE, because the questions asked in the MDPH study (used to determine the number of meals per year, and subsequently the consumption rate) were based solely on hunting in the Housatonic River area. Therefore, the fraction ingested was already accounted for in the derivation of the daily consumption rate.

Although it is possible that some individuals may harvest ducks from other uncontaminated areas, it is also possible and likely that other individuals may hunt the PSA exclusively. The time and effort necessary to locate a suitable area for waterfowl hunting and the additional effort often expended by hunters in establishing blinds and similar improvements dictate that the same areas are visited consistently. Numerous blinds and frequent occupancy of these blinds in the PSA was observed by EPA and its contractors in 1998 prior to the consumption advisory being issued in 1999, after which hunting was still observed, but less frequently.

4.6.2.4 Exposure Frequency

The consumption rates were calculated as average daily consumption rates derived over a year. Thus, an exposure frequency of 365 d/year was used for both the RME and CTE scenarios.

4.6.2.5 Exposure Duration

Residence time in a single residence is typically used in risk assessments to determine exposure duration (ED). However, this may not be a reliable indicator of exposure duration for hunters, because individuals may move into a nearby residence and continue to hunt in the same location, or an individual may choose to stop hunting irrespective of the location of their home.

In the absence of robust site-specific hunting duration information, the angling exposure duration (as presented in MDPH, 2001a and discussed in Section 4.5.2.6) was used as the waterfowl consumption duration. Note that individuals may consume waterfowl for a longer duration than they hunt, if their parents hunted and waterfowl were shared. A summary of the exposure duration values used in the waterfowl consumption assessment is presented in Table 4-45.

Table 4-45

Waterfowl Exposure Duration Values Summary

Effect/Receptor	Exposure Duration (years)	
	RME	CTE
Cancer Risk	50	23
Noncancer Effects		
Adult	44	17
Child	6	6

4.6.2.6 Body Weight

An average body weight of 70 kg was used for the adult and an average body weight of 15 kg was used for a 1- to 6-year-old child (EPA, 1989a).

4.6.2.7 Averaging Time

A 70-year lifetime averaging time (25,550 d) was used for calculating cancer risks (EPA, 1989a). For noncancer hazards, the averaging time for the child is 6 years times 365 days per year. Assuming that the individual spends ages 1 through 6 consuming waterfowl from the Housatonic River, the resulting averaging times for the adult were calculated as the exposure duration of 50 years minus 6 years times 365 days per year. Noncancer averaging times for each receptor are presented in Table 4-46.

Table 4-46

Waterfowl Noncancer Averaging Time Summary

Receptor	Averaging Time (d)	
	RME	CTE
Adult	16,060	6,205
Child	2,190	2,190

4.6.3 ADD Calculations

Using the exposure model and the exposure parameter values presented in Section 4.5.2, ADDs were calculated for each receptor and scenario. These ADDs are presented in Tables 4-47 and 4-48.

Table 4-47

Summary of Duck Ingestion Cancer Doses
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RME Cancer Dose (mg/kg-d)	CTE Cancer Dose (mg/kg-d)
PCBs			
PCB, TOTAL	9.7	0.00057	0.00015
2,3,7,8-TCDD TEQs			
Dioxin Congener-based TEQ	0.0000046	0.00000000027	0.000000000070
Furan Congener-based TEQ	0.000017	0.0000000010	0.00000000026
Dioxin-like PCB Congener-based TEQ	0.0019	0.00000011	0.000000029

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

Table 4-48

Summary of Duck Ingestion Noncancer Doses
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RME Noncancer Dose Child (mg/kg-d)	RME Noncancer Dose Adult (mg/kg-d)	CTE Noncancer Dose Child (mg/kg-d)	CTE Noncancer Dose Adult (mg/kg-d)
PCBs					
PCB, TOTAL	9.7	0.0016	0.00069	0.00078	0.00033
2,3,7,8-TCDD TEQs					
Dioxin Congener-based TEQ	0.0000046	0.00000000077	0.00000000033	0.00000000037	0.00000000016
Furan Congener-based TEQ	0.000017	0.0000000028	0.0000000012	0.0000000014	0.00000000058
Dioxin-like PCB Congener-based TEQ	0.0019	0.00000032	0.00000014	0.00000015	0.000000065

CTE = central tendency exposure.
EPC = exposure point concentration.
mg/kg = milligrams per kilogram.
RME = reasonable maximum exposure.

4.7 REFERENCES

Amundson, D.S. 1984. Organochlorine Pesticides and PCBs in Edible Tissues of Giant Canada Geese from the Chicago Area. M.S. Thesis, University of Illinois at Chicago, 1984.

Armbruster, Gertrude, Kenneth G. Gerow, Walter H. Gutenmann, Cheryl B. Littman and Donald J. Lisk. 1987. The effects of several methods of fish preparation on residues of polychlorinated biphenyls and sensory characteristics in Striped Bass. *Journal of Food Safety* 8:235-243.

Armbruster, Gertrude, Kenneth L. Gall, Walter H. Gutenmann and Donald J. Lisk. 1989. Effects of trimming and cooking by several methods on polychlorinated biphenyls (PCB) residues in Bluefish. *Journal of Food Safety* 9:235-244.

ATSDR (Agency for Toxic Substances Disease Registry). 2000. Toxicological Profile for PCBs (Update November 2000).

Balcom, Nancy C., Constance M. Capacchione, and Diane Wright Hirsch. 1999. *Quantification of Fish and Seafood Consumption Rates for Connecticut.* Prepared for the Connecticut Department of Environmental Protection, Office of Long Island Sound Programs.

Barry, T.J. 1988. *An Angler Survey and Economic Study of the Housatonic River Fishery Resource*. Connecticut Department of Environmental Protection, Bureau of Fisheries, Hartford. Final Report.

Beard, J. 1972. *American Cookery*. Little, Brown and Company. 877 p.

Beehler, G.P., J.M. Weiner, S.E. McCann, J.E. Vena, D.E. Sandberg. 2002. Identification of sport fish consumption patterns in families of recreational anglers through factor analysis. *Environ Res* 89(1):19-28.

Bellrose, F.C., G.C. Sanderson, H.C. Schultz, and A.S. Hawkins. 1980. *Ducks, Geese and Swans of North America. Stackpole Books*. 540 pp.

Cameron, A. and J. Jones. 1983. *The L.L. Bean Game & Fish Cookbook*. Random House. 475 pp.

ChemRisk. 1992. *Consumption of Freshwater Fish by Maine Anglers.* 24 July 1992.

ChemRisk. 1994. *Methodology and Results of the Housatonic River Creel Survey*. Prepared for General Electric Company. 25 March 1994.

ChemRisk. 1995. *Evaluating the Impact of Cooking Processes on the Level of PCBs in Fish.* Prepared for General Electric Company. January 1995.

ChemRisk. 1996. Letter from Russ Keenan and Natalie Harrington, ChemRisk, to Kevin Garrahan, EPA. Re: Results of Additional Maine Angler Survey Analyses. March 1, 1996.

Connelly, N.A., B.A. Knuth, and C.A. Bisogni. 1992. *Effects of the Health Advisory Changes on Fishing Habits and Fish Consumption in New York Sport Fisheries*. Human Dimension Research Unit, Department of Natural Resources, New York State, College of Agriculture and Life Sciences, Fernow Hall, Cornell University, Ithaca, New York. Report for the New York Sea Grant Institute Project No. R/FHD-2-PD, September.

CTDEP (Connecticut Department of Environmental Protection). 1988. *An Angler Survey and Economic Study of the Housatonic River Fishery Resource. Final Report*. Bureau of Fisheries, Department of Environmental Protection, State of Connecticut.

CTDEP (Connecticut Department of Environmental Protection). 2003. *2003 Connecticut Angler's Guide.* http://dep.state.ct.us/burnatr/fishing/fishinfo/angler.htm

Ebert, E.S., N.W. Harrington, K.J. Boyle, J.W. Knight, and R.E. Keenan. 1993. Estimating Consumption of Freshwater Fish among Maine Anglers. *North American Journal of Fisheries Management* 13:737-745.

Ebert, E.S., S.H. Su, T.J. Barry, M.N. Gray, and N.W. Harrington. 1996. Estimated rates of fish consumption by anglers participating in the Connecticut Housatonic River Creel Survey. *North American Journal of Fisheries Management* 16:81-89.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. *The Birder's Handbook: A Field Guide to the Natural History of North American Birds*. Simon and Schuster, Inc., New York, NY, USA.

EPA (U.S. Environmental Protection Agency). 1989a. *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final.* Office of Emergency and Remedial Response, Washington DC, EPA/540/1-89/002. December 1989.

EPA (U.S. Environmental Protection Agency). 1989b. *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual*. EPA/Office of Marine and Estuarine Protection. EPA-503/8-89-002. September 1989.

EPA (U.S. Environmental Protection Agency). 1992a. *Guidelines for Exposure Assessment. National Center for Environmental Assessment* EPA/600Z-92/001. May 1992.

EPA (U.S. Environmental Protection Agency). 1992b. *Supplemental Guidance to RAGS: Calculating the Concentration Term.* Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division, OS-230. Intermittent Bulletin Volume 1, Number 1. Publication 9285.7-08.

EPA (U.S. Environmental Protection Agency). 1992c. *Baseline Human Health Risk Assessment: Saginaw River, MI, Area of Concern.* EPA-905-R92-008.

EPA (U.S. Environmental Protection Agency). 1995. *EPA Risk Characterization Program.* Memorandum from Administrator Carol M. Browner to Assistant Administrators, Associate Administrators, Regional Administrators, General Counsel and Inspector General on March 21, 1995. Office of the Administrator, Washington, DC.

EPA (U.S. Environmental Protection Agency). 1997. *Exposure Factors Handbook,* Volume I-III. Office of Research and Development, USEPA/600/P-95/002Fa August.

EPA (U.S. Environmental Protection Agency). 1999. *Human Health Risk Assessment for the Upper Hudson River*. Vol. 2F of the Hudson River PCBs Reassessment RI/FS. Prepared by TAMS Consultants, Inc. August 1999.

EPA (U.S. Environmental Protection Agency). 2000. *Child-Specific Exposure Factors Handbook* - External Review Draft. National Center for Environmental Assessment, Washington DC. June 2000. NCEA-W-0853.

EPA (U.S. Environmental Protection Agency). 2001. *Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment*. Office of Emergency and Remedial Response. Washington DC. EPA 540-R-02-002. December 2001.

EPA (U.S. Environmental Protection Agency). 2002a. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*. Office of Emergency and Remedial Response. December 2002. OSWER 9285.6-10.

EPA (U.S. Environmental Protection Agency). 2002b. ProUCL version 2.1.

EPA (U.S. Environmental Protection Agency). 2002c. *Estimated Per Capita Fish Consumption in the United States.* EPA-821-C-02-003. August 2002.

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold, New York.

Jacobs, Robert P. and Eileen B. O’Donnell. 2002. A Fisheries Guide to Lakes and Ponds of Connecticut – Including the Connecticut River and Its Coves. Connecticut Department of Environmental Protection, Bureau of Natural Resources, Fisheries Division.

Knuth, B.A., N.A. Connelly, and B.E. Matthews. 1998. Children’s Fishing and Fish Consumption Patterns. HDRU Series 98-3. Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY, USA.

Land, C. E. 1975. Tables of confidence limits for linear functions of the normal mean and variance. In: Selected Tables in Mathematical Statistics, Vol III, p 385-419.

MADEP (Massachusetts Department of Environmental Protection). 1995. *Guidance for Disposal Site Risk Characterization (In Support of the Massachusetts Contingency Plan).* Bureau of Waste Site Cleanup and Office of Research and Standards.

MassWildlife (Massachusetts Division of Fisheries and Wildlife). 2004. *MassWildlife Migratory Bird Regulations for 2004-2005.*

MassWildlife (Massachusetts Division of Fisheries and Wildlife). 2004. *MassWildlife Abstracts of the 2004 Massachusetts Fish and Wildlife Laws.*

MDPH (Massachusetts Department of Public Health). 1997. *Housatonic River Area PCB Exposure Assessment Study, Final Report.* Bureau of Environmental Health Assessment, Environmental Toxicology Unit. September 1997.

MDPH (Massachusetts Department of Public Health). 2001a. Memo from Martha Steele, Deputy Director, Bureau of Environmental Health Assessment to Bryan Olson, U.S. EPA, Region 1 regarding remainder of data request with respect to information gathered from questionnaires from Housatonic River area Exposure Assessment Study as well as questionnaires completed after the study and resulting from calls to the Bureau of Environmental Health Assessment (BEHA) hotline. 10 September 2001.

MDPH (Massachusetts Department of Public Health). 2001b. Letter from Suzanne K. Condon, Assistant Commissioner of the Bureau of Environmental Health Assessment to Bryan Olson, U.S. Environmental Protection Agency, Region I. Tables with *Hunting Information for Individual Family Members Who Reported Hunting Birds from the HRA, PCB Exposure Assessment Study, Volunteer Study, and Hotline Study* and *Calls from Individuals Concerned about Hunting after Hearing about the PCB Duck Advisory*. 21 August 2001.

MDPH (Massachusetts Department of Public Health). 2002. Memo from Elaine Krueger, Chief, Environmental Toxicology Program to Margaret McDonough, Risk Assessor, U.S. Environmental Protection Agency regarding Answers to follow-up questions on information forwarded previously (August and September 2001) and additional follow-up questions. 26 April 2002.

Moya, J, K.G. Garrahan, T.M. Poston, G.S. Durell. 1998. Effects of cooking on levels of PCBs in the fillets of Winter Flounder. *Bull. Environ. Contam. Toxicol* 60:845-851.

Pao, E.M., K.H. Fleming, P.M. Guenther, and S.J. Mickle. 1982. *Foods Commonly Eaten by Individuals: Amount Per Day and Per Eating Occasion*. Consumer Nutrition Center, Human Nutrition Information Service, U.S. Department of Agriculture. Hyattsville, Maryland. Home Economics Research Report Number 44.

Puffer, Harold W., Richard W. Gossett. 1983. PCB, DDT, and benzo(a)pyrene in raw and pan-fried White Croaker (*Genyonemus lineatus*). *Bull. Environ. Contam. Toxicol.* 30:65-73.

Roy, Bob. 2003. Personal communication from Bob Roy, Woodlot Alternatives, Inc., re: observations of duck broods.

Salama, A. A., M. A. M. Mohamed, B. Duval, T. L. Potter, R. E. Levin. 1998. Polychlorinated biphenyl concentration in raw and cooked North Atlantic Bluefish (*Pomatomus saltatrix*) fillets. *J. Agric. Food Chem.* 46:1359-1362.

Schecter, Arnold, Michael Dellarco, Olaf Papke, James Olson. 1998. A comparison of dioxins, dibenzofurans and coplanar PCBs in uncooked and broiled ground beef, catfish and bacon. *Chemosphere* 37:1723-1730.

Sherer, R.A., B.W. Found, P.S. Price. 1993. The effect of cooking processes on persistent lipophilic compounds in edible fish tissue using PCB as an example. Environmental Conference. TAPPI Proceedings.

Sherer, R.A. and P.S. Price. 1993. The effect of cooking processes on PCB levels in edible fish tissue. *Quality Assurance, Good Practice, Regulation, and Law* 2(4):396-407.

Skea, J.C., H.A. Simonin, E.J. Harris, S. Jackling, J.J. Spagnoli, J. Symula, J.R. Colquhoun, 1979. Reducing levels of mirex, Aroclor 1254, and DDE by trimming and cooking Lake Ontario Brown Trout (*Salmona Trutta Linnaeus*) and Smallmouth Bass (*Micropterus Dolomieui Lacepede*). *J. Great Lakes Res., Internat. Assoc. Great Lakes Res.* 5 (2):153-159.

Smith, Waldina E., Kaye Funk, Mary E. Zabik. 1973. Effects of cooking on concentrations of PCB and DDT compounds in Chinook (*Oncorhynchus tshawytsha*) and Coho (*O. kisutch*) Salmon from Lake Michigan. *J. Fish. Res Board Can.* 30:702-706.

Terres, John K. 1980. *The Audubon Society Encyclopedia of North American Birds.* Alfred A. Knopf, New York, NY. 1109 p.

Trotter, J. William, Paul E. Corneliussen, Ronald R. Laski, Joseph J. Vannelli. 1989. Levels of polychlorinated biphenyls and pesticides in Bluefish before and after cooking. *J. Assoc. Off. Anal. Chem.* 75:501-503.

USFWS (U.S. Fish and Wildlife Services). 1998a. *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation – Massachusetts.* FHW/96-MA.

USFWS (U.S. Fish and Wildlife Services). 1998b. *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation – Connecticut.* FHW/96-CT.

USFWS (U.S. Department of the Interior, Fish and Wildlife Service), and U.S. Department of Commerce, U.S. Census Bureau. 2001. *2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.*

Wang, Y. and S. Harrad. 2000. Cooking-induced reductions in concentrations of polychlorinated biphenyls (PCBs) in fish: ∑PCB versus ∑TE. *Human Exposure Posters – Organohalogen Compounds. Volume 48.* Division of Environmental Health and Risk Management, University of Birmingham, Birmingham, UK.

WDNR (Wisconsin Department of Natural Resources). 1999. *Baseline Human Health and Ecological Risk Assessment, Lower Fox River, Wisconsin.* Prepared by ThermoRetec Consulting Corp. Feb. 24, 1999.

WESTON (Roy F. Weston, Inc.). 1998. *Draft Final Source Area Characterization Report.* Prepared for U.S. Environmental Protection Agency. July 21, 1998.

WESTON (Weston Solutions, Inc.). 2004. *Ecological Risk Assessment for General Electric (GE)/Housatonic River Site, Rest of River*. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. November 12, 2004.

Wilson N.D., N.M. Shear, D.J. Paustenbach, P.S. Price. 1998. The effect of cooking practices on the concentration of DDT and PCB compounds in the edible tissue of fish. *J Expo Anal Environ Epidemiol* 8: 423-40.

Woodlot (Woodlot Alternatives, Inc.). 2002. *Fish Biomass Estimate for Housatonic River Primary Study Area*. Prepared for U.S. Environmental Protection Agency. DCN: GE-061202-ABBF. June 2002.

Zabik, Mary E. P. Hoojjat, C.M. Weaver. 1979. Polychlorinated biphenyls, dieldrin and DDT in lake trout cooked by broiling, roasting or microwave, *Bull. Environ. Contam. Toxicol.* 21:136-143.

Zabik, M.E. C. Merrill, and M.J. Zabik. 1982. PCBs and other xenobiotics in raw and cooked carp. *Bull. Environ. Contam. Toxicol.* 28:710-715.

Zabik, M.E., M.J. Zabik, A.M. Booren S. Daubenmire, M.A. Pascall, R. Welch, H. Humphrey. 1995a. Pesticides and total polychlorinated biphenyls residue in raw and cooked walleye and white bass harvested from the Great Lakes. *Bull. Environ. Contam. Toxicol*. 54:396-402.

Zabik, M.E., M.J. Zabik, A.M. Booren S. Daubenmire, M.A. Pascall, R. Welch, H. Humphrey. 1995b. Pesticides and total PCBs in Chinook salmon and carp harvested from the Great Lakes: Effects of skin-on and skin-off processing and selected cooking methods. *J. Agric. Food Chem.* 43:993-1001.

Zabik, M.E., A. Booren, M.J. Zabik, R. Welch, and H. Humphrey. 1996. Pesticide residues, PCBs and PAHs in baked, charbroiled, salt boiled and smoked Great Lakes lake trout.

Zabik, M.E. and M.J. Zabik, 1999. Polychlorinated biphenyls, polybrominated biphenyls and dioxin reduction during processing/cooking food. In *Impact of Processing on Food Safety*. ed. Jackson et al., Kluwer Academic/Plenum Pub: New York.

5. POINT ESTIMATE RISK CHARACTERIZATION

5.1 INTRODUCTION

The objective of the risk characterization is to integrate the information developed in the exposure assessment and the toxicity assessment into an evaluation of the potential health risks associated with consumption of fish and waterfowl. This section presents the results of the point estimate RME and CTE risk calculations for excess lifetime cancer risks and noncancer hazards. Section 7 describes the uncertainties associated with these results, and Section 8 compares these point estimates to the risk values using the quantitative analysis of variability and uncertainty (Section 6).

5.1.1 Cancer Risks

Cancer risks were calculated using the linear low-dose risk approach (EPA, 1989):

$$\text{Risk} = \text{LADD} * \text{CSF}$$

Where:

Risk = Excess lifetime cancer risk, or the added risk of developing cancer due to the evaluated exposure over a 70-year (assumed) lifetime.

LADD = Lifetime average daily dose; intake averaged over a 70-year lifetime as mg contaminant/kg-body weight per day.

CSF = Contaminant-specific cancer slope factor $(\text{mg/kg-d})^{-1}$.

For situations in which the linear low-dose approach resulted in calculated risks greater than 1E-02 (0.01), risks were also calculated using the one-hit equation:

$$\text{Risk} = 1 - \text{EXP}(-\text{LADD} * \text{CSF})$$

Where:

EXP = constant (base of the natural log, equal to 2.718)

LADD = Lifetime average daily dose; intake averaged over a 70-year lifetime as mg contaminant/kg-body weight per day.

CSF = Contaminant-specific cancer slope factor $(mg/kg\text{-}d)^{-1}$.

The one-hit equation is more appropriate for calculating risks greater than 1E-02 (EPA, 1989). In all cases, the same result was obtained using the linear low-dose approach and one hit equation, and only one result is presented in the tables and graphs.

EPA's cancer risk range is an increased risk of developing cancer, based on a plausible upper-bound exposure, of approximately 1 in 1,000,000 (1E-06, equivalent to 1×10^{-6}) to 1 in 10,000 (1E-04, equivalent to 1×10^{-4}) over a 70-year (assumed) lifetime. Where the cumulative site risk to an individual based on the RME exceeds the 1E-04 lifetime excess cancer risk end of the risk range, action is generally warranted at a site. For sites where the cumulative site risk to an individual based on the RME is less than 1E-04, action generally is not warranted, but may be warranted if a chemical-specific standard that defines acceptable risk is violated or if there are noncancer effects or an adverse environmental impact that warrants action. EPA may also decide that a lower level of risk is unacceptable and that action is warranted where, for example, there are uncertainties in the risk assessment results. Once EPA has decided to take an action, EPA has expressed a preference for cleanups achieving the more protective end of the range (i.e., 1E-06), although strategies achieving reductions in site risks anywhere in the risk range may be deemed acceptable by EPA (EPA, 1991).

Cancer risks were calculated for both the RME and CTE scenarios.

5.1.2 Noncancer Hazards

Noncancer effects are described using the hazard index (HI), which is calculated by summing the hazard quotients (HQs) for all COPCs. An HQ is the ratio of the exposure duration-averaged estimated daily dose (ADD) to the contaminant-specific RfD. The HQ is calculated using the following equation:

$$HQ = ADD/RfD$$

Where:

HQ = Hazard quotient.

ADD = Average daily dose; estimated daily dose averaged over the exposure period (mg contaminant/kg-body weight per day).

RfD = Reference dose (mg/kg-d).

HIs of less than 1 indicate that adverse health effects associated with the exposure scenario are unlikely to occur. EPA considers action when the HI exceeds 1.

HQs were summed for all COPCs to calculate HIs for both the fish and waterfowl consumption pathways, respectively. HQs and HIs were calculated separately for the RME and CTE scenarios, and for children and adults.

5.2 RISK CHARACTERIZATION – FISH CONSUMPTION

5.2.1 Cancer Risks

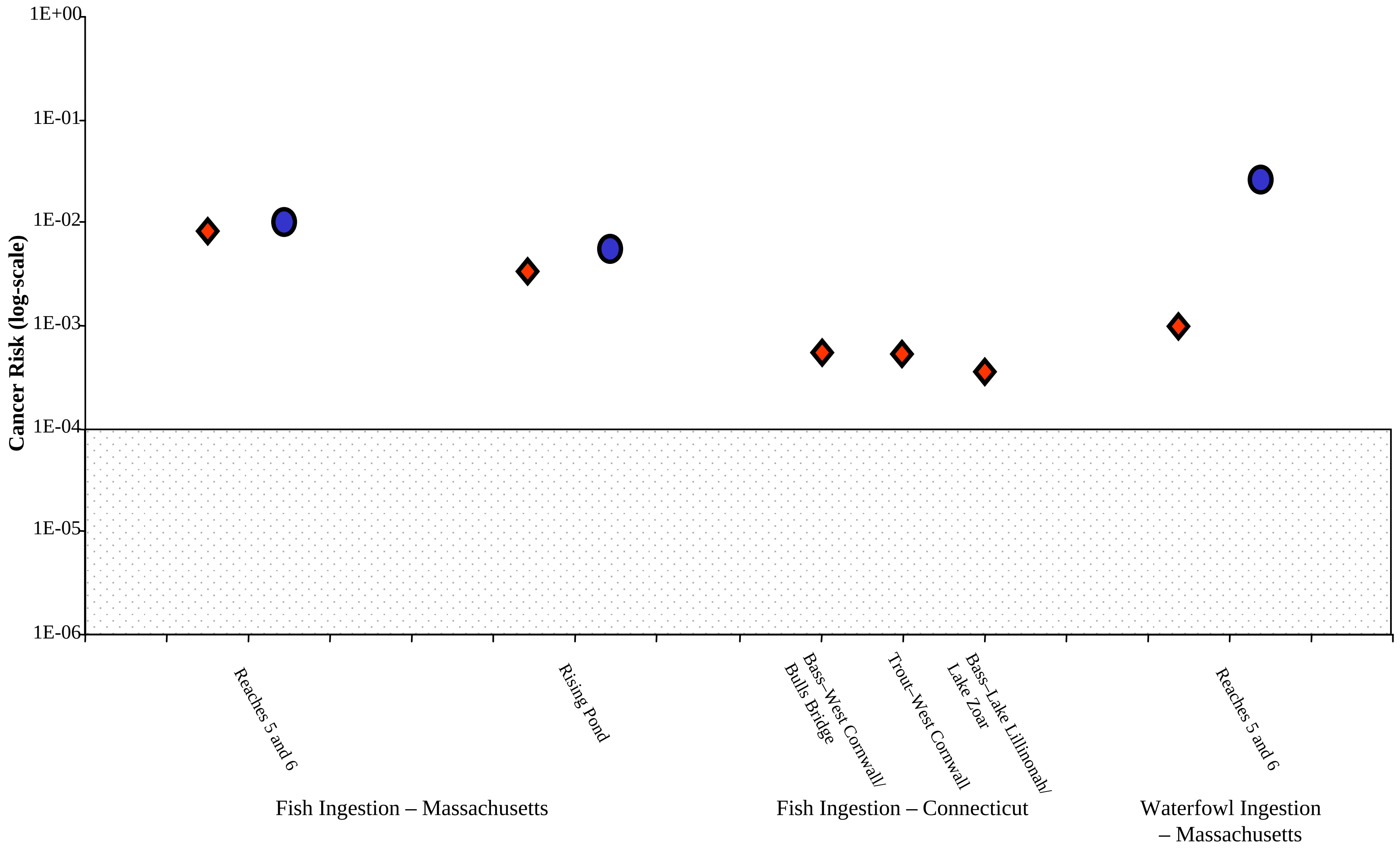
Cancer risks from the fish consumption pathway for the Housatonic River were calculated for four areas: the Primary Study Area (PSA) (Reaches 5 and 6), Rising Pond, West Cornwall/Bulls Bridge, and Lakes Lillinonah and Zoar. The following sections present the results of the cancer risk characterization for each of these areas. A summary of the cancer risks is presented in Table 5-1. Graphical representations of the RME and CTE cancer risks from tPCBs and TEQ for all locations are presented in Figures 5-1 and 5-2, respectively.

Table 5-1

Summary of Cancer Risks from the Fish Consumption Pathway

Location	RME	CTE
PSA (Reaches 5 and 6)	tPCBs: 8E-03 TEQ: 1E-02	tPCBs: 3E-04 TEQ: 9E-04
Rising Pond	tPCBs: 5E-03 TEQ: 6E-03	tPCBs: 2E-04 TEQ: 4E-04
Smallmouth Bass - West Cornwall/Bulls Bridge*	6E-04	2E-05
Brown Trout - West Cornwall*	6E-04	3E-05
Smallmouth Bass - Lake Lillinonah / Lake Zoar*	4E-04	2E-05

*Only tPCB data were available in Connecticut locations.



⬚ = EPA risk range (1E-06 to 1E-04).

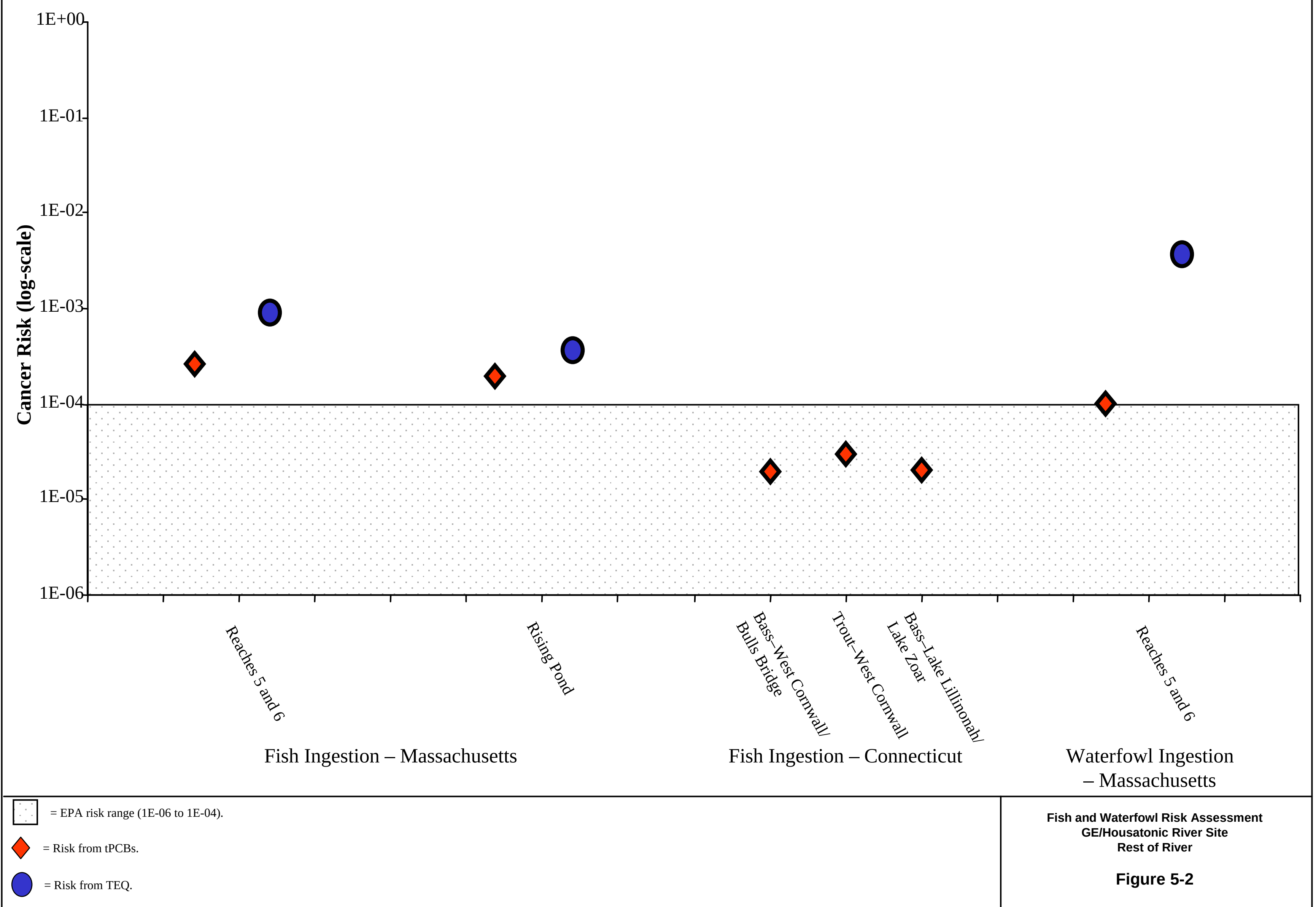
◆ = Risk from tPCBs.

● = Risk from TEQ.

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 5-1

Summary of the RME Cancer Risks from the Fish and Waterfowl Consumption Exposure Scenarios



Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 5-2

Summary of the CTE Cancer Risks from the Fish and Waterfowl Consumption Exposure Scenarios

Cancer risks from tPCBs and TEQ are presented separately, and represent two separate toxicological evaluations of cancer risks based on the mixture of contaminants present in the Rest of River study area. The cancer risks from these separate evaluations were not summed. The potential underestimate of tPCB cancer risk as a result of the potential enrichment of persistent congeners, including dioxin-like PCB congeners, is presented in the uncertainty analysis (Section 7) of this report, and is discussed in more detail in Section 4 of HHRA Volume I.

5.2.1.1 Primary Study Area (Reaches 5 and 6)

Table 5-2 presents the RME and CTE cancer risks associated with the consumption of fish from Reaches 5 and 6. The cancer risks for tPCB and TEQ for the RME evaluation were 8E-03 and 1E-02, respectively. The cancer risk from the PCB congener-based TEQ (1E-02) contributed approximately 96% of the RME total TEQ cancer risk. The risk from furan congeners (4E-04) was the second greatest contributor to the total TEQ cancer risk (3%). The cancer risks for tPCBs and TEQ for the CTE evaluation were 3E-04 and 9E-04, respectively. The cancer risk based on the PCB congener TEQ (9E-04) contributed approximately 96% of the CTE total TEQ cancer risk. The risk from furan congeners (3E-05) was the second greatest contributor to the total TEQ cancer risk (3%).

5.2.1.2 Rising Pond

Table 5-3 presents the RME and CTE cancer risks for consumption of fish from Rising Pond. The cancer risks for tPCBs and TEQ for the RME evaluation were 5E-03 and 6E-03, respectively. The cancer risk from PCB congener-based TEQ (5E-03) contributed approximately 91% of the total TEQ cancer risk. The risk from furan congeners (5E-04) contributed 9% to the total cancer risk. The cancer risks for tPCBs and TEQ for the CTE evaluation were 2E-04 and 4E-04, respectively. The cancer risk based on the PCB congener TEQ (4E-04) contributed approximately 91% of the total cancer risk. The risk from furan congeners (4E-05) was the second greatest contributor to the total TEQ cancer risk (9%).

Table 5-2

Cancer Risks from Fish Consumption for Each COPC
Reaches 5 and 6

Contaminant	EPC (mg/kg)	CSF $(mg/kg\text{-}d)^{-1}$	RME Cancer Dose (mg/kg-d)	RME Cancer Risk	CTE Cancer Dose (mg/kg-d)	CTE Cancer Risk
PCBs						
PCB, TOTAL	14	2 (RME); 1 (CTE)	0.0038	8E-03	0.00029	3E-04
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.0000027	1.5E+05	0.00000000073	1E-04	0.000000000055	8E-06
Furan Congener-based TEQ	0.0000096	1.5E+05	0.0000000026	4E-04	0.00000000020	3E-05
Dioxin-like PCB Congener-based TEQ	0.00028	1.5E+05	0.000000075	1E-02	0.0000000057	9E-04
Total TEQ Risk	---	---	---	*1E-02*	---	*9E-04*
METALS						
Mercury	0.61	NTV	0.00016	NA	0.000013	NA

CSF = oral cancer slope factor.
CTE = central tendency exposure.
EPC = exposure point concentration.
RME = reasonable maximum exposure.
NTV = no toxicity value.
NA = not available.

Table 5-3

Cancer Risks from Fish Consumption for Each COPC
Rising Pond

Contaminant	EPC (mg/kg)	CSF $(mg/kg\text{-}d)^{-1}$	RME Cancer Dose (mg/kg-d)	RME Cancer Risk	CTE Cancer Dose (mg/kg-d)	CTE Cancer Risk
PCBs						
PCB, TOTAL	9.4	2 (RME); 1 (CTE)	0.0025	5E-03	0.00019	2E-04
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.00000028	1.5E+05	0.000000000075	1E-05	0.0000000000057	9E-07
Furan Congener-based TEQ	0.000013	1.5E+05	0.0000000035	5E-04	0.00000000027	4E-05
Dioxin-like PCB Congener-based TEQ	0.00013	1.5E+05	0.000000035	5E-03	0.0000000027	4E-04
Total TEQ Risk	---	---	---	*6E-03*	---	*4E-04*

CSF = oral cancer slope factor.

CTE = central tendency exposure.

EPC = exposure point concentration.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

5.2.1.3 West Cornwall/Bulls Bridge

Table 5-4 presents the RME and CTE cancer risks associated with the consumption of smallmouth bass from the West Cornwall/Bulls Bridge area of Connecticut. The cancer risks from tPCBs for the RME and CTE evaluations were 6E-04 and 2E-05, respectively.

Table 5-5 presents the RME and CTE cancer risks associated with the consumption of brown trout from the West Cornwall area of Connecticut. The cancer risks from tPCBs based on the linear low-dose approach for the RME and CTE evaluations were 6E-04 and 3E-05, respectively.

5.2.1.4 Lake Lillinonah/Lake Zoar

Table 5-6 presents the RME and CTE cancer risks associated with the consumption of smallmouth bass from the Lake Lillinonah/Lake Zoar area of Connecticut. The cancer risks from tPCBs based on the linear low-dose approach for the RME and CTE evaluations were 4E-04 and 2E-05, respectively.

5.2.2 Noncancer Hazards

Noncancer hazard quotients from the fish consumption pathway were calculated for the PSA, Rising Pond, West Cornwall/Bulls Bridge, and Lakes Lillinonah and Zoar. The following sections present the results of the noncancer risk characterization for each of these areas. A summary of the hazard indices is presented in Table 5-7. A graphical representation of the tPCB HIs is presented in Figure 5-3.

5.2.2.1 Primary Study Area (Reaches 5 and 6)

Table 5-8 presents the RME and CTE HQs and HIs associated with consumption of fish from Reaches 5 and 6 for the adult. The HI based on the RME evaluation was 230. The HQ from tPCBs (230 when rounded to two significant figures) contributed almost all of the HI. Mercury, evaluated as methyl mercury, had an HQ of 2, and thus was not a significant contributor to the HI.

Table 5-4

Cancer Risks from Smallmouth Bass Consumption
West Cornwall/Bulls Bridge Area

Contaminant	EPC (mg/kg)	CSF $(mg/kg\text{-}d)^{-1}$	RME Cancer Dose (mg/kg-d)	RME Cancer Risk	CTE Cancer Dose (mg/kg-d)	CTE Cancer Risk
PCBs						
PCB, TOTAL	1.1	2 (RME); 1 (CTE)	0.00030	6E-04	0.000023	2E-05

CSF = oral cancer slope factor.
CTE = central tendency exposure.
EPC = exposure point concentration.
RME = reasonable maximum exposure.

Table 5-5

Cancer Risks from Brown Trout Consumption
West Cornwall

Contaminant	EPC (mg/kg)	CSF $(mg/kg\text{-}d)^{-1}$	RME Cancer Dose (mg/kg-d)	RME Cancer Risk	CTE Cancer Dose (mg/kg-d)	CTE Cancer Risk
PCBs						
PCB, TOTAL	2.9	2 (RME); 1 (CTE)	0.00030	6E-04	0.000028	3E-05

CSF = oral cancer slope factor.
CTE = central tendency exposure.
EPC = exposure point concentration.
RME = reasonable maximum exposure.

Table 5-6

Cancer Risks from Smallmouth Bass Consumption
Lake Lillinonah/Lake Zoar

Contaminant	EPC (mg/kg)	CSF $(mg/kg\text{-}d)^{-1}$	RME Cancer Dose (mg/kg-d)	RME Cancer Risk	CTE Cancer Dose (mg/kg-d)	CTE Cancer Risk
PCBs						
PCB, TOTAL	0.80	2 (RME); 1 (CTE)	0.00022	4E-04	0.000016	2E-05

CSF = oral cancer slope factor.

CTE = central tendency exposure.

EPC = exposure point concentration.

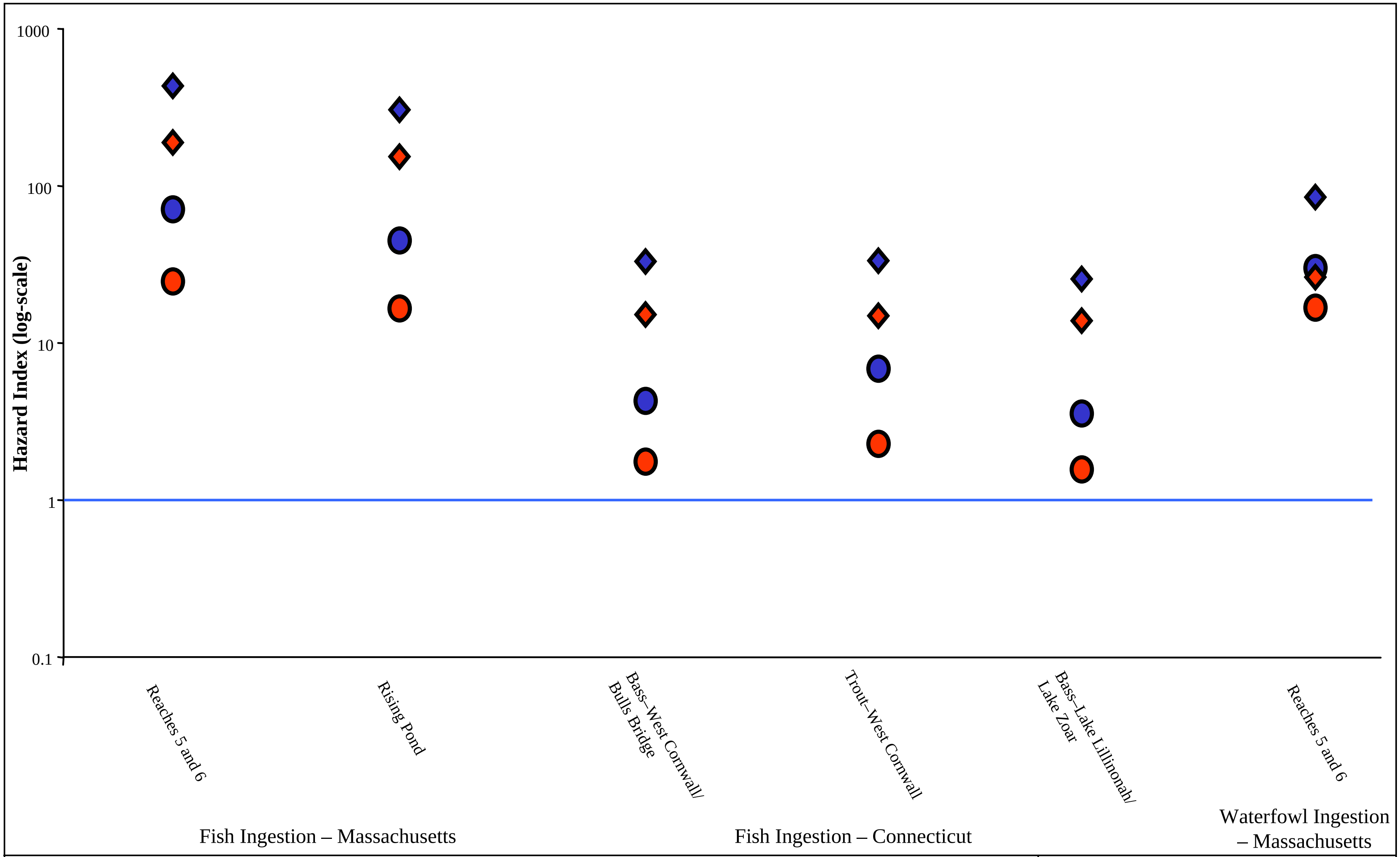
RME = reasonable maximum exposure.

Table 5-7

Summary of the Hazard Indices* from the Fish Consumption Pathway

Location	RME		CTE	
	Adult	**Child**	**Adult**	**Child**
PSA (Reaches 5 and 6)	230	550	33	76
Rising Pond	150	360	22	51
Smallmouth Bass—West Cornwall/Bulls Bridge	18	43	2.6	5.9
Brown Trout—West Cornwall	18	42	3.1	7.3
Smallmouth Bass—Lake Lillinonah/Lake Zoar	13	31	1.9	4.3

* Presented as two significant figures.



* The HIs are based on tPCBs only.

◆ = Adult RME ◆ = Child RME

● = Adult CTE ● = Child CTE

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 5-3

Summary of the Adult and Child Hazard Indices from the Fish and Waterfowl Exposure Scenarios*

Table 5-8

Hazard Quotients from Adult Consumption of Fish
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient*	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient*
PCBs						
PCB, TOTAL	14	2E-05	0.0045	230	0.00065	33
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.0000027	NTV	0.00000000087	NA	0.00000000013	NA
Furan Congener-based TEQ	0.0000096	NTV	0.0000000031	NA	0.00000000045	NA
Dioxin-like PCB Congener-based TEQ	0.00028	NTV	0.000000090	NA	0.000000013	NA
METALS						
Mercury	0.61	1E-04	0.00020	2.0	0.000028	0.28
		Totals	**---**	**230**	**---**	**33**

*Rounded to two significant figures.

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

The HI based on the CTE evaluation was 33. The HQ from tPCBs (33) contributed nearly 100% of the HI. Mercury had an HQ less than 1.0. An RfD was not available for 2,3,7,8-TCDD; and noncancer hazards associated with dioxins, furans, and PCB congener TEQ were not quantified.

Table 5-9 presents the RME and CTE HQs and HIs associated with consumption of fish from Reaches 5 and 6 for the child. The HI based on the RME evaluation was 550. The HQ from tPCBs (540) contributed almost 100% of the HI. Mercury had an HQ of 4.7. The HI based on the CTE evaluation was 76. The HQ from tPCBs contributed nearly 100% of the HI. Mercury had an HQ of 0.66.

5.2.2.2 Rising Pond

Table 5-10 presents the RME and CTE HQs and HIs associated with consumption of fish from Rising Pond for the adult. The HIs for the RME and CTE scenarios were 150 and 22, respectively. Table 5-11 presents the RME and CTE HQs and HIs associated with consumption of fish from Rising Pond for the child. The HIs for the RME and CTE scenarios were 360 and 51, respectively.

5.2.2.3 West Cornwall/Bulls Bridge

Table 5-12 presents the RME and CTE HQs associated with the consumption of smallmouth bass from the West Cornwall/Bulls Bridge area of Connecticut for the adult. The HIs for the RME and CTE scenarios were 18 and 2.6, respectively. Table 5-13 presents the RME and CTE HQs associated with the consumption of smallmouth bass from the West Cornwall/Bulls Bridge area of Connecticut for the child. The HIs for the RME and CTE scenarios were 43 and 5.9, respectively.

Table 5-14 presents the RME and CTE HQs associated with the consumption of brown trout from the West Cornwall area of Connecticut for the adult. The HIs for the RME and CTE scenarios were 18 and 3.1, respectively. Table 5-15 presents the RME and CTE HQs associated with the consumption of brown trout from the West Cornwall area of Connecticut for the child. The HIs for the RME and CTE scenarios were 42 and 7.3, respectively.

Table 5-9

Hazard Quotients from Child Consumption of Fish
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient*	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient*
PCBs						
PCB, TOTAL	14	2E-05	0.011	540	0.0015	75
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.0000027	NTV	0.0000000021	NA	0.00000000029	NA
Furan Congener-based TEQ	0.0000096	NTV	0.0000000074	NA	0.0000000010	NA
Dioxin-like PCB Congener-based TEQ	0.00028	NTV	0.00000022	NA	0.000000030	NA
METALS						
Mercury	0.61	1E-04	0.00047	4.7	0.000066	0.66
		Totals	**---**	**550**	**---**	**76**

*Rounded to two significant figures.

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

Table 5-10

Hazard Quotients from Adult Consumption of Fish
Rising Pond

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient*	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient*
PCBs						
PCB, TOTAL	9.4	2E-05	0.0030	150	0.00044	22
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.00000028	NTV	0.000000000090	NA	0.000000000013	NA
Furan Congener-based TEQ	0.000013	NTV	0.0000000042	NA	0.00000000061	NA
Dioxin-like PCB Congener-based TEQ	0.00013	NTV	0.000000042	NA	0.0000000061	NA

*Rounded to two significant figures.

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

Table 5-11

Hazard Quotients from Child Consumption of Fish
Rising Pond

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient*	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient*
PCBs						
PCB, TOTAL	9.4	2E-05	0.0073	360	0.0010	51
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.00000028	NTV	0.00000000022	NA	0.000000000030	NA
Furan Congener-based TEQ	0.000013	NTV	0.000000010	NA	0.0000000014	NA
Dioxin-like PCB Congener-based TEQ	0.00013	NTV	0.00000010	NA	0.000000014	NA

*Rounded to two significant figures.

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

Table 5-12

Hazard Quotients from Adult Consumption of Smallmouth Bass
West Cornwall/Bulls Bridge Area

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient
PCBs						
PCB, TOTAL	1.1	2E-05	0.00035	18	0.000051	2.6

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

Table 5-13

Hazard Quotients from Child Consumption of Smallmouth Bass
West Cornwall/Bulls Bridge Area

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient
PCBs						
PCB, TOTAL	1.1	2E-05	0.00085	43	0.00012	5.9

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

Table 5-14

Hazard Quotients from Adult Consumption of Brown Trout
West Cornwall

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient
PCBs						
PCB, TOTAL	2.9	2E-05	0.00036	18	0.000062	3.1

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

Table 5-15

Hazard Quotients from Child Consumption of Brown Trout
West Cornwall

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient
PCBs						
PCB, TOTAL	2.9	2E-05	0.00084	42	0.00015	7.3

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

5.2.2.4 Lake Lillinonah/Lake Zoar

Table 5-16 presents the RME and CTE HQs associated with the consumption of smallmouth bass from the Lake Lillinonah/Lake Zoar area of Connecticut for the adult. The HIs for the RME and CTE scenarios were 13 and 1.9, respectively. Table 5-17 presents the RME and CTE HQs associated with the consumption of smallmouth bass from the Lake Lillinonah/Lake Zoar area of Connecticut for the child. The HIs for the RME and CTE scenarios were 31 and 4.3, respectively.

Table 5-16

Hazard Quotients from Adult Consumption of Smallmouth Bass
Lake Lillinonah/Lake Zoar

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient
PCBs						
PCB, TOTAL	0.80	2E-05	0.00026	13	0.000037	1.9

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

Table 5-17

Hazard Quotients from Child Consumption of Smallmouth Bass
Lake Lillinonah/Lake Zoar

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient
PCBs						
PCB, TOTAL	0.80	2E-05	0.00062	31	0.000086	4.3

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

5.3 RISK CHARACTERIZATION – WATERFOWL CONSUMPTION

5.3.1 Cancer Risks

Cancer risks from the waterfowl consumption pathway were calculated for the PSA (Reaches 5 and 6 combined). Table 5-18 presents a summary of the total cancer risks associated with waterfowl consumption and Table 5-19 presents the RME and CTE cancer risks for each COPC.

Table 5-18

Summary of the Cancer Risks from the Waterfowl Consumption Pathway, Reaches 5 and 6

RME	CTE
tPCBs: 1E-03 TEQ: 2E-02	tPCBs: 1E-04 TEQ: 4E-03

The cancer risks for tPCBs and TEQ for the RME evaluation were 1E-03 and 2E-02, respectively. The cancer risk from PCB congener-based TEQ (2E-02) contributed approximately 99% of the total TEQ cancer risk. The risk from furan congeners (2E-04) was the second greatest contributor to the total TEQ cancer risk. The risk from dioxin congeners was 4E-05.

The cancer risks for tPCBs and TEQ for the CTE evaluation were 1E-04 and 4E-03, respectively. The cancer risk from PCB congener-based TEQ (4E-03) contributed approximately 99% of the total TEQ cancer risk. The risk from furan congeners (4E-05) was the second greatest contributor to the total TEQ cancer risk. The risk from dioxin congeners was 1E-05.

Table 5-19

Cancer Risks from Waterfowl Consumption for Each COPC
Reaches 5 and 6

Contaminant	EPC (mg/kg)	CSF $(mg/kg-d)^{-1}$	RME Cancer Dose (mg/kg-d)	RME Cancer Risk	CTE Cancer Dose (mg/kg-d)	CTE Cancer Risk
PCBs						
PCB, TOTAL	9.7	2 (RME); 1 (CTE)	0.00057	1E-03	0.00015	1E-04
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.0000046	1.5E+05	0.00000000027	4E-05	0.000000000070	1E-05
Furan Congener-based TEQ	0.000017	1.5E+05	0.0000000010	2E-04	0.00000000026	4E-05
Dioxin-like PCB Congener-based TEQ	0.0019	1.5E+05	0.00000011	2E-02	0.000000029	4E-03
Total TEQ Risk	---	---	---	*2E-02*	---	*4E-03*

CSF = oral cancer slope factor.

CTE = central tendency exposure.

EPC = exposure point concentration.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

5.3.2 Noncancer Hazards

Noncancer hazard indices for the waterfowl consumption pathway in Reaches 5 and 6 were calculated, and hazard quotients were calculated for tPCBs. An RfD was not available for 2,3,7,8-TCDD; therefore, HQs associated with dioxins, furans, and PCB congener TEQ were not calculated. For the waterfowl consumption pathway, the HQs and HIs are numerically the same. A summary of the hazard indices is presented in Table 5-20. The HIs for the adult RME and CTE scenarios were 35 and 17, respectively. The HIs for the child RME and CTE scenarios were 81 and 39, respectively. Table 5-21 presents the RME and CTE noncancer doses and HQs for adults, and Table 5-22 presents noncancer doses and HQs for children.

Table 5-20

Summary of the Hazard Indices from the Waterfowl Consumption Pathway

	RME		**CTE**	
Location	**Adult**	**Child**	**Adult**	**Child**
PSA	35	81	17	39

Table 5-21

Hazard Quotients from Adult Consumption of Waterfowl
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient*	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient*
PCBs						
PCB, TOTAL	9.7	2E-05	0.00069	35	0.00033	17
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.0000046	NTV	0.00000000033	NA	0.00000000016	NA
Furan Congener-based TEQ	0.000017	NTV	0.0000000012	NA	0.00000000058	NA
Dioxin-like PCB Congener-based TEQ	0.0019	NTV	0.00000014	NA	0.000000065	NA

*Rounded to two significant figures.

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

Table 5-22

Hazard Quotients from Child Consumption of Waterfowl
Reaches 5 and 6

Contaminant	EPC (mg/kg)	RfD (mg/kg-d)	RME Noncancer Dose (mg/kg-d)	RME Hazard Quotient*	CTE Noncancer Dose (mg/kg-d)	CTE Hazard Quotient*
PCBs						
PCB, TOTAL	9.7	2E-05	0.0016	81	0.00078	39
2,3,7,8-TCDD TEQs						
Dioxin Congener-based TEQ	0.0000046	NTV	0.00000000077	NA	0.00000000037	NA
Furan Congener-based TEQ	0.000017	NTV	0.0000000028	NA	0.0000000014	NA
Dioxin-like PCB Congener-based TEQ	0.0019	NTV	0.00000032	NA	0.00000015	NA

*Rounded to two significant figures.

CTE = central tendency exposure.

EPC = exposure point concentration.

RfD = oral reference dose.

RME = reasonable maximum exposure.

NTV = no toxicity value.

NA = not available.

5.4 REFERENCES

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final*. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002. December 1989.

EPA (U.S. Environmental Protection Agency). 1991. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Memorandum from Don R. Clay to Division Directors. 22 April 1991.

6. PROBABILISTIC RISK ASSESSMENT

Probabilistic risk assessments (PRAs), including both Monte Carlo analysis and probability bounds analysis, were performed for the fish ingestion exposure pathway at four locations (two in Massachusetts and two in Connecticut) and for the waterfowl ingestion pathway at one location (in Massachusetts). These approaches used the same exposure model as the point estimate assessment described in Section 5. However, in the Monte Carlo approach, probability distributions were used for many of the exposure variables, rather than the single values (point estimates) presented in previous sections of this report. The Monte Carlo analysis is used to infer best estimates for probabilities of risks of various magnitudes and to graphically illustrate these risks with a probability distribution. The probability bounds analysis is used to assess the reliability of the estimated probabilities by accounting for sources of uncertainty such as the selection and parameterization of probability distributions, and relationships between input variables. Both approaches permit the graphical illustration of the variability and uncertainty in risk estimates, and provide a convenient yet comprehensive form of sensitivity analysis. Extensive guidance is available on the methodology and use of Monte Carlo and other probabilistic analyses in human health risk assessments (EPA, 2001). Attachment 5 of HHRA Volume I provides an overview of the basis for the probability bounds approach.

In PRA, the high end of the risk distribution, the 90th to 99.9th percentile, is generally used to represent the RME scenario, rather than a single RME risk value as in the point estimate approach. Because of the uncertainty in the probability distributions that define the input variables in this risk assessment, there is expected to be significant uncertainty in the estimate of the 99.9th percentile. Therefore, for this probabilistic analysis, the high end of the RME range was defined by the 99th percentile. The 95th percentile is EPA's recommended starting point for defining the RME in most human health risk assessments (EPA, 2001a, p. 7-5). The CTE for the PRA was characterized as the 50th percentile, or median. "A descriptor of central tendency may be either the arithmetic mean risk (average estimate) or the median risk (median estimate)" (EPA, 1992). These two measures of central tendency are the same for variables that are normally distributed but not for variables with skewed distributions, such as the lognormal distribution. To the extent that some input variables fit skewed distributions and arithmetic means were used as measures of central tendency, the 50th percentile output from the PRA might differ from the CTE values in the point estimate approach.

This section is organized as follows:

- Section 6.1 describes the application of the tiered approach to probabilistic modeling used for the fish and waterfowl risk assessment.
- Section 6.2 describes the target receptors and the models used to calculate exposure.
- Section 6.3 provides a brief introduction to microexposure event (MEE) modeling.
- Section 6.4 provides an explanation of the treatment of dependencies between input variables in the exposure models.
- Section 6.5 provides a brief introduction to probability bounds analysis.
- Section 6.6 presents the fish exposure assessment beginning with the details of the derivation of each input distribution.
- Section 6.7 presents the waterfowl exposure assessment.
- Section 6.8 presents the risk characterization.
- Section 6.9 presents sensitivity analyses of the results.
- Section 6.10 details sources of uncertainty.

6.1 TIERED APPROACH TO PROBABILISTIC RISK ASSESSMENT

EPA guidance (EPA, 2001) outlines a sequential "tiered" approach to the application of probabilistic models in a risk assessment. Each tier is evaluated and the results are used in proceeding to the succeeding tiers. With this approach, increasingly complex models and data are applied to further quantify the effects of variability and/or uncertainty regarding risk model input variables on the risk assessment result.

Variability arises from natural stochasticity, environmental variation across space or through time, genetic heterogeneity among individuals, and other sources of randomness. Uncertainty arises from incomplete knowledge about the world. While uncertainty can in principle be reduced by focused empirical effort, such additional study can only better characterize, not reduce, variability. One aspect of the modeling efforts associated with each tier of the assessment is to conduct a sensitivity analysis that can be used to determine for which input variables, if any, a reduction in uncertainty or a better understanding of variability (or both) could lead to a substantially improved characterization of risk.

The fish and waterfowl risk assessment comprises three tiers. The point estimate risk models represent the first tier of the risk assessment. These models describe input variables with point estimates, and address variability and uncertainty regarding inputs to the risk calculation in a qualitative fashion. The risk characterization based on this approach is presented in Section 5, and the qualitative uncertainty is discussed in Section 7.

For the second tier of the risk assessment, the COPC dose received from fish or waterfowl ingestion was calculated using one-dimensional Monte Carlo analyses and probability bounds analyses. The term “one-dimensional” refers to a probabilistic modeling approach that separates the characterization of variability and uncertainty. The one-dimensional Monte Carlo simulations replace point estimates used as inputs to the first-tier point estimate models with probability distributions that represent only variability, yielding a distribution of risk. The probability bounds analyses use intervals or p-boxes (see Section 6.5 and Attachment 5 of the HHRA) to comprehensively bound the uncertainty in the distribution of risk in a manner generally analogous to a two-dimensional Monte Carlo analysis. The resulting second-tier risk analysis consists of a precise probability distribution of risk and a quantification of dependencies in variables, and uncertainty bounds on the risk distribution, for fish ingestion and waterfowl ingestion scenarios at each location. EPA (2001, Volume 3, Part A, Chapter 3, Section 3.4) discusses the application of one-dimensional and two-dimensional Monte Carlo analyses to the characterization of uncertainty and variability in exposure variables within the tiered approach. A comparison of the results of a one-dimensional Monte Carlo analysis with uncertainty quantified by probability bounds and a two-dimensional Monte Carlo analysis (one dimension quantifying variability and another dimension quantifying uncertainty), respectively, is provided in Attachment C.7 of this volume.

The third tier of the risk assessment includes a microexposure event (MEE) Monte Carlo analysis (Price et al., 1996; EPA, 2001, Appendix D) and a corresponding MEE probability bounds analysis. The MEE Monte Carlo analysis is intended to account for the day-to-day and year-to-year variation in an individual's habits (e.g., hunting, fishing, cooking), and for the meal-to-meal and year-to-year variability in the fish and waterfowl that the individual consumes. Like the second-tier risk analysis, the third-tier analysis produces a probability distribution of risk, generated by the MEE Monte Carlo simulation, and the extreme and plausible uncertainty bounds on that risk, generated by the MEE probability bounds analysis, for fish ingestion and waterfowl ingestion at each site. Unlike the one-dimensional Monte Carlo analysis, in which a single extreme value (high or low) selected from a probability distribution can result in an extreme estimate of long-term average exposure, the MEE approach averages multiple short-term estimates of exposure. Differences between the one-dimensional and MEE Monte Carlo approaches, including the uncertainties in the underlying assumptions and the corresponding effects on the risk distribution, are explained further in Section 6.3.

The risk distributions from the third-tier MEE analysis and the corresponding probability bounds are compared to the results of the one-dimensional second-tier risk results to assess the importance of day-to-day and year-to-year variability in the risk assessment. Attachment 5 of the HHRA contains a more detailed technical discussion of probability bounds analysis, variability, uncertainty, and the use of probability bounds analysis within EPA's tiered approach framework. One-dimensional Monte Carlo analysis and MEE modeling are discussed in more detail in Sections 6.2 and 6.3.

6.1.1 Exposed Populations

The potentially exposed populations for the fish consumption exposure pathway are anglers or members of their family who consume at least one meal per year from the Housatonic River. The potentially exposed populations for the waterfowl consumption exposure pathway are hunters or members of their family who consume at least one meal per year of waterfowl that were inhabitants of the Housatonic River. Models were used to assess cancer risk and noncancer risk for adults and children (ages 1 to 6).

6.2 EXPOSURE MODELS

For the second-tier analysis, exposure to tPCBs and dioxin-like PCB TEQs due to ingestion of fish and waterfowl was calculated using the same models for dose calculations applied in the point estimate assessment. This means that the one-dimensional Monte Carlo and probability bounds models are straightforward generalizations of the models used in the first-tier point estimate approach, except that probability distributions, intervals, and p-boxes (see Section 6.5) are used in place of many of the point estimate inputs. The equations are shown in Table 4-8 and Table 4-9 for cancer dose, and Table 4-10 for noncancer dose due to fish ingestion, and in Tables 4-38 and 4-39 for cancer dose and Table 4-40 for noncancer dose due to waterfowl ingestion.

For the third-tier analysis, these equations were rearranged to accommodate each specific exposure analysis in the MEE model. The exact equations used in the probabilistic analyses differed from those used in the point estimate analyses in the following ways. The following variables:

- Exposure frequency (EF) (Tables 4-8, 4-10, 4-38, and 4-40),
- Fish consumption rate (IRF) (Table 4-10),
- Child fish consumption rate (IRF_c) and adult fish consumption rate (IRF_a) (Table 4-9),
- Waterfowl consumption rate (IRWF) (Table 4-40), and
- Child waterfowl consumption rate $IRWF_c$, and adult waterfowl consumption rate ($IRWF_a$) (Table 4-39)

were not annualized, which means exposure frequencies (*EF*) in the MEE probabilistic analyses were in units of meals per year, and the various ingestion rates for fish and waterfowl (*IRF*, *IRF*c, *IRF*a, *IRWF*, *IRWF*c, and *IRWF*a) were in units of grams per meal. The *EF* variable was produced from the intake rate data by first specifying a meal size distribution and then performing a deconvolution to derive an exposure frequency distribution which, when multiplied by the specified meal size, results in the original data distribution. This has no effect on the dimensionality of the underlying exposure model, because exposure frequency multiplied by ingestion rate ($EF \times IR$) results in the same units, grams per year, used in the first-tier analysis. It was necessary to use non-annualized variables in the probabilistic models in order to sample individual meals and individual years in the MEE analyses.

One-dimensional Monte Carlo simulations for cancer and noncancer calculations were performed in the second-tier analyses using Crystal Ball (Decisioneering, Inc., 1999) MEE Monte Carlo simulations were performed in the third-tier analyses using custom code written in Pascal. Analyses in both tiers calculated exposure using both a noncancer and a cancer model. For the noncancer model, separate simulations were run with parameters for children (ages 1 to 6) and adults, and for tPCBs only for both fish and waterfowl. The cancer model was constructed in the same manner as the noncancer model except that for each iteration (angler or hunter), childhood and adult exposures were simulated sequentially for both tPCBs and TEQ. The cancer doses were computed as the sum of exposure during childhood at child body weight and exposure during adulthood at adult body weight. Results of the TEQ calculation are in units of μg/kg-d. All variables were assumed mutually independent because there was no quantitative information that could be used to parameterize any correlation coefficients. Dependencies *between variables* were accounted for quantitatively using dependency bounds analysis (see Section 6.4). Dependencies *between exposure events* are accounted for by performing both one-dimensional and MEE Monte Carlo analyses. The one-dimensional model assumes perfect dependence between events, e.g., individuals consuming fish frequently in 1 year consume fish just as frequently in the next year. The MEE model assumes independence between consumption events (see Section 6.3). Exhibit 6-1 contains an example of the Pascal code used for the Monte Carlo MEE simulations. One-dimensional and MEE probability bounds analyses were performed for cancer and noncancer models. The MEE cancer model was simulated in two parts, one for children and one for adults, which were summed to calculate cancer exposure. The MEE analysis probability bounds cancer model exposure to tPCBs and TEQ from fish or waterfowl ingestion was calculated using the following equation:

$$Dose_i = CF / AT \times (((ED_{\mathrm{c}} / BW_{\mathrm{c}}) \times mean(FI \times EF_{i,\mathrm{c}}) \times Z_c) \,|+|\, ((ED_{\mathrm{a}} / BW_{\mathrm{a}}) \times mean(FI \times EF_{i,\mathrm{a}}) \times Z_a))$$

where:

$$Z_j = mean(C_i \,|\times|\, (1 - LOSS_i) \,|\times|\, IR_{i,j}) .$$

The subscript *i* indicates fish or waterfowl, the subscripts c and a indicate child and adult values, respectively, and the vertical bars "| |" around a mathematical operation indicate that the operation was conducted assuming independence between the operands. Operations with operators lacking the vertical bars were conducted allowing for any and all possible dependencies between variables. The mean function indicates that bounds on the mean of the term within the parentheses were calculated. The variable Z_j, which represents the mean of the product of the three variables C_i, (1-$LOSS_i$), and $IR_{i,j}$, is the inner loop of the MEE model. Z_j is expressed in mg COPC per meal. The middle loop is meals per year, given by the mean of $EF_{i,a}$ or $EF_{i,c}$. The outer loop is years per exposure, given by ED_c or ED_a, and standardized by body weights of children (BW_c) and adults (BW_a), respectively. The term *CF* converts kilograms to grams and the *FI* variable (unitless) represents the proportion of fish meals composed of fish harvested from each location. This equation resulted in a p-box around the dose distribution calculated in units of milligrams of PCB per kilogram body weight per day (mg/kg-d). This p-box bounds all dose distributions consistent with the uncertainty regarding the shape, dependencies, and magnitude of the actual distribution of each variable. This equation is equivalent to that used in the Monte Carlo cancer model MEE simulation.

The equation used for calculating probability bounds for the noncancer dose was simpler because children and adults were treated as separate models and because ED_j and AT_j are equivalent and therefore canceled out of the equation. The equation was as follows:

$$Dose_{i,j} = (CF_1 / (CF_2 \times BW_j) \,|\times|\, (FI \times EF_{i,j} \times mean(C_i \,|\times|\, (1 - LOSS_i) \,|\times|\, IR_{i,j}))$$

where the subscript *i* indicates fish or waterfowl, the subscript *j* indicates child or adult, CF_1 converts kilograms to grams, CF_2 converts years to days, and all other conventions are the same as in the cancer dose model described above. This equation is an MEE model, like the cancer model above, but with two computational loops instead of three. It returns a p-box bounding all dose distributions consistent with the uncertainty regarding the shapes, dependencies, and magnitudes of each variable distribution, in units of mg/kg-d. Exhibit 6-2 includes an example of the Risk Calc (Ferson, 2002) code used to run the second- and third-tier probability bounds analyses.

6.3 MICROEXPOSURE EVENT SIMULATION

Microexposure event simulation (Price et al., 1996; EPA, 2001, Appendix D) characterizes intra-individual variability differently from the one-dimensional Monte Carlo simulation approach. In one-dimensional Monte Carlo analyses, all values represent long-term averages, whether the input variable is characterized by a point estimate or a probability distribution. For example, an individual may be randomly assigned an exposure frequency of 20 meals per year - this value may represent the average exposure frequency over a 30-year period. In MEE simulation, the individual's number of meals may fluctuate on an annual basis. When combined with other exposure variables that are also characterized by probability distributions and sampled more frequently, MEE simulates an individual's long-term average daily dose as a series of consecutive short-term average daily doses. In this probabilistic assessment, exposure variables that are simulated with the MEE approach include cooking loss, ingestion rate, and exposure frequency.

In a one-dimensional Monte Carlo analysis, an angler is assigned a randomly selected value from the probability distribution representing each of the following variables: *LOSS*, *IR*, *EF*, *FI*, *ED*, and *BW*. The process is repeated for many such anglers and the results form a distribution for the average daily dose. The selection of single random value to characterize a long-term average equates to the assumption that an individual angler harvests fish from the same locations, eats the same number of fish meals each year, and uses the same cooking method to cook the same quantity of fish at each fish meal, for an entire lifetime.

In the MEE model, the size of the meal and cooking method vary among meals, and the number of fish meals in a year and the locations at which those fish were caught vary in each angler's lifetime. This is simulated in the microexposure model by nesting computational loops representing each time scale: meal, year, and lifetime (Figure 6-1). For each iteration (individual angler or hunter), a body weight and exposure duration are selected, and for each year of the exposure duration, an exposure frequency (number of meals eaten that year) and fraction ingested (proportion of fish meals consisting of fish from each location) are selected. Further, for each exposure (meal), a cooking loss and ingestion rate are selected. These last two variables are multiplied together with the COPC concentration in fish, and summed over all meals in that year, resulting in total milligrams of COPC consumed that year from all meals. Next, these yearly totals are summed for the first iteration, and divided by the body weight and averaging time chosen for that iteration, resulting in intake of COPC in mg/kg-d. This process is repeated for numerous iterations (10,000 times in the simulations performed for this risk assessment), and a cumulative frequency distribution is constructed.

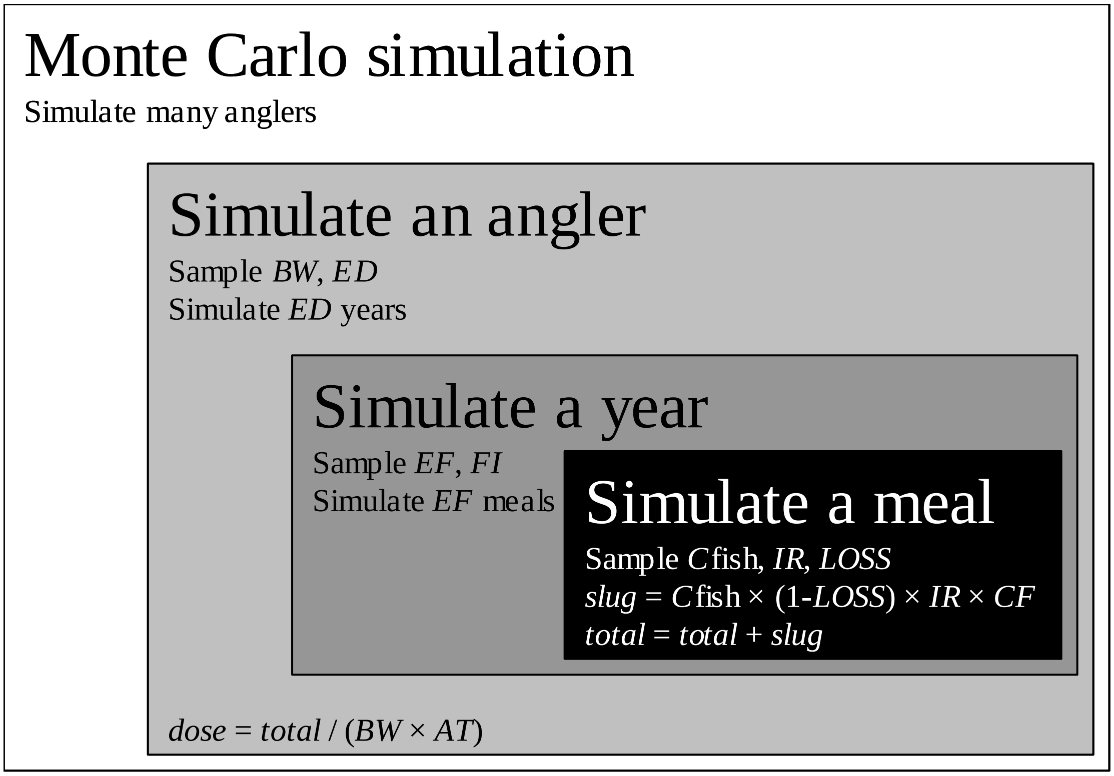


Figure 6-1 Illustration of the Nested Structure of the Monte Carlo Simulation Used to Perform the MEE Analysis

The MEE modeling removes the possibility that some individual will be simulated who eats the maximum amount of the most contaminated fish and waterfowl at every meal for an entire lifetime. Conversely, with the MEE model, simulating each meal for each year of an individual's life tends to overemphasize the average of the input distributions. This raises the possibility that some individuals, who eat larger-than-average meals of more-contaminated-than-average fish and waterfowl more often than would be expected purely by chance, are not represented in the model results.

The uncertainty in the MEE approach reflects the uncertainty in intra-individual variability in exposure. The approach applied in this assessment is to assume that an individual's consecutive exposure events are independent, so there is no correlation or relationship between the quantity of fish consumed per meal, the fish species preference, or cooking method; however, these variables may in fact be correlated for an individual. For example, a person may have a preference for a particular fish species and cooking method. By assuming independence among consecutive exposure events, differences between individuals become less apparent as every individual tends to approach the same long-term average dose. Together, the one-dimensional Monte Carlo Analysis and the MEE approaches bracket the potential effect of dependencies between exposure events on variability in the risk distributions.

6.4 RELAXING INDEPENDENCE ASSUMPTIONS

To model correlations or, more generally, dependencies among random variables using Monte Carlo simulation, the analyst must specify the correlation coefficient or the functional form of the interdependence among the variables. The Monte Carlo analyses assumed strict independence between all variables, not because this is likely, but because of a lack of relevant data required to parameterize a more realistic model. Dependency bounds analysis (Ferson and Long, 1995) was used to relax the assumptions of independence made in the Monte Carlo analysis and explore risks from ingestion under other dependency assumptions. This is a sensitivity analysis that considers any and all possible dependencies between the variables and propagates them through the calculations. The results are plausible extreme bounds encompassing the set of risk distributions that could result from exposure through ingestion, without making any assumption about the dependence among the variables. Attachment 5 of HHRA Volume I provides details regarding dependency bounds analysis.

The dependency bounds analyses relaxed the independence assumption for the pairs of variables marked with "?" in Table 6-1. In the table, *C* is the concentration of COPC in fish or waterfowl (mg/kg or μg/kg), *LOSS* is cooking loss (unitless proportion), *IR* is ingestion rate (g/meal), *EF* is exposure frequency (meals/year), *FI* is the fraction of fish ingested from each location (unitless), *ED* is exposure duration (years), and *BW* is body weight (kg). No assumption was made about

Table 6-1

Dependencies Modeled with Dependency Bounds Analysis

	C	LOSS	IR	EF	FI	ED
C						
LOSS	I					
IR	I	I				
EF	I	I	?			
FI	I	I	I	I		
ED	I	I	?	I	I	
BW	I	I	?	I	I	?

"I" indicates independence assumed, "?" indicates possible dependency relationship.
Definitions for variable abbreviations are given in the text.

dependence between body weight and exposure duration, or between body weight, exposure duration, or exposure frequency and ingestion rate. All other variables, marked with "I" in the table, were assumed to be mutually independent.

When all the variables were assumed to be independent of one another, the dependency bounds analysis gave exactly the same (within discretization error, see Attachment 5 of the HHRA) risk distribution as the Monte Carlo analysis. This confirms consistency between the two computational approaches.

6.5 PROBABILITY BOUNDS ANALYSIS

Probability bounds analysis is a combination of the methods of standard interval analysis (Moore, 1966; Neumaier, 1990) and classical probability theory (Feller, 1968; 1971). The concept of calculating bounds around probability distributions has a very long tradition in probability theory (e.g., Boole, 1854; Chebyshev, 1874; Markov, 1886; Fréchet, 1935). The methods of probability bounds analysis were developed and made widely available over the last 20 years (Yager, 1986; Frank et al., 1987; Williamson and Downs, 1990; Ferson and Long, 1995; Ferson et al., 1997; Ferson, 2002; Berleant, 1993, 1996; Berleant and Cheng, 1998; Berleant and Goodman-Strauss, 1998). Examples of application of probability bounds analysis to environmental risk assessments include Donald and Ferson (1997), Spencer et al. (1999; 2001), and Regan et al. (2002a; 2002b).

In a probability bounds analysis, the uncertainty surrounding the probability distributions for each input in a risk assessment is expressed in terms of bounds on the cumulative distribution function. These bounds form a “p-box” for each input variable. For example, the concentration variable is expressed in the first-tier point estimate analysis as a single point, the exposure point concentration (EPC). The EPC is an estimate based upon a finite number of samples of fish or waterfowl tissue. The exact value of that point is, therefore, uncertain. Probability bounds analysis provides an approach to evaluating this uncertainty by substituting an interval for the previously precisely specified point. The interval must be bounded below by a value that is known to be as low as the EPC could possibly be, and above by a value that is known to be as high as the EPC could possibly be. This interval represents a quantitative measure of variability and uncertainty surrounding the actual EPC value. The methods of probability bounds analysis allow for that variability and uncertainty to be modeled and analyzed in ways analogous to the single-point-estimate-based first-tier approach, drawing mathematically rigorous bounds around the risk result beyond which it is certain the risk distribution does not extend. Probability bounds analysis also provides the methods necessary to draw bounds around precisely specified input distributions, such as those used by Monte Carlo simulations, as well as methods that draw rigorous p-boxes in cases where even the shape of the underlying distribution is unknown. These p-boxes can be used as input variables to the exposure equation to obtain bounds around the resulting exposure distribution. The resulting estimate of exposure is also a p-box, and it reflects the overall uncertainty of the estimate.

With respect to distributions considered in this analysis, the p-box for exposure is known to be rigorous in the sense that it contains all distributions of exposure that could possibly result from combining the input distributions to the exposure model as long as they are within their respective p-boxes (Frank et al., 1987; Williamson and Downs, 1990). The p-box for exposure is also known to be best-possible or optimal in the sense that the bounds could not be any tighter and still contain all such resulting distributions (Williamson and Downs, 1990). Like any calculation, the guarantees of the answer are contingent on the assumptions, including those associated with the supporting data, as described in Section 7.2. Attachment 5 of HHRA

Volume I provides a detailed explanation of the methods of probability bounds analysis and several numerical examples.

Probability bounds analysis does not require the analyst to assume independence when it is not warranted or to specify the precise shapes of input distributions when they are difficult to estimate. Thus, results of p-bounds may in some cases provide useful information for risk managers to assess the impact on the risk distribution when the assumptions in the Monte Carlo approach are relaxed. In this fish and waterfowl risk assessment, these two complementary approaches are used together.

6.6 EXPOSURE DUE TO FISH CONSUMPTION

This section details the inputs and results for exposure to tPCBs and TEQs from the consumption of fish. The derivation of the input variables is discussed first, followed by the results of the second-tier Monte Carlo simulations and probability bounds analyses. Results of the third-tier MEE exposure analyses are then presented.

6.6.1 Input Variables

6.6.1.1 Deriving the Inputs

Seven variables required the selection of point estimates, intervals, distributions, or p-boxes to use as inputs in the probabilistic assessment. These variables are:

- Concentration of PCBs and TEQs in fish tissue (C_{fish})
- Cooking loss (*LOSS*)
- Fish ingestion rate (*IR*)
- Exposure frequency (*EF*)
- Fraction ingested (FI)
- Exposure duration (*ED*)
- Body weight (*BW*).

Some of the seven variables needed multiple estimates. For instance, *BW* was needed both for children and adult anglers and C_{fish} was needed seven times (i.e., two locations with one fish data set, estimated once for tPCBs and once again for TEQ; and one location with one fish species and another with two, estimated for tPCBs only). For each variable, a point estimate or a probability distribution was needed for the Monte Carlo simulation and for the dependency bounds analysis. A point estimate, interval estimate, or p-box around the Monte Carlo input variable was needed for the probability bounds analysis. Two model variables in the cancer model, the conversion factor (*CF*) and averaging time (*AT*), were constants. In the noncancer model, *AT* was a distribution equal to *ED*, and both canceled from the exposure equation. Table 6-2 summarizes all of the inputs used in the Monte Carlo simulations, and Table 6-3 shows all of the inputs to the probability bounds analyses. The subsections below provide more details regarding each input.

6.6.1.2 Concentration in Fish: tPCBs and TEQ

Several species of fish were sampled from the Housatonic River and the tissues analyzed for PCBs and other contaminants. EPCs were calculated for the first-tier point estimate approach analyses (Section 4.4, Tables 4-5 through 4-7) for four species (combined) at the two locations in Massachusetts, bass at two locations in Connecticut, and trout at one location in Connecticut.

These same EPC estimates were used as inputs to the second- and third-tier Monte Carlo simulations because as described in EPA guidance (“Characterizing Variability and Uncertainty in the Concentration Term,” EPA, 2001), the reason for using the 95% UCL in place of the sample mean is to “account for uncertainty” regarding the actual value of the sample mean. Because the 95% UCL is an upper confidence limit around the mean, using this estimate for the EPC ensures that the mean is not underestimated. The second- and third-tier probability bounds analyses used an interval with the sample mean and the EPC as left and right endpoints, respectively. Using these intervals instead of the sample means or EPCs alone accounts for some of the incertitude in the EPC estimates due to issues such as limited sample size and combination of samples from different species at the same location (see Section 4.4). This interval ranges from a value that assumes that the sample mean equals the true mean to a value that assumes that the sample mean underestimates the true mean because, as noted above, EPA is concerned with the risk of underestimating the mean. Table 6-2 shows the Monte Carlo simulation concentration inputs for tPCBs and for TEQs by location and fish species. Table 6-3 shows the probability bounds analysis concentration inputs.

Table 6-2

Summary of All Inputs to the Monte Carlo Simulations of the Fish Exposure Assessment

Variable	Symbol	Units	Min, Max	Central Estimate[a]	Standard Deviation	Distribution Type[b]
tPCB concentration	C_{fish}	mg/kg				
PSA	R56		-	13.9	-	Point estimate
Rising Pond	RP		-	9.5	-	Point estimate
West Cornwall/Bulls Bridge bass	CB		-	1.1	-	Point estimate
West Cornwall trout	CT		-	2.9	-	Point estimate
Lakes Lillinonah/Zoar bass	L		-	0.8	-	Point estimate
TEQ concentration	qC_{fish}	µg/kg				
PSA			-	0.28	-	Point estimate
Rising Pond			-	0.13	-	Point estimate
Cooking loss	LOSS	unitless				
Bake			0.05, 0.67	0.22	0.112	Lognormal
Broil			0.02, 1	0.19	0.18	T-lognormal
Pan fry			0.04, 0.9	0.24	0.15	Lognormal
Deep fat fry			0.15, 1	0.44	0.17	T-lognormal
Stochastic mixture			0.16, 1.0	0.26	0.18	Mixture
Ingestion rate – 1-D model	EF×IR	g/day				
Bass			0.27, 80.22	8.5	13.6	EDF
Trout			0.27, 46.62	4.2	7.3	EDF
Ingestion rate – MEE model	IR	g/meal				
Adult			142, 340	227	-	Triangular
child			70.9, 170	113.5	-	Triangular
Exposure frequency – MEE model	EF	meals/yr				
Bass			0.25, 145	13.1	22.2	Decon EDF
Trout			0.27, 75	6.4	11.4	Decon EDF
Fraction ingested	FI	unitless	0.1, 1	0.48	0.27	EDF
Exposure duration	ED	yr				
Adult			1, 64	29	20	T-lognormal
Child			1, 6	3.5	1.4	Uniform
Body weight	BW	kg				
Adult			39, 119	72	15	Lognormal
Child			12, 23	17	2.3	Lognormal

[a] For inputs that are point estimates, the central estimate is used as the point value. For concentrations, this value is the EPC. For EDFs and most parametric distributions, the central estimate is the arithmetic mean. For triangular distributions, the central estimate is the inflection-point. Some of the central estimate values differ slightly from the parameter values in the point estimate risk assessment (Sections 4 and 5). The difference is due to the use of slightly different datasets (ED for adult), or point estimate default values obtained from EPA guidance (adult BW). The minimum, maximum, and central estimate cooking loss values differ from the point estimate parameters because these are based on lognormal distributions fitted to the raw data while the point estimate values are based on the raw data itself.

[b] EDF stands for empirical distribution function; Decon EDF is an EDF resulting from a probabilistic deconvolution; Lognormal, Triangular, and Uniform are probability distributions; T-lognormal is a truncated lognormal distribution; Mixture is a stochastic mixture of probability distributions; and Point estimate is a single point value.

Table 6-3

Summary of All Inputs to the Probability Bounds Analyses for the Fish Exposure Analysis

Variable	Symbol	Units	Min, Max	Central Estimate[a]	Standard Deviation	P-box Type[b]
tPCB concentration	C_{fish}	mg/kg				
PSA	R56		10.8, 13.9	[10.8, 13.9]	-	Interval
Rising Pond	RP		6, 9.5	[6, 9.5]	-	Interval
West Cornwall/Bulls Bridge bass	CB		1.0, 1.1	[1.0, 1.1]	-	Interval
West Cornwall trout	CT		1.9, 2.8	[1.9, 2.8]	-	Interval
Lakes Lillinonah/Zoar bass	L		0.6, 0.8	[0.6, 0.8]	-	Interval
TEQ concentration	qC_{fish}	µg/kg				
PSA			0.15, 0.28	[0.15, 0.28]	-	Interval
Rising Pond			0.03, 0.13	[0.03, 0.13]	-	Interval
Cooking loss	LOSS	unitless				
Bake			0,1	0.22	0.11	MMMS
Broil			0,1	0.2	0.2	MMMS
Pan fry			0,1	0.24	0.15	MMMS
Deep fat fry			0,1	0.44	0.18	MMMS
Stochastic mixture			0,1	0.26	0.18	Mixture
Ingestion rate – 1-D model	EF×IR	g/day				
Bass			0.03, 647	[5.2, 15.7]	[9.9, 37.7]	ENV EDF
Trout			0.03, 473	[1.9, 9.2]	[4.2, 32.5]	ENV EDF
Ingestion rate- MEE model	IR	g/meal				
Adult			142, 340	[142 ,340]	-	Interval
Child			70.9, 170	[70.9, 170]	-	Interval
Exposure frequency – MEE model	EF	meals/yr				
Bass			0.03, 490	[8.3, 24.3]	[14.8, 60.4]	ENV decon EDF
Trout			0.03, 508	[3, 14.2]	[6.1, 53.8]	ENV decon EDF
Fraction ingested	FI	unitless	0.1, 1	0.48	0.27	MMMS
Exposure duration	ED	yr				
Adult			1, 64	[25, 32]	[18, 24]	MMMS
Child			1, 6	[1,6]	-	Interval
Body weight	BW	kg				
Adult			39, 119	72	14.8	Lognormal
Child			12, 23	16.5	2.3	Lognormal

[a] For intervals, the central estimate is the entire interval used in the calculations. For concentrations, this interval ranges from the arithmetic mean to the EPC. For p-boxes and parametric distributions, the central estimate is the arithmetic mean, which may itself be an interval. Intervals are shown in square brackets.

[b] Interval stands for an interval input; Mixture is a weighted mixture of some combination of point estimates, intervals, precise probability distributions, and/or p-boxes; MMMS is a distribution-free p-box formed using the minimum, maximum, mean, and standard deviation; ENV EDF is an envelope formed around two or more empirical distribution functions; ENV decon EDF is an envelope formed around two or more deconvolved EDFs; and Lognormal is a probability distribution (see text).

6.6.1.3 Cooking Loss

Cooking losses of PCBs for fish were derived from the proportion of PCBs lost during cooking as measured in multiple studies (see Section 4.5.2.3, Table 4-18).

Data are presented for four cooking methods most typically reported by the Housatonic River angler population: baking, broiling, pan frying, and deep fat frying. For the Monte Carlo simulation inputs, lognormal distributions were fit to the data using the method of matching moments (Figures 6-2 through 6-5). These lognormal distributions were stochastically mixed using weights based on cooking method preferences to produce a weighted empirical distribution function (Figure 6-6, gray line). The weights used were 0.2 each for baking, broiling, and deep fat frying, respectively, and 0.4 for pan frying (see Table 4-21 and discussion in Section 4.5.2.3) for the derivation of the preference-based weights used to produce the mixture). For the probability bounds analysis inputs, p-boxes were constructed assuming a minimum of no loss, a maximum of 100% loss, and the observed means and standard deviations. These p-boxes were mixed stochastically using the preference-based weights. Figure 6-6 (black line) shows the resulting weighted mixture p-box that was produced and used as input to the probability bounds exposure analyses.

Note that in Figures 6-2 through 6-6, as well as in most other figures in the probabilistic risk assessment, the vertical y-axis is labeled “Exceedance Probability.” This refers to the use of the complementary cumulative distribution. When a probability distribution is displayed on a complementary cumulative axis, the probabilities are read as probabilities of exceeding corresponding values on the x-axis. In Figure 6-2, for example, if one were to draw a horizontal line from 0.5 on the exceedance probability axis to the fitted lognormal distribution, and then read the corresponding value on the x-axis, one would read that there is a 50% chance that the proportion of contaminant lost during baking *exceeds* 0.19. Similarly, there is a 5% chance that the proportion of contaminant lost exceeds 0.42 and a 95% chance that it exceeds 0.08.

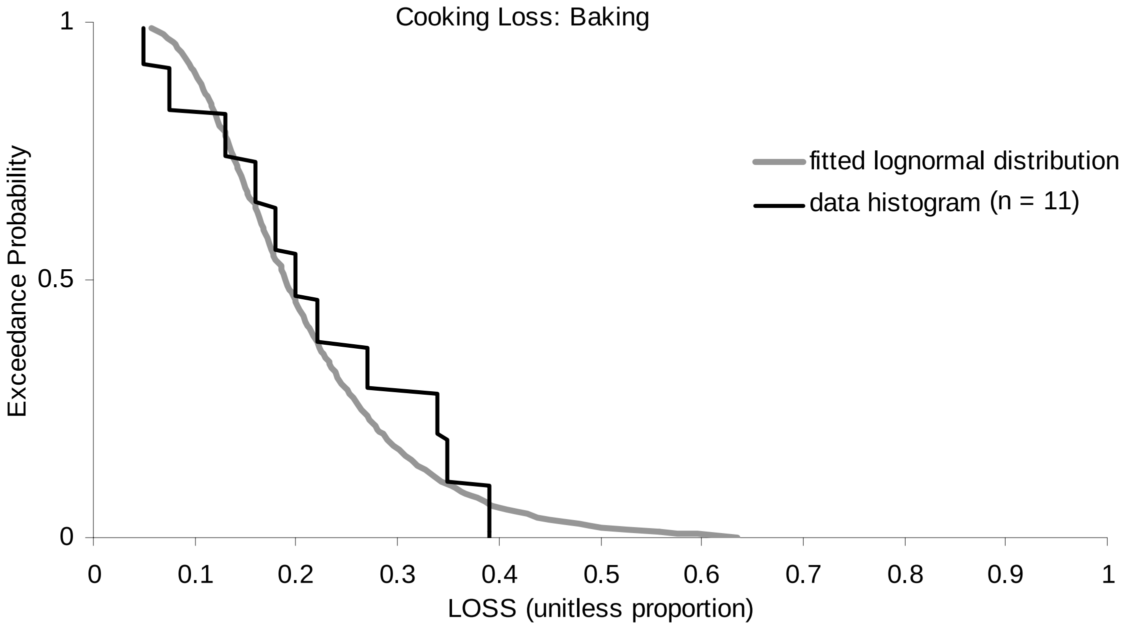


Figure 6-2 Empirical Distribution Function for Cooking Loss from Baking and Lognormal Distribution Fit to the Data

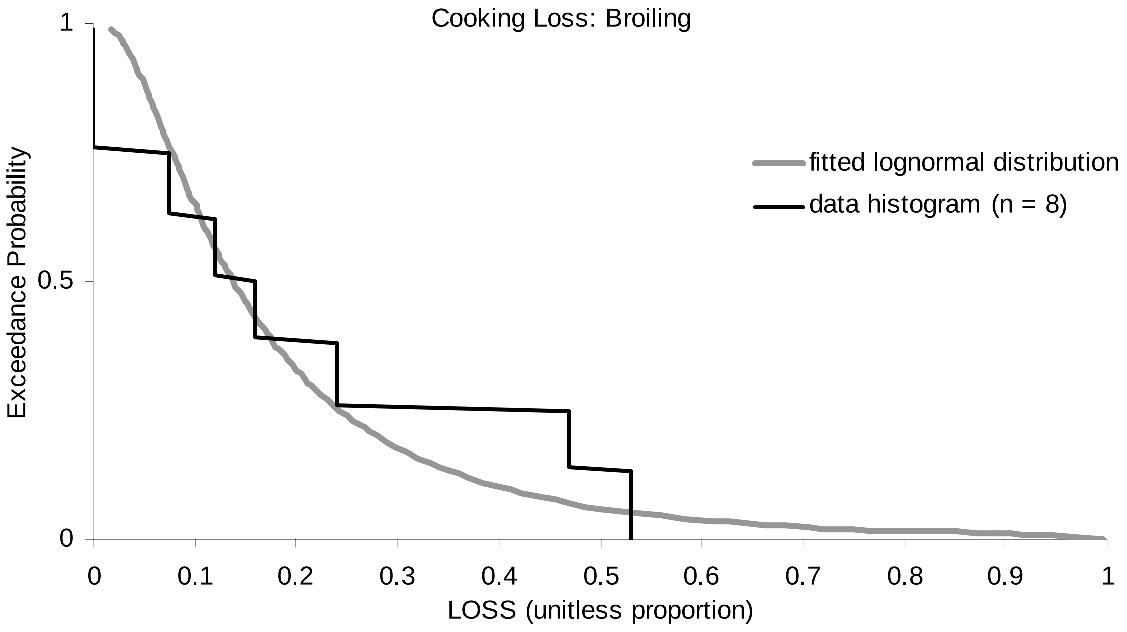


Figure 6-3 Empirical Distribution Function for Cooking Loss from Broiling and Lognormal Distribution Fit to the Data

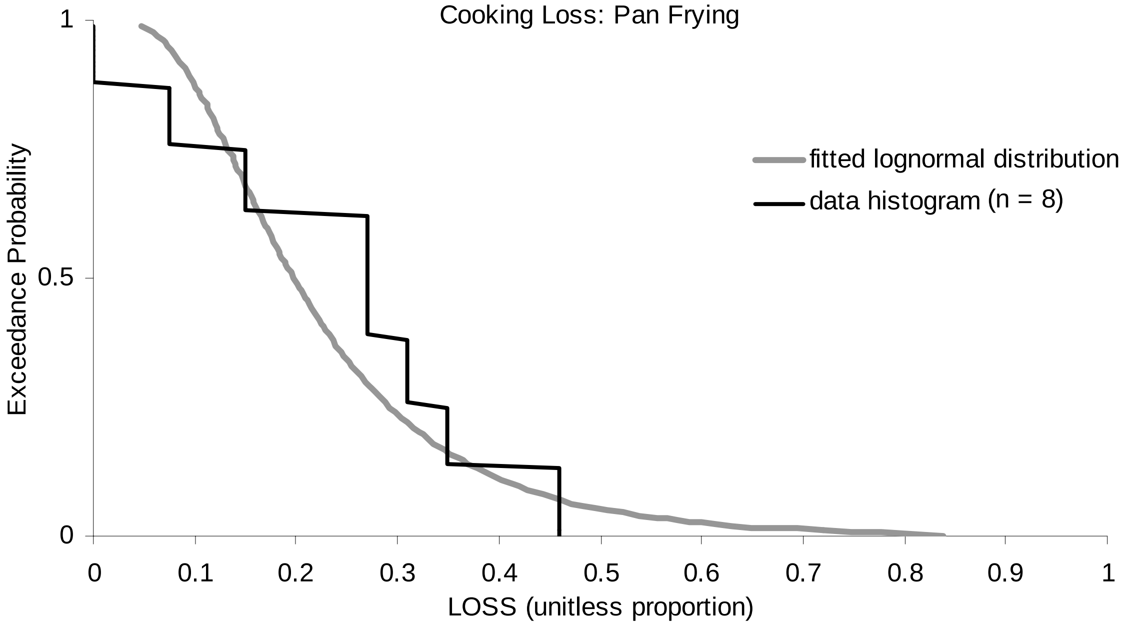


Figure 6-4 Empirical Distribution Function for Cooking Loss from Pan Frying and Lognormal Distribution Fit to the Data

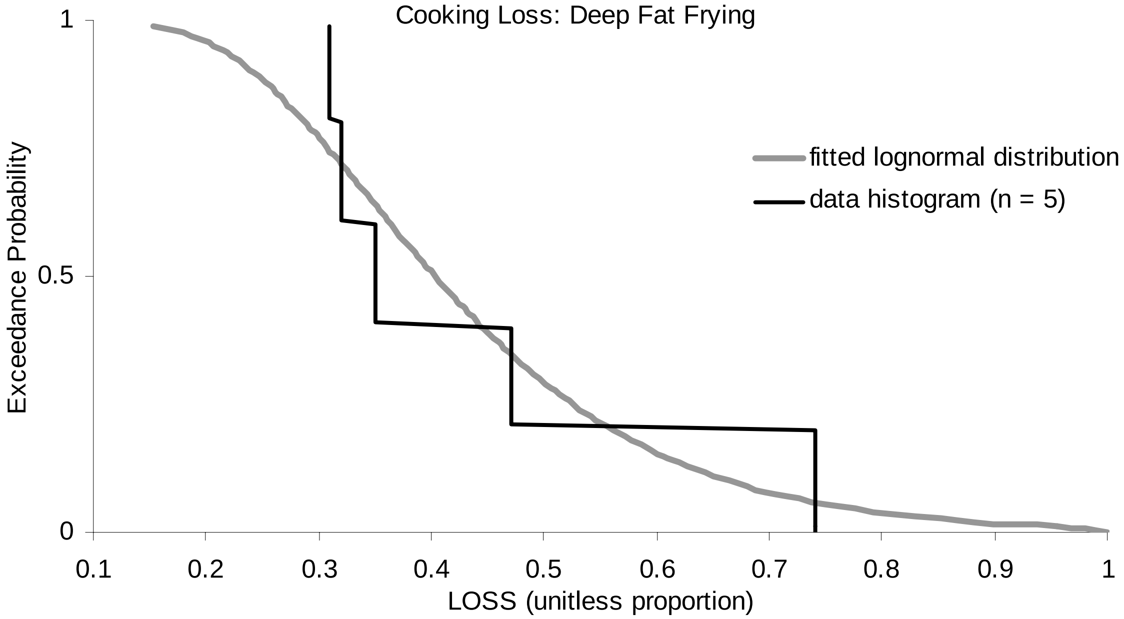


Figure 6-5 Empirical Distribution Function for Cooking Loss from Deep Fat Frying and Lognormal Distribution Fit to the Data

Figure 6-6 shows the cooking loss input distribution used in the Monte Carlo simulations (gray line) and the probability bounds analyses (black line) of the exposure model. In the figure, the abscissa is the value of the random variable.

The probability bounds (black lines) in the figure enclose all probability distributions that are consistent with the cooking loss data. The bounds can be read at each probability level as intervals. For example, the probability bounds indicate that the lowest 50th percentile cooking loss possible given variability and uncertainty is 0.08 and the highest is 0.41. Similarly, at least 5% of cooking losses will exceed 0.32 and no more than 5% of cooking losses may equal 1.

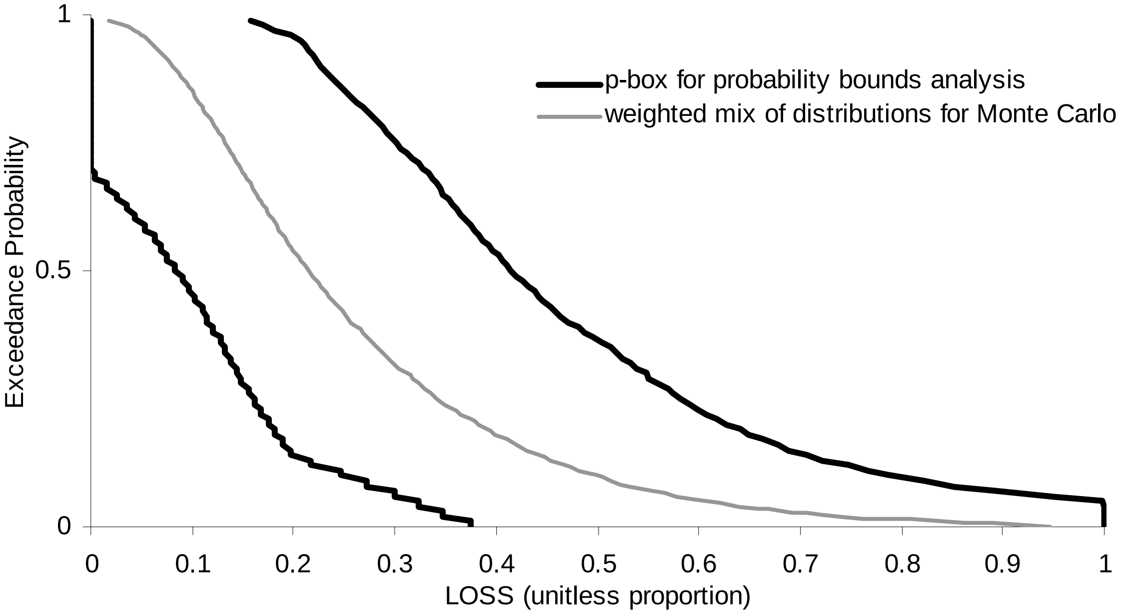


Figure 6-6 Cooking Loss Input Distribution for Monte Carlo Simulation Analysis and p-Box Input for Probability Bounds Analysis

6.6.1.4 Fish Ingestion Rate – MEE Model Only

The fish ingestion rate variable used in the MEE model was derived using data from studies discussed in Section 4.5.2.2. For the Monte Carlo simulation, a triangular distribution with a minimum of 142 g/meal (5 oz/meal), a midpoint value of 227 g/meal (8 oz/meal), and a maximum of 340 g/meal (12 oz/meal), was used. The midpoint is equivalent to the 8-oz portion size cited by EPA in “Guidance for Assessing Chemical Contaminant Data for Use In Fish

Advisories" (EPA, 2000). For the probability bounds analysis, an interval from 142 to 340 g/meal was used. This interval was intended to include uncertainty around the Monte Carlo triangular distribution, and the endpoints were derived from the West et al. (1993) survey. In this survey, respondents were asked to categorize their fish meals as smaller than, the same as, or larger than a picture of a 227-g fish meal. For children's portions, ingestion rate was set to one-half that of adults as detailed in Section 4.5.2.2. Figure 6-7 and Figure 6-8 show the ingestion rate inputs to the MEE analyses for adults and children, respectively.

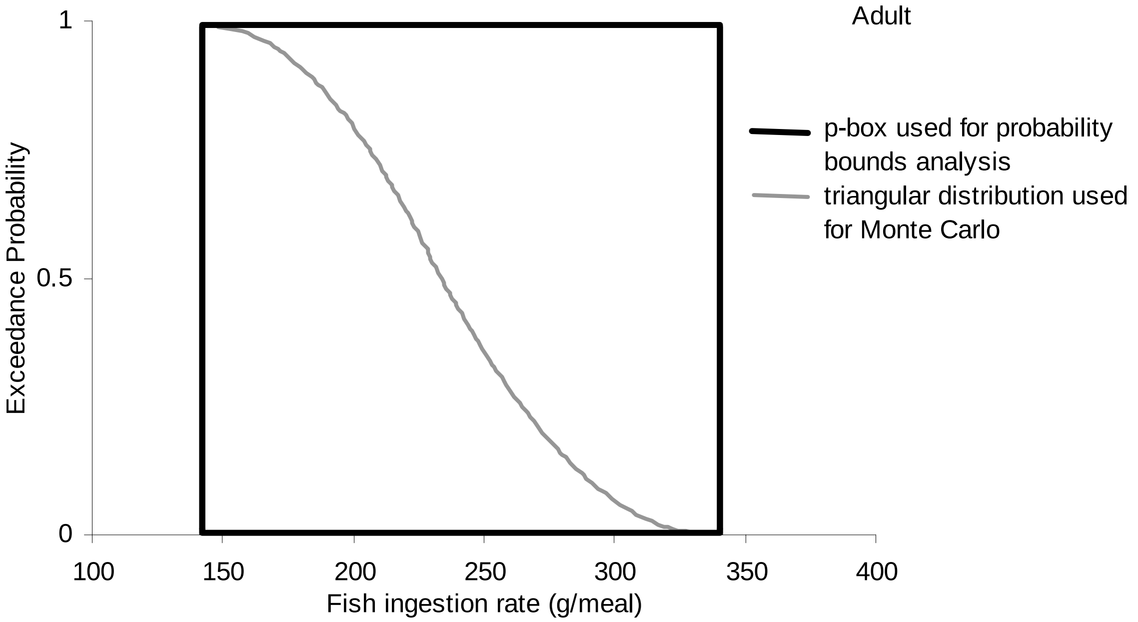


Figure 6-7 Triangular Distribution Used as an Input Variable in the MEE Monte Carlo Simulations and Interval Used as an Input Variable in the MEE Probability Bounds Analyses of Adult Exposure from Fish Ingestion

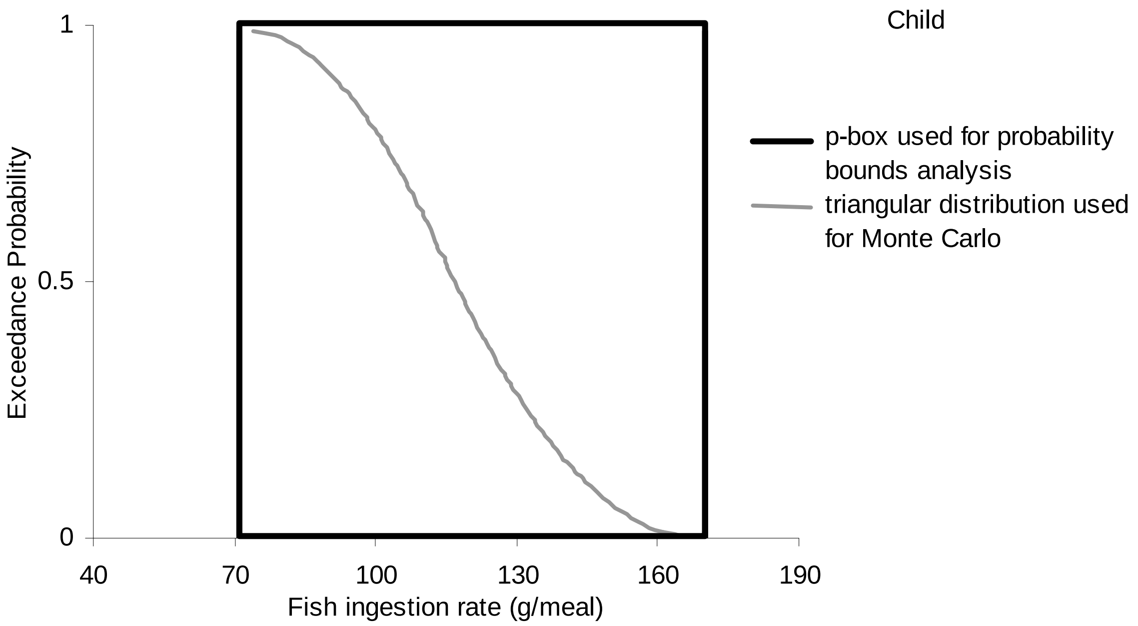


Figure 6-8 Triangular Distribution Used as an Input Variable in the MEE Monte Carlo Simulations and Interval Used as an Input Variable in the MEE Probability Bounds Analyses of Child Exposure from Fish Ingestion

6.6.1.5 Fish Ingestion Rate – 1-D Model Only

Ingestion rate empirical distribution functions and p-boxes were constructed from data collected in a survey of Maine anglers (ChemRisk, 1992[1], Ebert, 1993; Ebert (raw data provided 2003)). As for the first-tier point estimate exposure assessment presented in Section 4, data from adult anglers who fished all types of waters (rivers and streams, lakes and ponds, ice fishing, and other) were used to model ingestion rate for all anglers except those who fish only for trout. Data from adult anglers who fished rivers and streams were used to model exposure frequency for trout anglers.

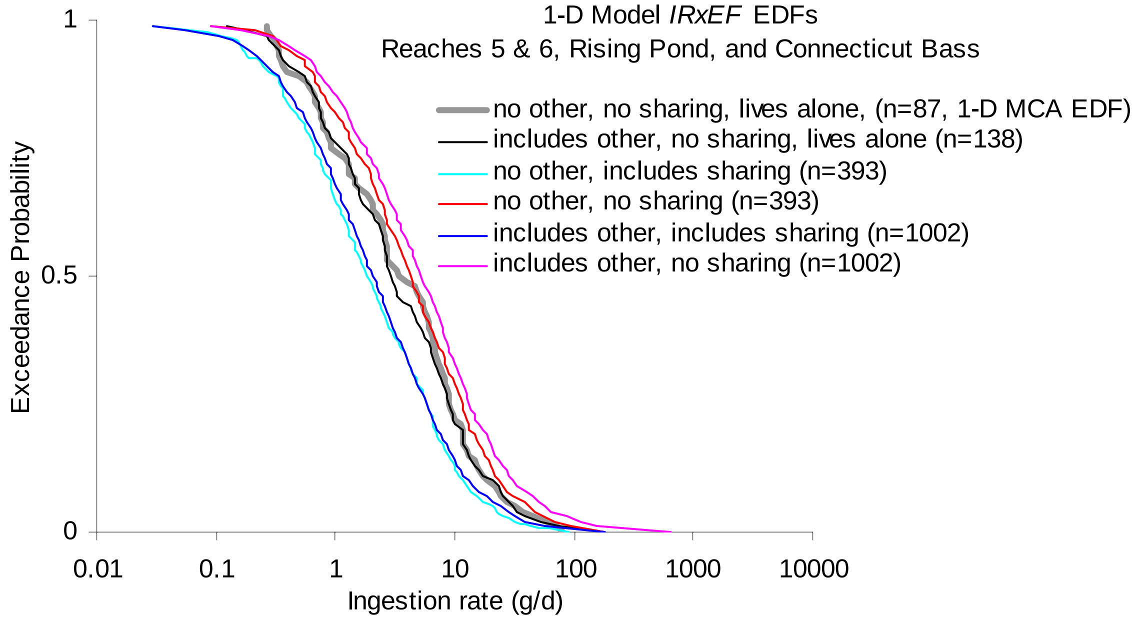
Empirical distribution functions were used as ingestion rate input to the 1-D Monte Carlo simulations. As explained in Section 4, data representing anglers who fished all waters, received no fish from other anglers, and reported only one household member consuming freshwater fish

---

[1] Raw data from the Maine angler survey was provided for use in this risk assessment in electronic form by E. Ebert, and was used to produce empirical data distributions for the exposure frequency input to the models.

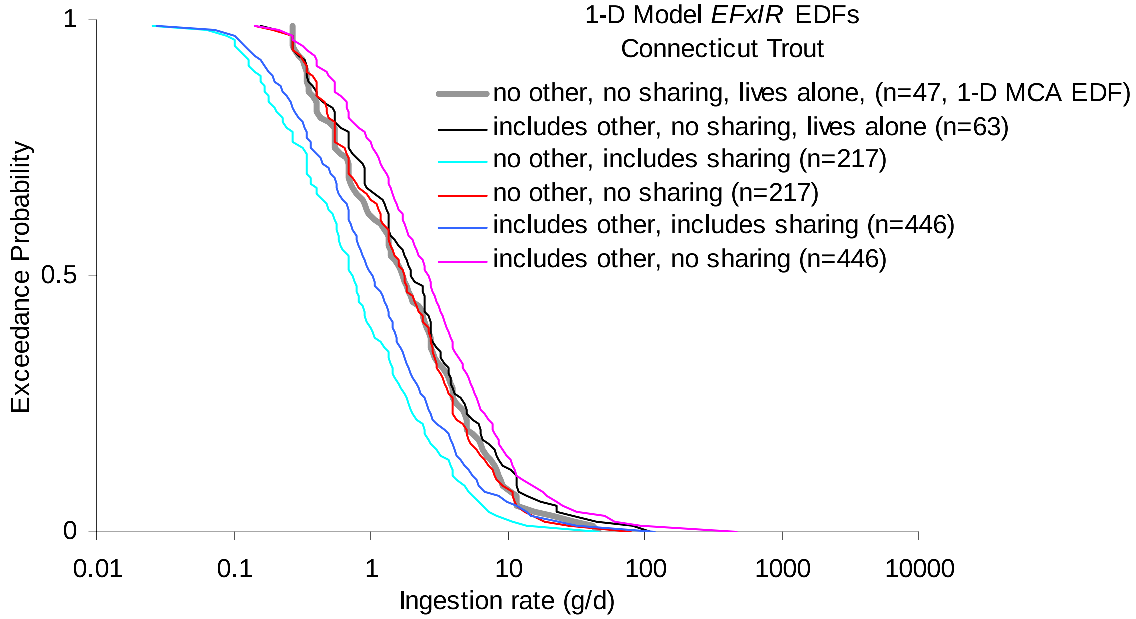
(n=87) were used for four of the five locations. Data representing anglers who fished only rivers or streams, received no fish from other anglers, and reported only one household member consuming freshwater fish(n=47) were used for the trout fishing location in Connecticut.

To construct p-boxes around the 1-D Monte Carlo input distributions, 10 additional empirical distribution functions were derived from the Maine angler survey data. For five of these, the all-waters Monte Carlo EDF was used to produce a p-box for the four non-trout fishing locations; and for the other five, the rivers-and-streams Monte Carlo EDF was used to create the p-box for the trout fishing location. Each of these additional EDFs relaxed one of the assumptions behind the two distributions chosen for the Monte Carlo simulations. For the all-waters distributions, the first relaxation allowed anglers to receive fish from other sources but assumed no sharing based on the angler’s response that only one household member consumed freshwater fish (n=138); the second allowed sharing within the household but included no fish from other sources (n=393); the third allowed no fish from other sources and no sharing, but included anglers in households with any number of consumers (n=393); the fourth allowed both fish from other sources and sharing with others in the household (n=1002); and the fifth allowed fish from other sources but assumed the angler was the only consumer of fish in the household (n=1002). Figure 6-9 shows these five additional empirical distribution functions. A parallel set of five EDFs was constructed from the data for rivers and streams anglers (n=63, n=217, n=217, n=446, and n=446, respectively). Figure 6-10 shows these five additional EDFs.



Note: The 1-D MCA EDF (gray line) is the distribution used in the Monte Carlo simulations. X-axis is log-scaled.

Figure 6-9 Six Empirical Distribution Functions from the Maine Angler Data Used to Develop the Ingestion Rate p-Box Used in the Exposure Assessment for Anglers at Two Locations in Massachusetts and Bass Anglers at Two Locations in Connecticut



Note: The 1-D MCA EDF (gray line) is the distribution used in the Monte Carlo simulations. X-axis is log-scaled.

Figure 6-10 Six Empirical Distribution Functions from the Maine Angler Data Used to Develop the Ingestion Rate p-Box Used in the Exposure Assessment for Trout Anglers at Connecticut Location

Figure 6-11 shows the 1-D model ingestion rate input distribution and p-box used in the exposure assessment for adult non-trout (bass) anglers. Figure 6-12 shows the ingestion rate input distribution and p-box used in the exposure assessment for adult trout anglers. The ingestion rate for children was assumed to be half that of adults, as detailed in Section 4.5.2.2. Figure 6-13 and Figure 6-14 show ingestion rates for child non-trout (bass) anglers and child trout anglers, respectively.

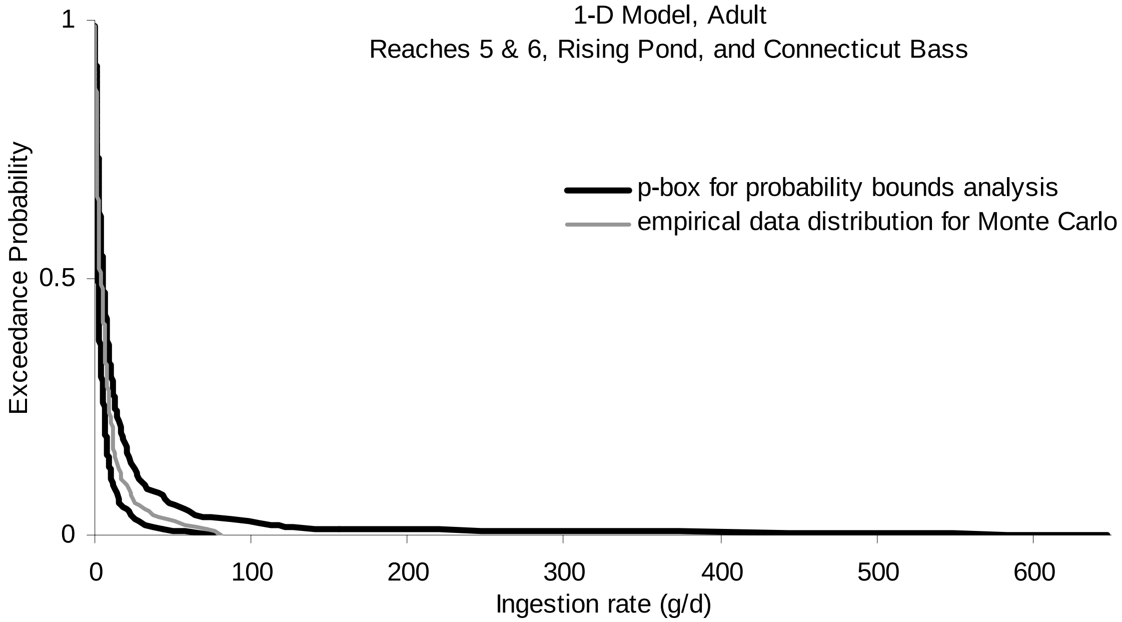


Figure 6-11 Ingestion Rate Input Distribution and Input p-Box Used in the 1-D Exposure Assessment for Adult Anglers at Two Locations in Massachusetts and Two Locations in Connecticut

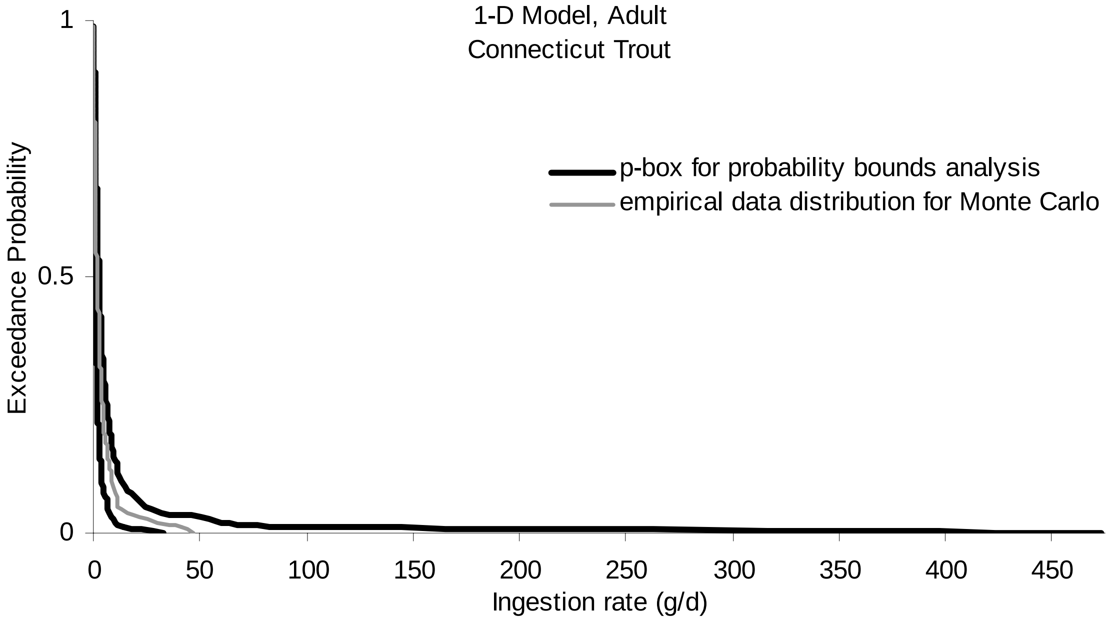


Figure 6-12 Ingestion Rate Input Distribution and Input p-Box Used in the 1-D Exposure Assessment for Adult Trout Anglers at One Location in Connecticut

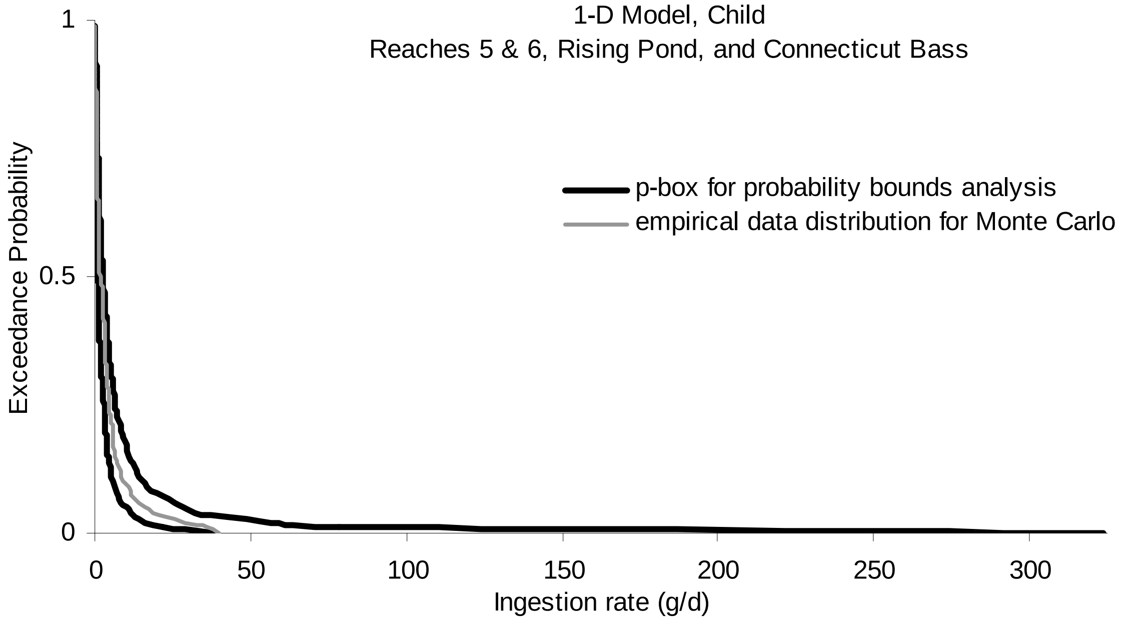


Figure 6-13 Ingestion Rate Input Distribution and Input p-Box Used in the 1-D Exposure Assessment for Child Anglers at Two Locations in Massachusetts and Two Locations in Connecticut

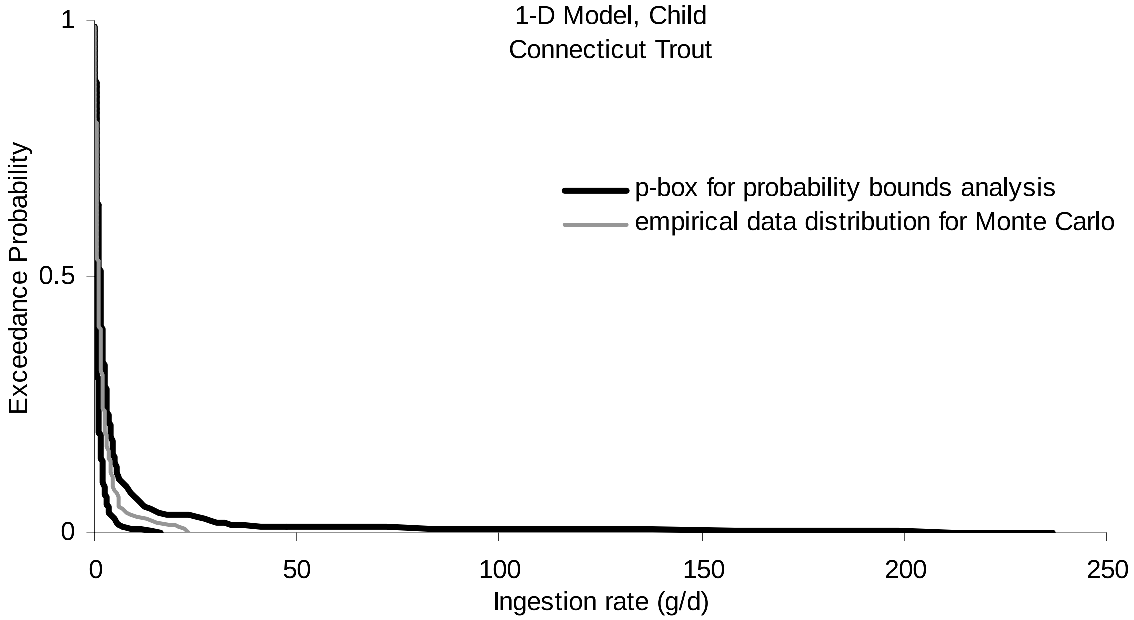


Figure 6-14 Ingestion Rate Input Distribution and Input p-Box Used in the 1-D Exposure Assessment for Child Trout Anglers at One Location in Connecticut

6.6.1.6 Exposure Frequency – MEE Model Only

For the MEE models, exposure frequency was deconvolved from the 1-D model ingestion rate inputs. The 1-D model ingestion rates are expressed in units of grams per day, and represent an angler's meals per year (*EF*) multiplied by grams per meal (*IR*) and divided by the constant 365 days per year. To separate *EF* from *IR* for the MEE model simulations, the 1-D ingestion rate distributions must be divided by the *IR* input distribution specified in Section 6.6.1.4. Because *IR* and *EF* are probability distributions, this division, called a deconvolution, has many potential solutions. A solution was selected for each *EF* that, when multiplied by the specified *IR* distribution, returns the original ingestion rate EDF used as input to the 1-D model.

The EDF *EF* inputs to the MEE Monte Carlo models and the p-boxes for the MEE probability bounds analyses are shown in Figure 6-15 and Figure 6-16 for the non-trout (bass) and the trout anglers, respectively.

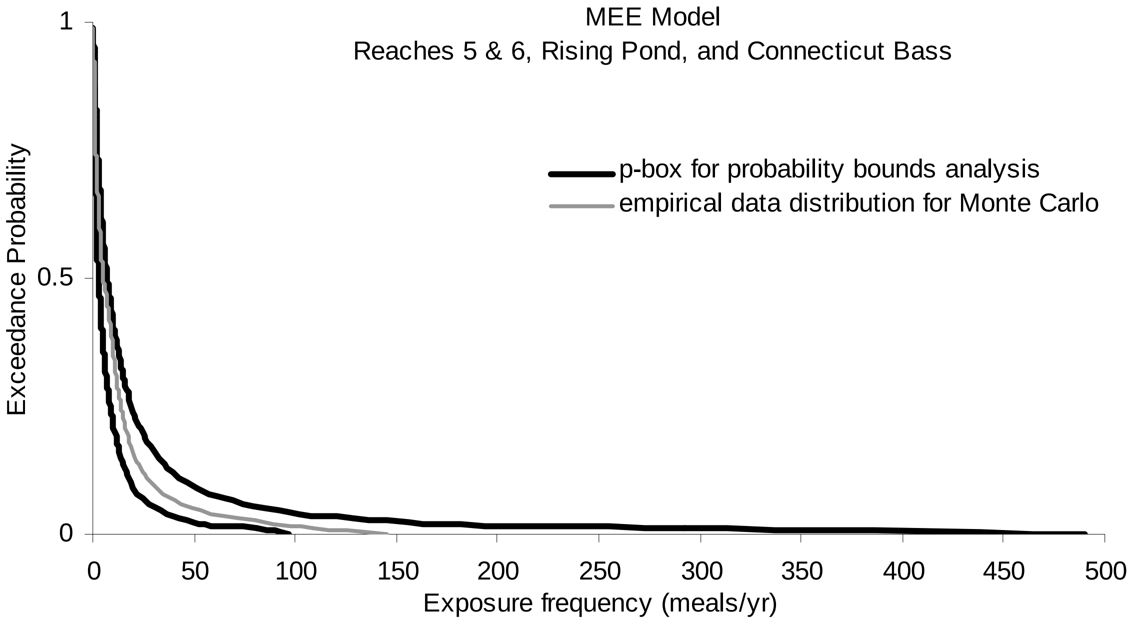


Figure 6-15 Exposure Frequency Input Distribution and Input p-Box Used in the MEE Exposure Assessment for Adult and Child Anglers at Two Locations in Massachusetts and Two Locations in Connecticut

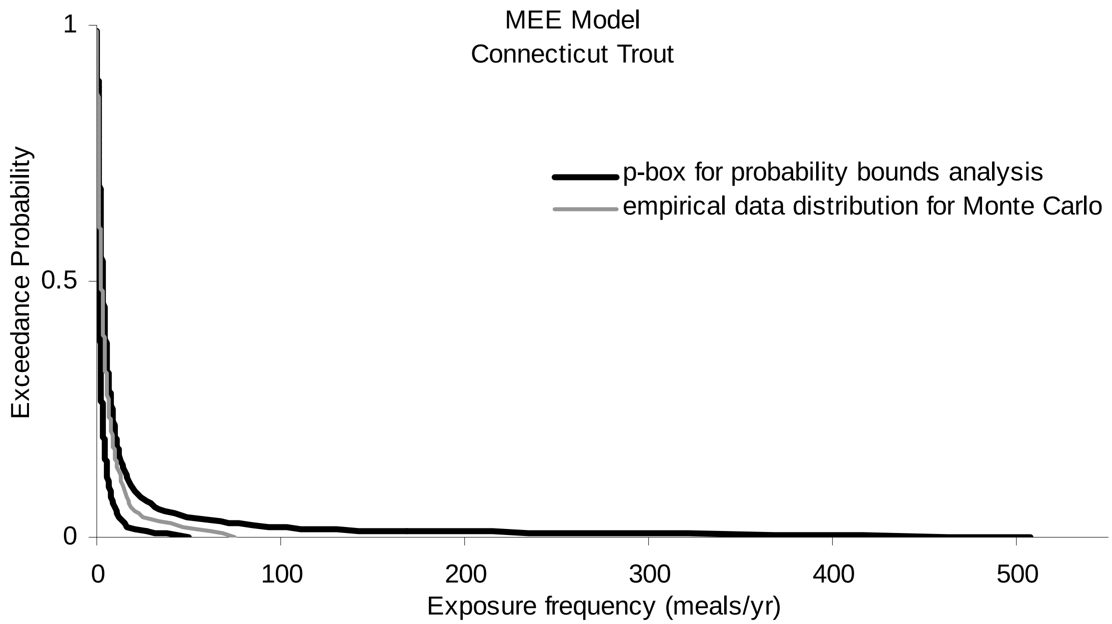


Figure 6-16 Exposure Frequency Input Distribution and Input p-Box Used in the MEE Exposure Assessment for Adult and Child Trout Anglers at One Location in Connecticut

6.6.1.7 Fraction Ingested

For all Monte Carlo analyses, the fraction of fish meals consumed that were harvested from each exposure area is represented by the fraction ingested (*FI*) variable. Two studies were used to weight six fractions (see Section 4.5.2.4), and these weighted fractions were used to construct an empirical distribution function. Figure 6-17 shows the EDF used in all Monte Carlo analyses (gray line).

For all probability bounds analyses, a distribution free p-box was constructed to bound all *FI* distributions consistent with the minimum, maximum, mean, and standard deviation of the data. Figure 6-17 shows the p-box used in all probability bounds analyses (black lines).

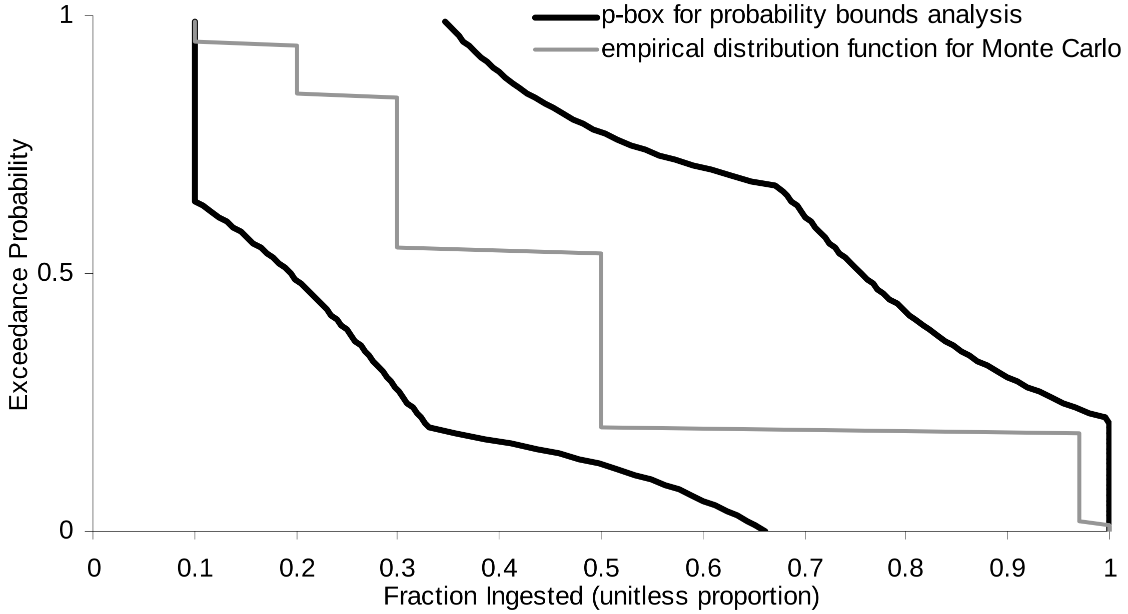


Figure 6-17 Fraction Ingested Input Distribution and Input p-Box Used in the Exposure Assessment for All Anglers at All Locations

6.6.1.8 Exposure Duration

The exposure duration input variable was used only in the cancer exposure model calculations. Exposure duration distributions were derived from studies and data presented in Section 4.5.2.6. For adults, the minimum, maximum, and 95% confidence intervals around the mean and standard deviation were used to form a p-box for the probability bounds analyses. Confidence intervals for the mean were calculated using the central limit theorem method, and confidence limits around the standard deviation were calculated using the method of shortest unbiased confidence intervals (Sokal and Rohlf, 1981). For the Monte Carlo simulations, the lognormal distribution was derived from data provided by the MDPH (2001) on exposure duration for respondents who had ever consumed freshwater fish from the Housatonic River. The lognormal distribution was truncated at 64 years for adults, and the p-box range was limited to a maximum of 64 years. Children’s exposure durations were assumed to span the years from ages 1 to 6, and an interval from one to six was used for the probability bounds analyses, while a uniform distribution was used as input to the Monte Carlo simulations. These inputs allowed child exposure durations of any number of years from 1 to 6. The choices of uniform distribution and a degenerate (interval) p-box reflect a lack of empirical information about the childhood exposure duration. The maximum exposure durations equal 70 years, which is equal to the averaging time used in the cancer model (EPA, 2001). Figures 6-18 and 6-19 show the exposure duration input distributions for adults and children.

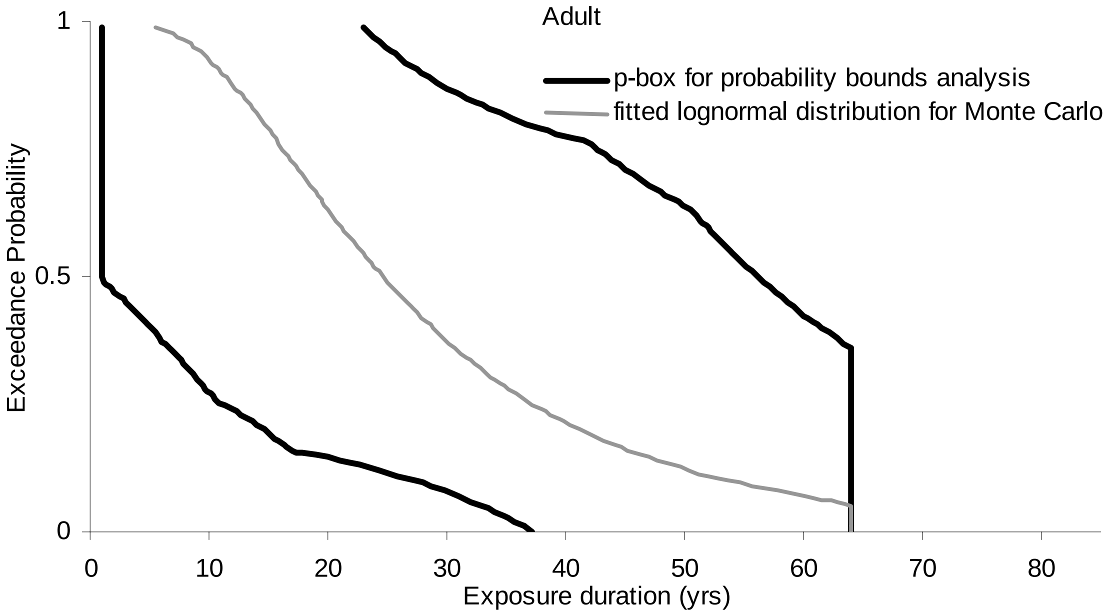


Figure 6-18 Adult Exposure Duration Input Probability Distribution Used in the Monte Carlo Exposure Assessment and the p-Box Used as Input to the Probability Bounds Exposure Analysis

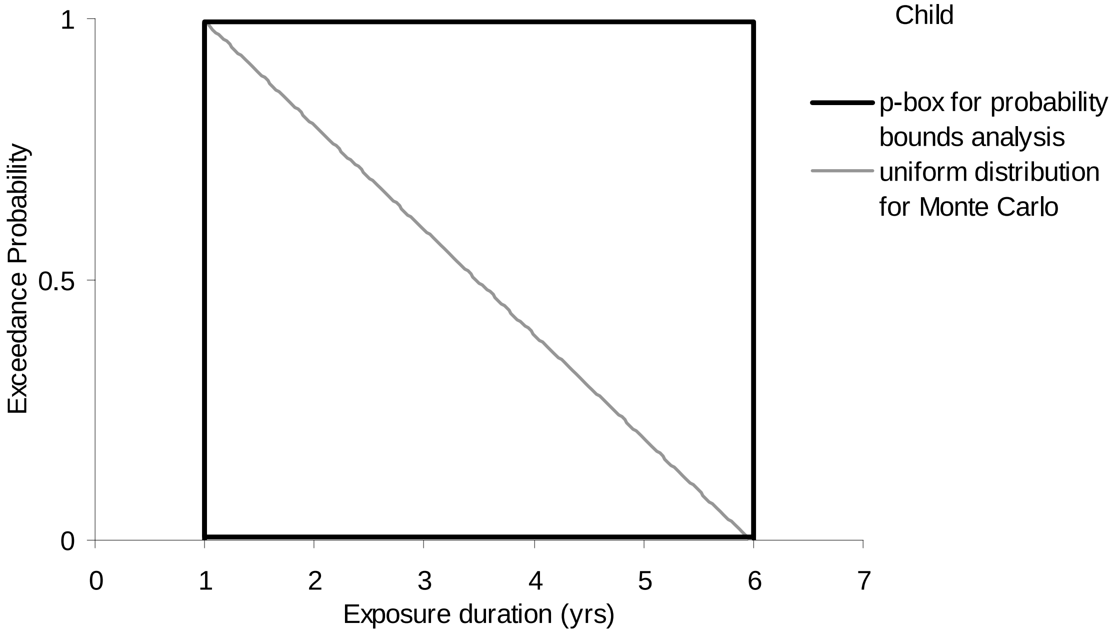
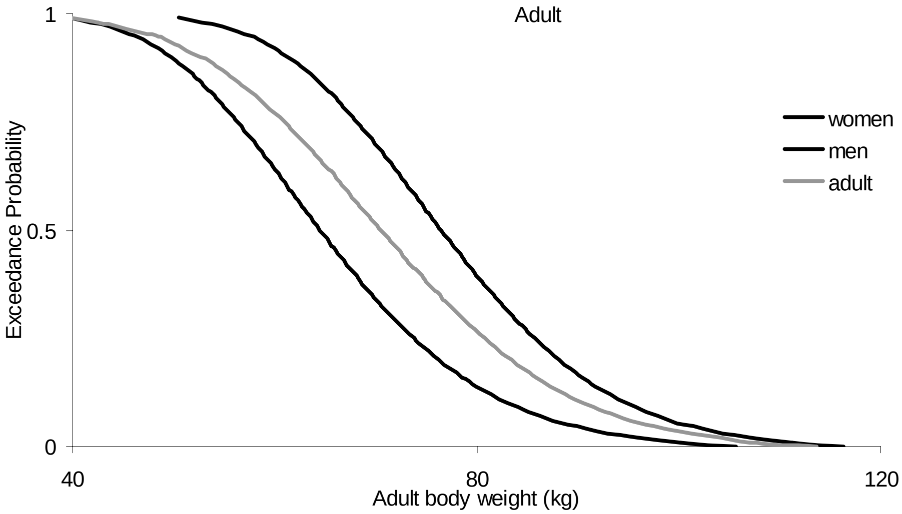


Figure 6-19 Child Exposure Duration Input Probability Distribution Used in the Monte Carlo Exposure Assessment and as Input to the Probability Bounds Exposure Analysis

6.6.1.9 Body Weight

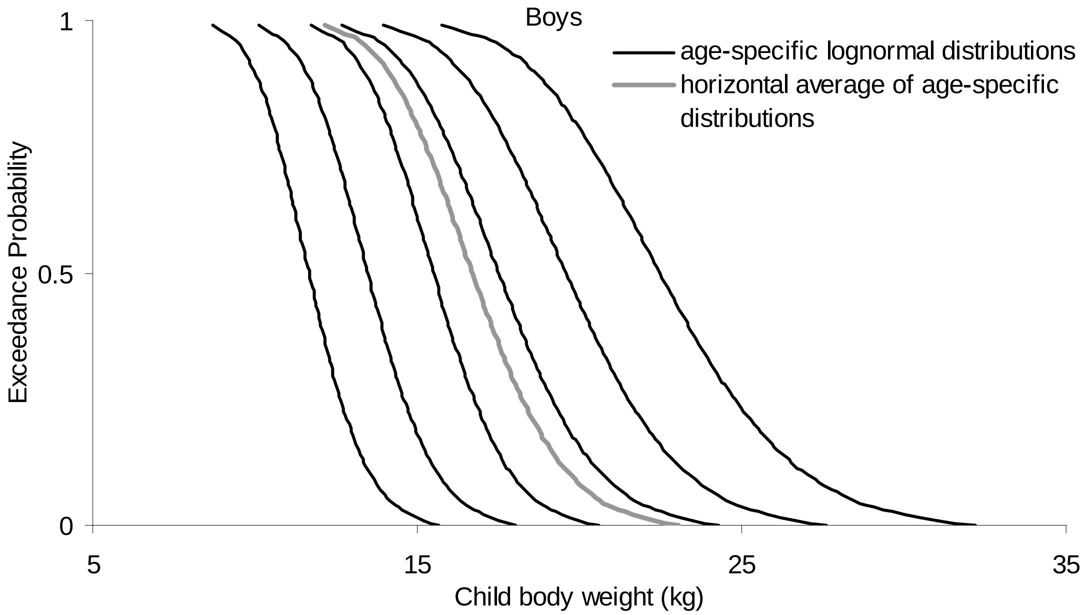
Adult body weights were taken from the NHANES II survey of individuals aged 18 to 74 between 1976 and 1980 (Brainard and Burmaster, 1992). There were 9,983 men and 10,339 women sampled and one distribution developed for men and another for women. The body weight distribution of a generic adult receptor was constructed for this study as a stochastic mixture of the two gender-specific distributions with equal weights. The mixed distribution was computed by vertically averaging the respective probability values for the distribution functions at each value of the abscissa. This corresponds to a distribution formed by randomly picking from each of the mixed distributions with probabilities given by their respective weights. This is appropriate for a population consisting of both men and women (or boys and girls, see below). Given the large sample sizes and the rigorous nature of the NHANES II survey, uncertainty regarding body weight distributions was considered negligible. Epistemic uncertainty regarding temporal change in body weight within an individual due to growth, diet, etc., was considered, but not modeled, because the complexity and consequent modeling uncertainty that would result would be greater than the uncertainty it was meant to characterize. Likewise, uncertainty regarding the appropriateness of applying a distribution of body weights describing the general population to a regional population of recreational anglers was considered. However, the population demographics of the area, as described in HHRA Volume I, Section I, provide no basis for concluding the regional population would have a different body weight distribution than that obtained from the national dataset. Therefore, the precise lognormal distribution resulting from this mixture was used in both the Monte Carlo analysis and the probability bounds analysis. Figure 6-20 shows the adult body weight distributions for men and women from Brainard and Burmaster (1992; black lines) and the distribution resulting from a mixture of the gender-specific distributions (gray).



The black lines show the body weight distributions for men and women that were mixed with equal weighting to form the input variable.

Figure 6-20 Adult Body Weight Probability Distribution Used as an Input Variable in the Monte Carlo Exposure Assessment and in the Probability Bounds Analysis

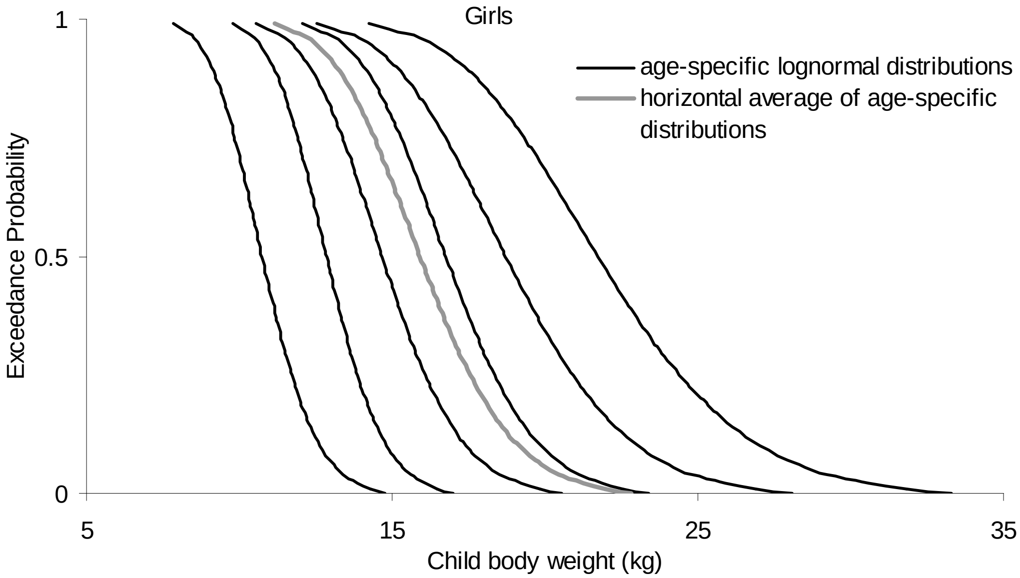
For childhood body weights, the NHANES II database was segregated by age and gender for each year of development (Burmaster and Crouch, 1997). Figures 6-21 and 6-22 show successive lognormal distributions of body weights at ages 1, 2, 3, 4, 5, and 6 (black curves) for boys and girls, separately, as reported in Burmaster and Crouch (1997). The gender-specific averages of these yearly body weight distributions (shown in gray) were computed assuming perfect temporal autocorrelation. This assumed that a larger-than-average 1-year-old was also a larger-than-average child for each of the 6 years. This correlation seemed more reasonable than



Source: Burmaster and Crouch, 1997

The average of these yearly body weight distributions (gray line) was computed assuming perfect temporal autocorrelation.

Figure 6-21 Lognormal Probability Distributions of Body Weights at Ages 1 Through 6 for Boys

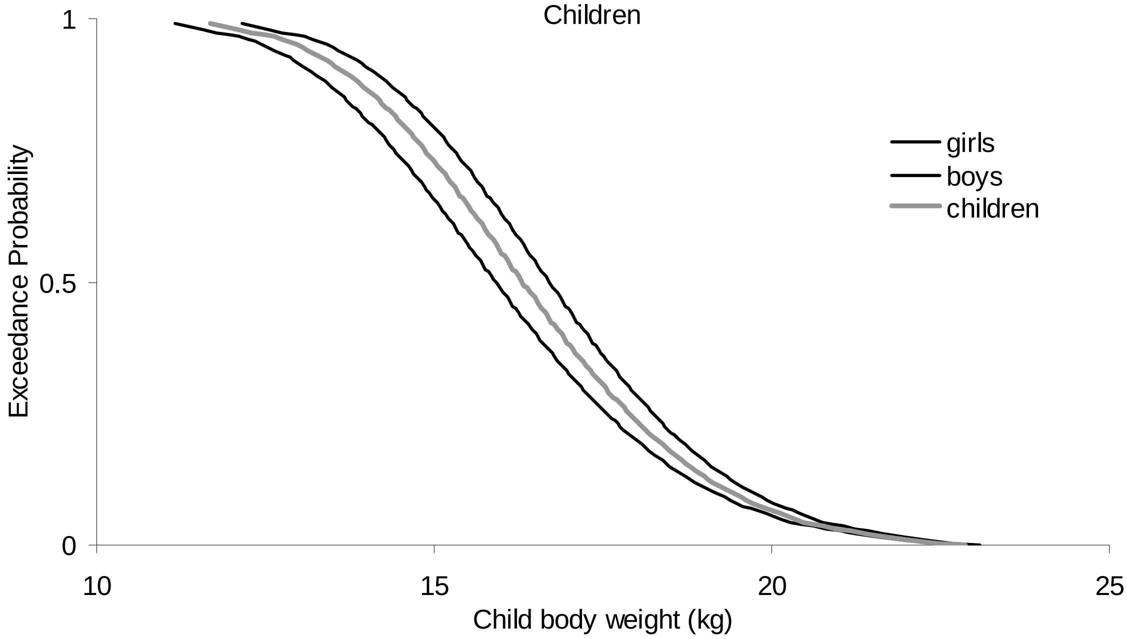


Source: Burmaster and Crouch, 1997

The average of these yearly body weight distributions (gray line) was computed assuming perfect temporal autocorrelation.

Figure 6-22 Lognormal Probability Distributions of Body Weights at Ages 1 Through 6 for Girls

an assumption of independence among the years of childhood. This correlation assumption could be replaced with precise correlations if available, or, in the absence of empirical information, could be relaxed using the method of dependency bounds analysis (see Section 6.4). The average distribution was computed by horizontally averaging the respective percentiles of the six distribution functions. This is appropriate for a population, each member of which experiences all of the age categories. The equally weighted stochastic mixture of the two average distributions (calculated by averaging vertically, as with the distributions for men and women above) is depicted in Figure 6-23.



The black lines show the average body weight distributions for boys and girls that were mixed with equal weighting to form the input variable.

Figure 6-23 Child Body Weight Probability Distribution Used as an Input Variable in the Monte Carlo Exposure Assessment and in the Probability Bounds Analysis

6.6.1.10 Averaging Time

The averaging time variable was used only in the cancer model calculations. Averaging time was set at 70 years (25,550 d) in the cancer exposure model (see Section 4.5.2.8).

6.6.2 Second-Tier One-Dimensional Fish Exposure Model Results for tPCBs

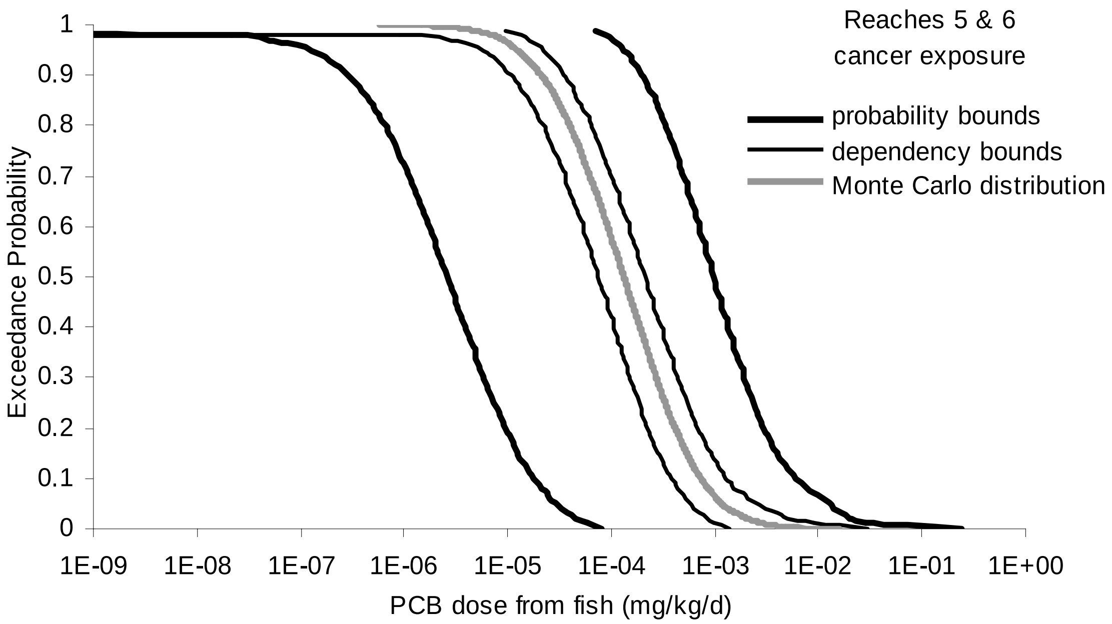
The results of the second-tier one-dimensional exposure models for tPCBs are presented below.

6.6.2.1 Cancer Models

The one-dimensional cancer exposure model was calculated for tPCBs for each location. Adult and child receptors were combined in the model. Figures 6-24 through 6-28 show cancer exposures for the PSA and Rising Pond anglers in Massachusetts, and cancer exposures for West Cornwall/Bulls Bridge bass anglers, West Cornwall trout anglers, and Lakes Lillinonah/Zoar bass anglers in Connecticut, respectively. The figures show distributions for exposure calculated with the one-dimensional Monte Carlo simulation (gray line), the dependency bounds analysis (narrow black line), and the probability bounds analysis (thick black line). The Monte Carlo simulation provides an estimate of one of the exposure distributions that is possible. The dependency bounds are upper and lower bounds on all exposure distributions that could result from relaxing the assumption of strict independence between ingestion rate and exposure duration, and ingestion rate and body weight made by the Monte Carlo simulation. The probability bounds analysis relaxes these same dependency assumptions and allows for uncertainty regarding the precise magnitude and distributional form of the input distributions. Any exposure distribution that can be plotted between the probability bounds is consistent with the input data. The plots use a log scale for the x-axis in order to show the values close to zero more clearly.

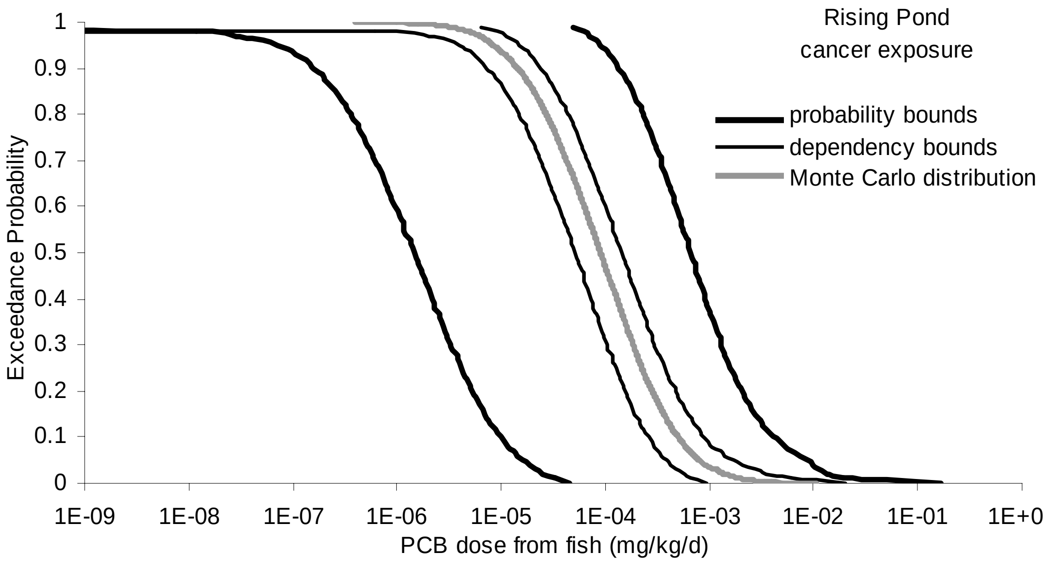
Because exceedance probabilities are plotted as a complementary cumulative distribution, these exposure figures show the risk percentiles greater than or equal to each percentile on the y-axis. In Figure 6-24, for example, the probability bounds around the exposure at the 90th percentile (0.1 on the y-axis) range from about 2E-5 to 6E-3 (or more precisely 1.8 E-5 to 6.1 E-3, although this level of precision cannot be read from the figure). Likewise, the 90th percentile of the Monte

Carlo distribution can be seen to be about 8E-4 (or more precisely 7.8E-4). Section 8 and Figure 8-1 and the accompanying text provides a more detailed discussion of interpreting the exposure and risk figures, and Section 6.6.1.3 provides a more-detailed explanation of the interpretation of exceedance probabilities.



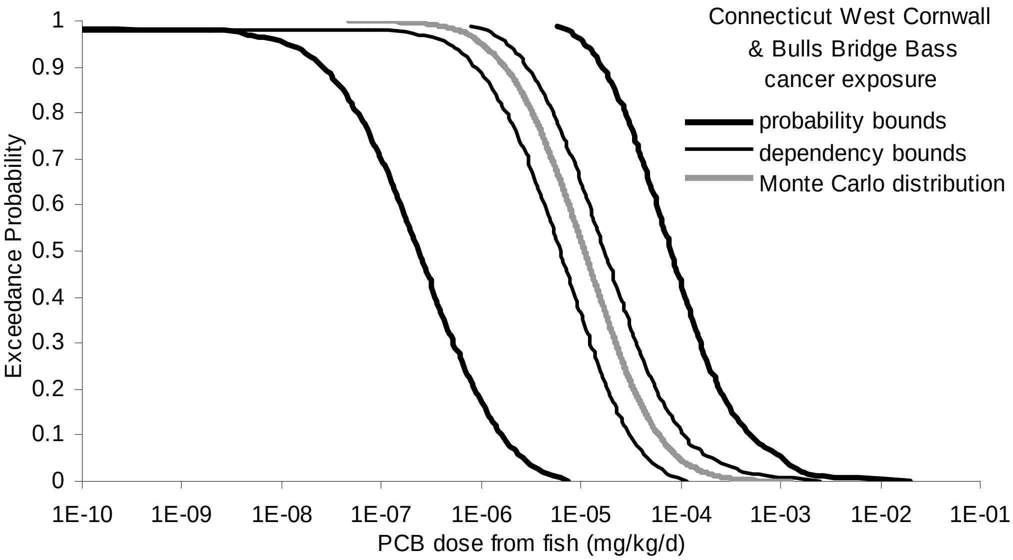
(Note: x-axis is log scaled.)

Figure 6-24 Cancer Exposure to tPCBs from Fish Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



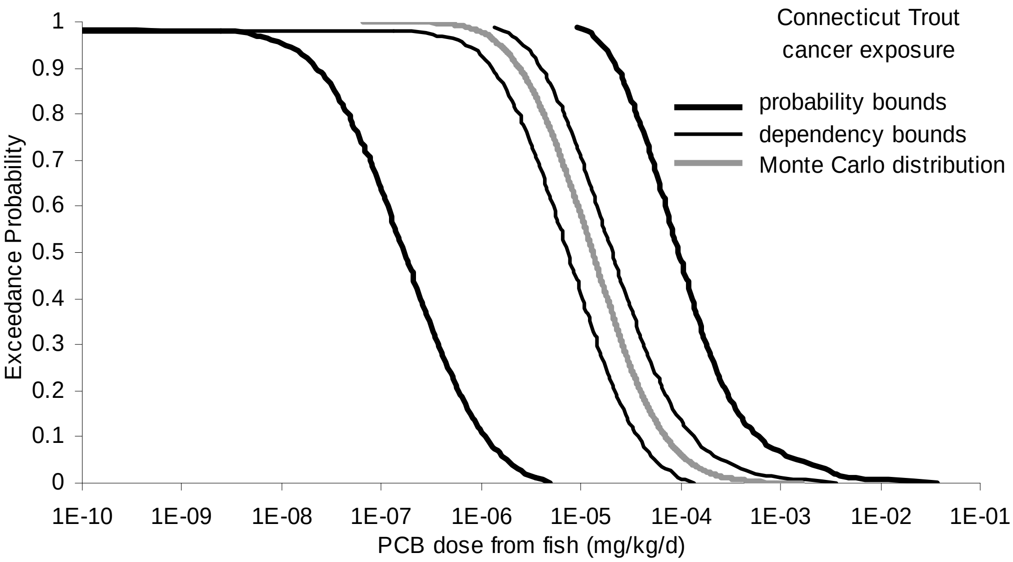
(Note: x-axis is log scaled.)

Figure 6-25 Cancer Exposure to tPCBs from Fish Consumption at Rising Pond—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



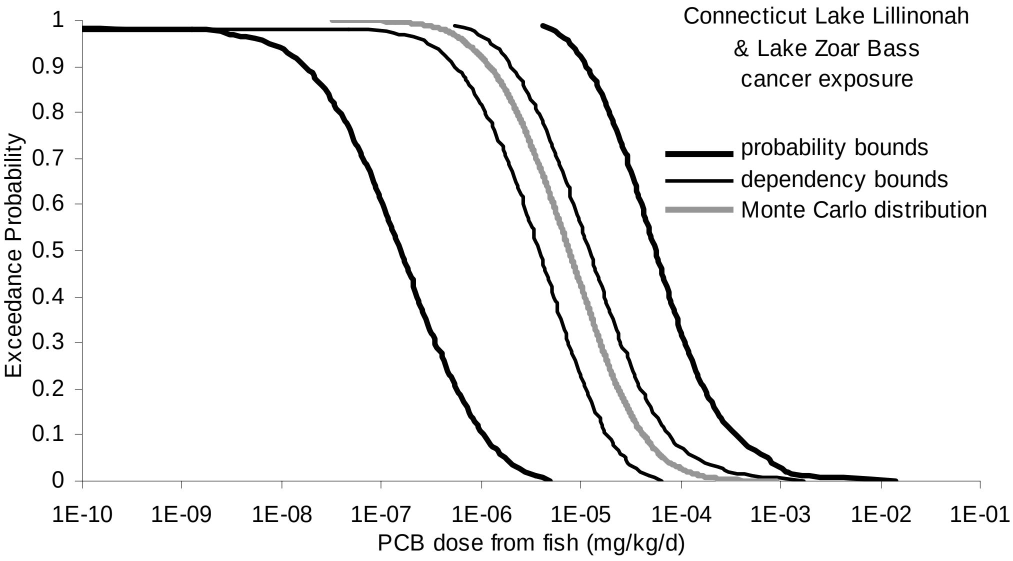
(Note: x-axis is log scaled.)

Figure 6-26 Cancer Exposure to tPCBs from Bass Consumption at West Cornwall/Bulls Bridge—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-27 Cancer Exposure to tPCBs from Trout Consumption at West Cornwall—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

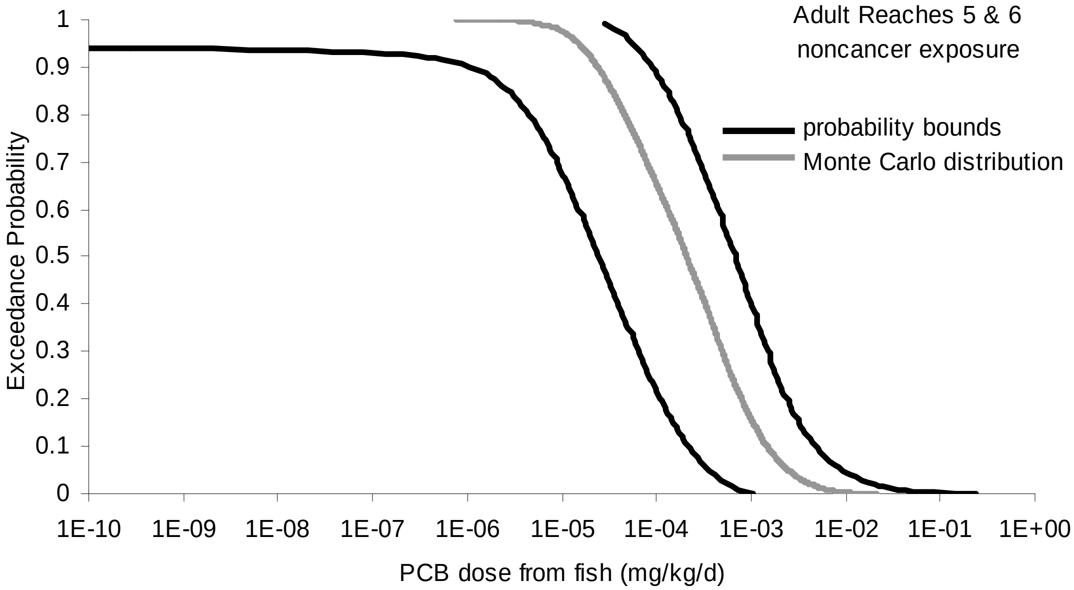


(Note: x-axis is log scaled.)

Figure 6-28 Cancer Exposure to tPCBs from Bass Consumption at Lakes Lillinonah/Zoar—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

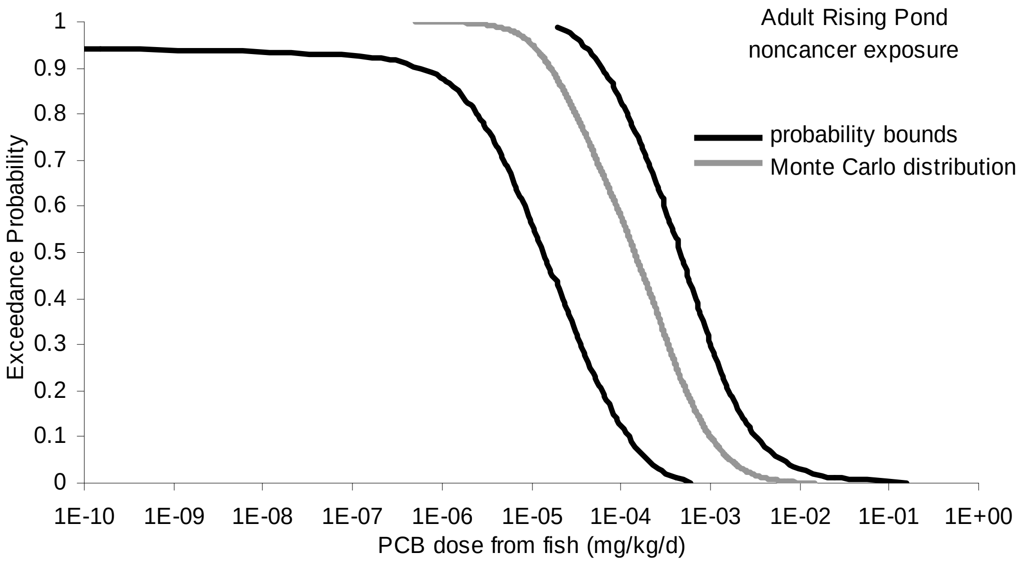
6.6.2.2 Noncancer Models

The one-dimensional noncancer exposure model was calculated for tPCBs for fish consumption at each location in Massachusetts, bass consumption at the two locations in Connecticut, and for trout consumption only at the West Cornwall location in Connecticut. Adult and child receptors were calculated separately. Figures 6-29 through 6-33 show noncancer exposures for adults at the four locations and for trout anglers at the West Cornwall location. Figures 6-34 through 6-38 show noncancer exposures for children of anglers who catch bass and other species at the four locations and for children of trout anglers at the West Cornwall location. The figures show distributions for exposure calculated with the one-dimensional Monte Carlo simulation (gray line) and the one-dimensional probability bounds analysis (thick black line). No dependency bounds analysis was conducted for noncancer models because no effect of dependency structure is possible, except for that between body weight and exposure frequency. This latter dependency relationship was assumed independent (Table 6-1).



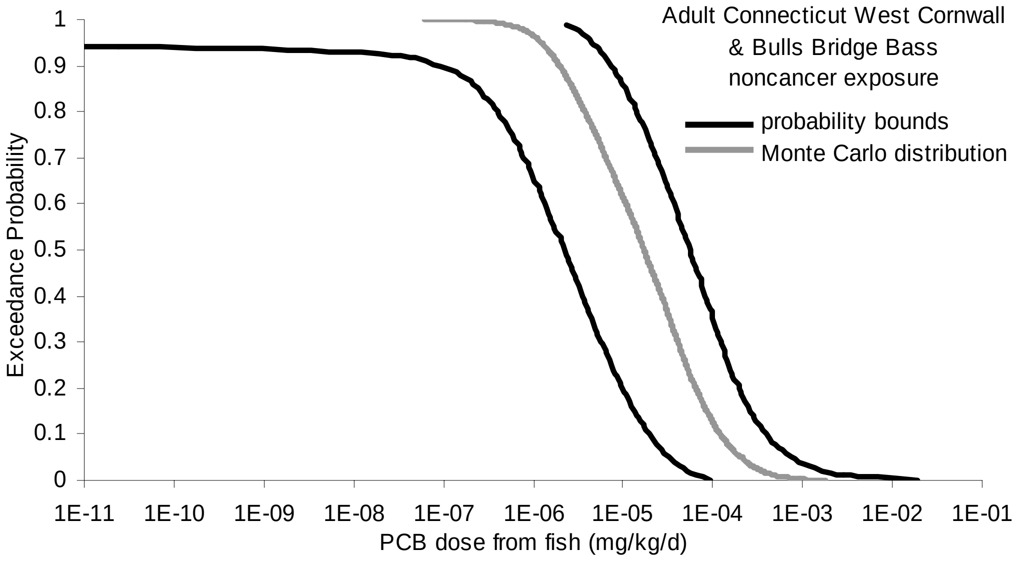
(Note: x-axis is log scaled.)

Figure 6-29 Adult Noncancer Exposure to tPCBs from Fish Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



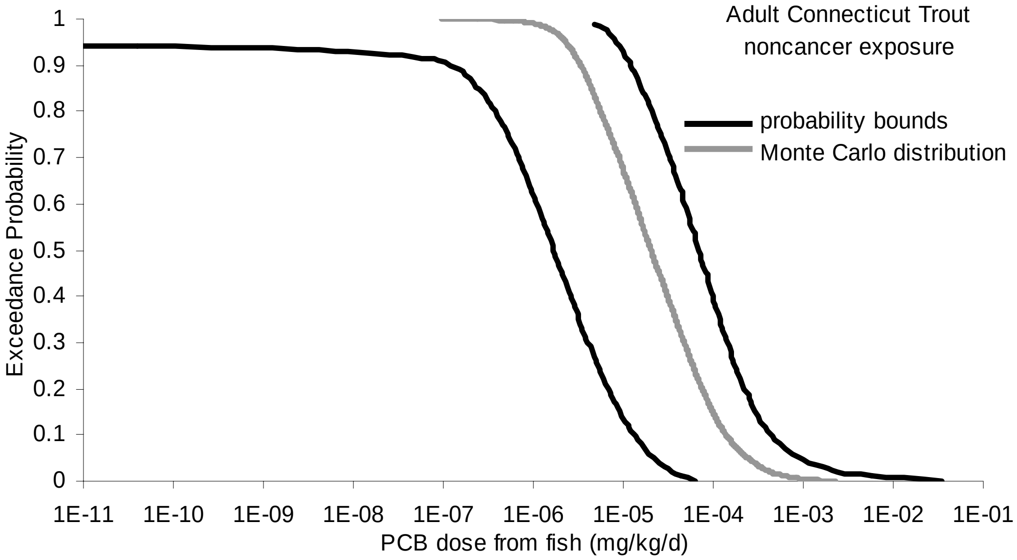
(Note: x-axis is log scaled.)

Figure 6-30 Adult Noncancer Exposure to tPCBs from Fish Consumption at Rising Pond—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



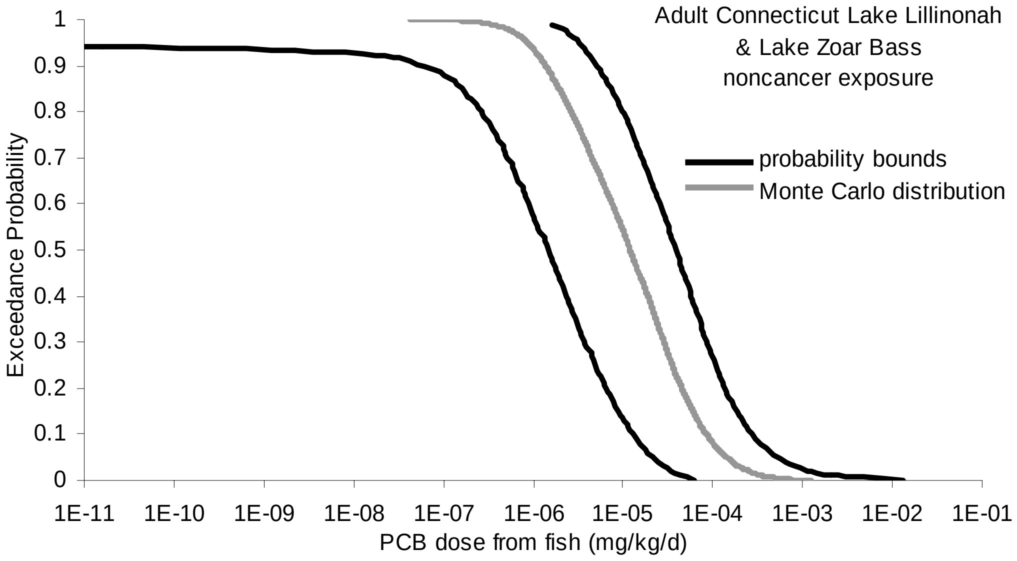
(Note: x-axis is log scaled.)

Figure 6-31 Adult Noncancer Exposure to tPCBs from Bass Consumption at West Cornwall/Bulls Bridge—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



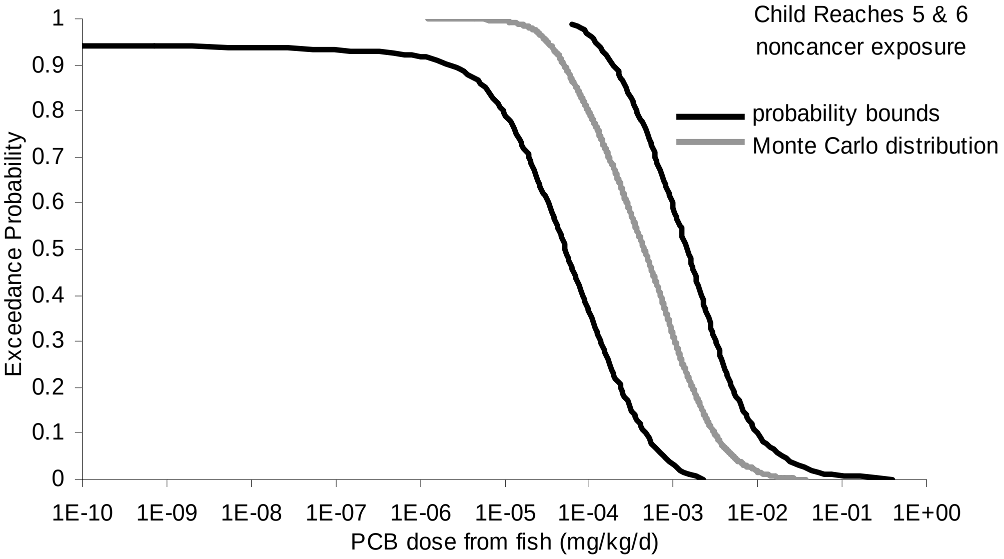
(Note: x-axis is log scaled.)

Figure 6-32 Adult Noncancer Exposure to tPCBs from Trout Consumption at West Cornwall—Results of the One-Dimensional Monte Carlo Simulation



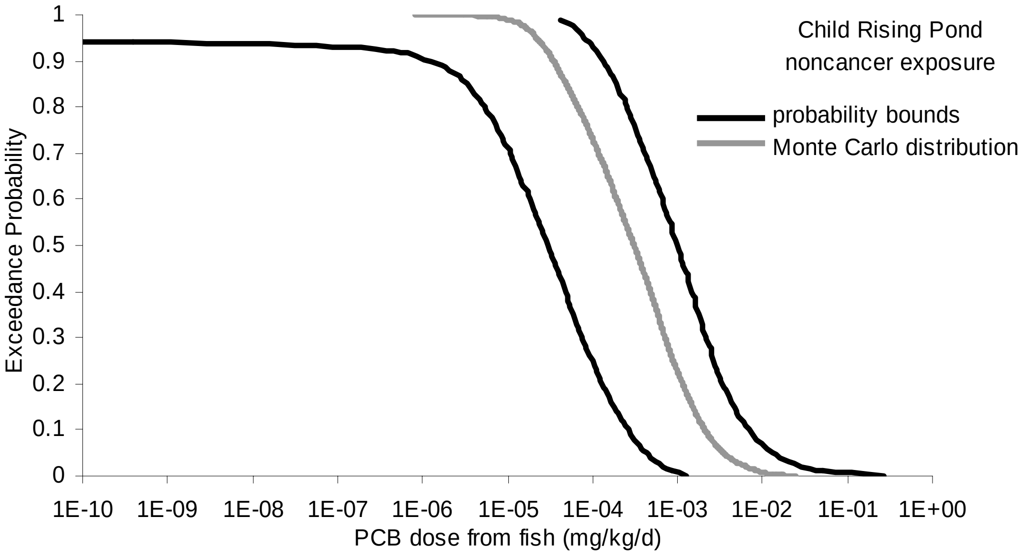
(Note: x-axis is log scaled.)

Figure 6-33 Adult Noncancer Exposure to tPCBs from Bass Consumption at Lakes Lillinonah/Zoar—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



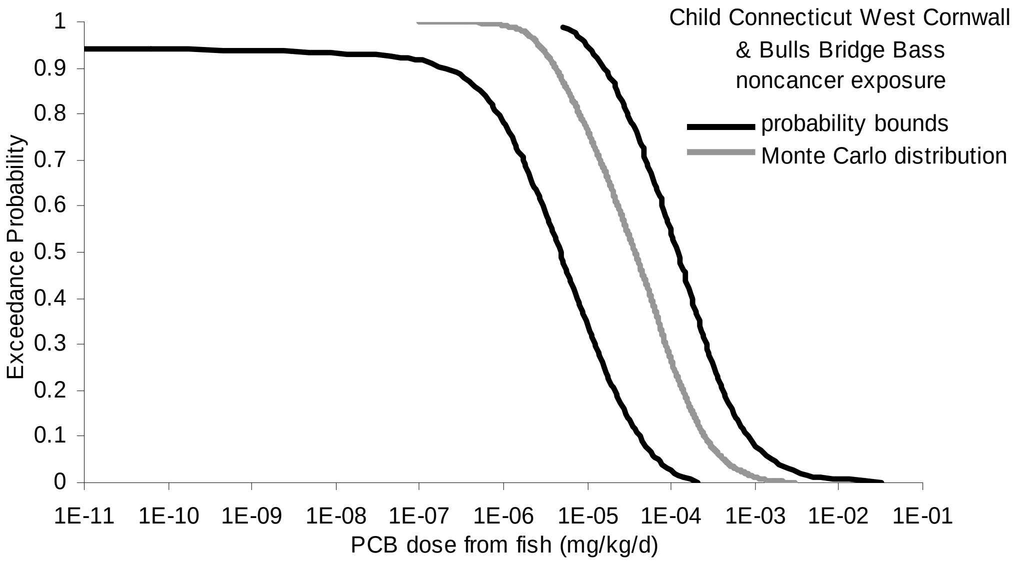
(Note: x-axis is log scaled.)

Figure 6-34 Child Noncancer Exposure to tPCBs from Fish Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



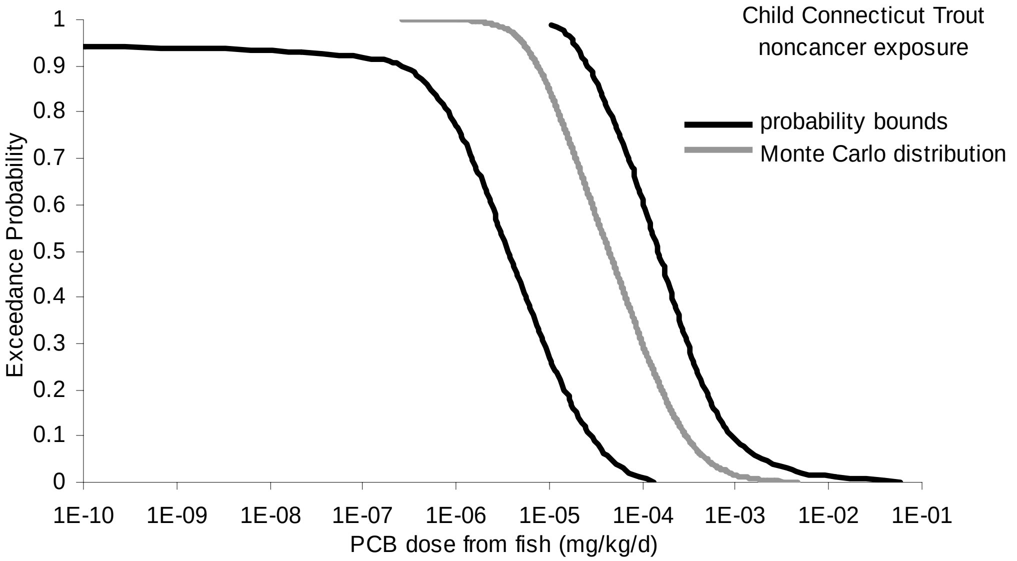
(Note: x-axis is log scaled.)

Figure 6-35 Child Noncancer Exposure to tPCBs from Fish Consumption at Rising Pond—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



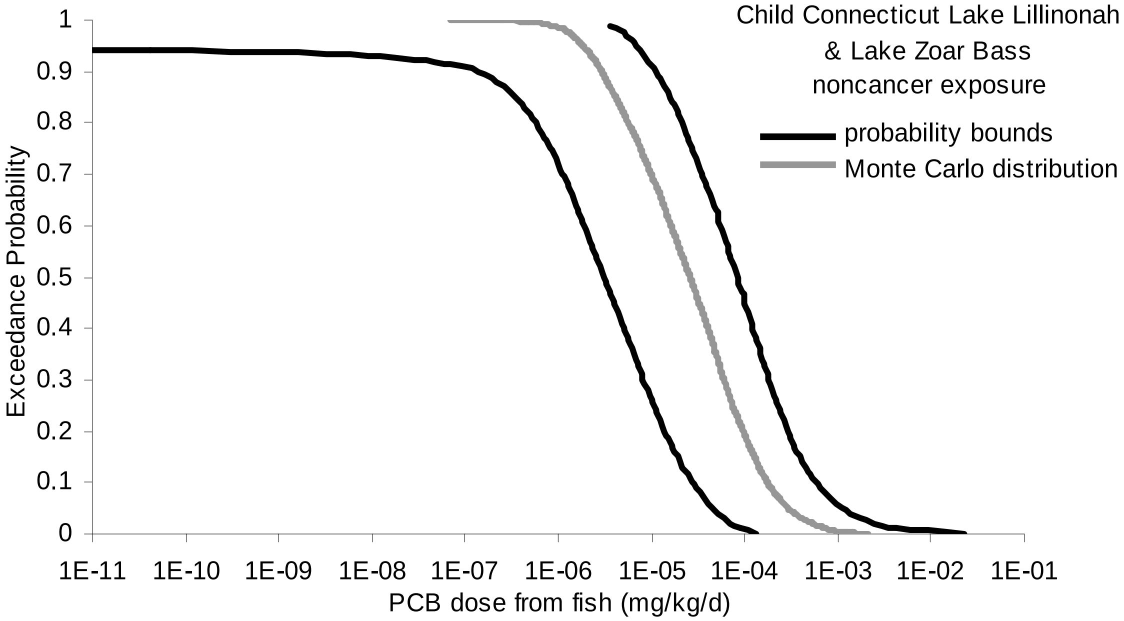
(Note: x-axis is log scaled.)

Figure 6-36 Child Noncancer Exposure to tPCBs from Bass Consumption at West Cornwall/Bulls Bridge—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-37 Child Noncancer Exposure to tPCBs from Trout Consumption at West Cornwall—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

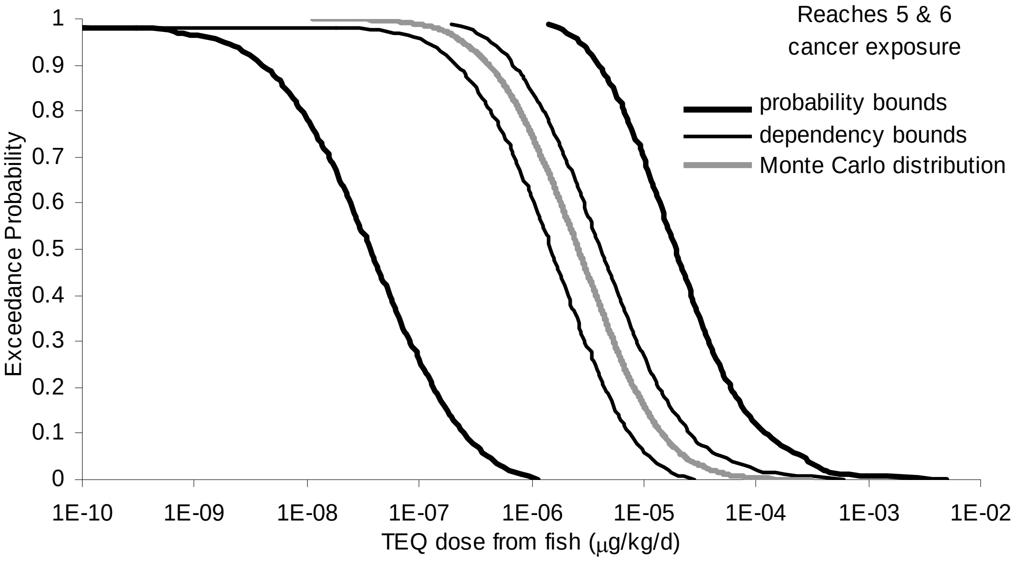


(Note: x-axis is log scaled.)

Figure 6-38 Child Noncancer Exposure to tPCBs from Bass Consumption at Lakes Lillinonah/Zoar—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

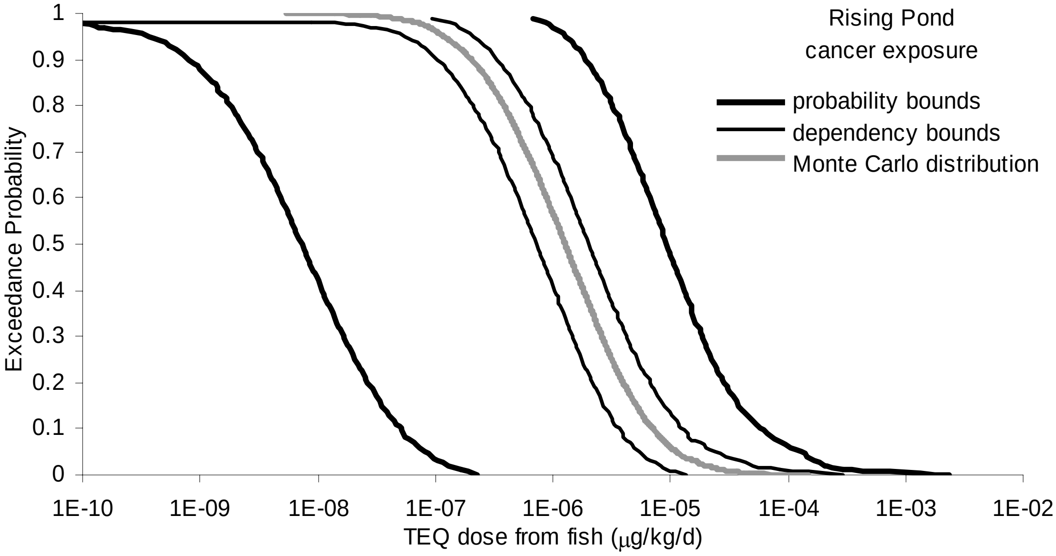
6.6.3 Second-Tier One-Dimensional Fish Exposure Model Results for TEQ

The analyses conducted in Section 6.6.2.1 for tPCBs were repeated using TEQ. Only the cancer exposure model was calculated for TEQ. Figure 6-39 and Figure 6-40 show cancer exposures for the PSA and Rising Pond, respectively. The figures show distributions for exposure calculated with the one-dimensional Monte Carlo simulation (gray line), the dependency bounds analysis (narrow black line), and the one-dimensional probability bounds analysis (thick black line).



(Note: x-axis is log scaled.)

Figure 6-39 Cancer Exposure to TEQ from Fish Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

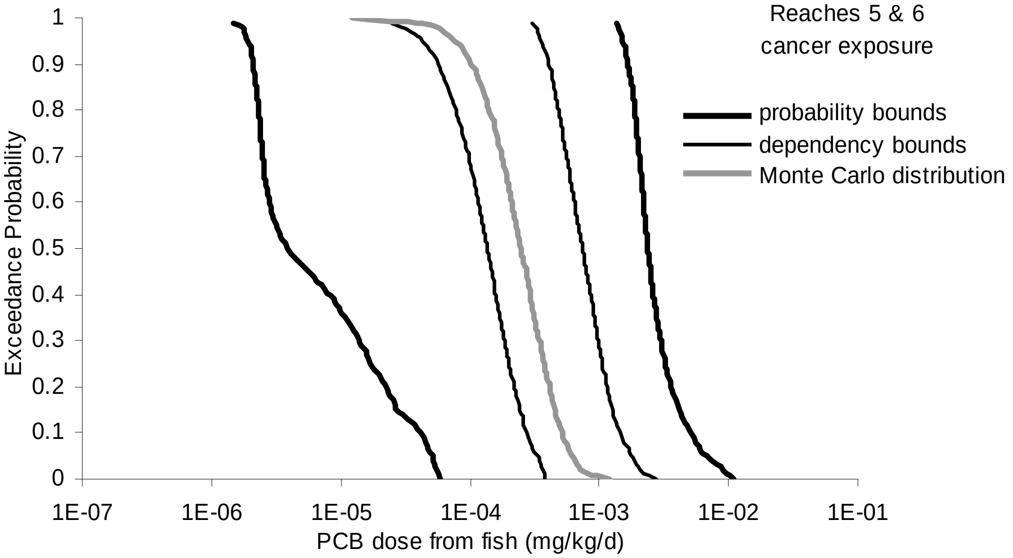
Figure 6-40 Cancer Exposure to TEQ from Fish Consumption at Rising Pond—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

6.6.4 Third-Tier MEE Fish Exposure Model Results for tPCBs

The results of the third-tier MEE exposure models for tPCBs are presented below.

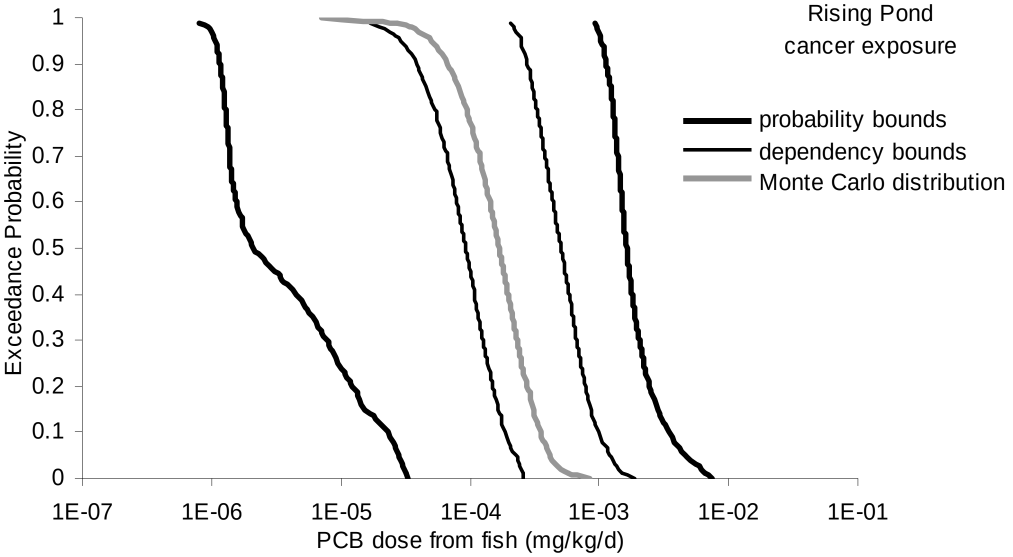
6.6.4.1 Cancer Models

The MEE cancer exposure model was calculated for tPCBs for each location. Figures 6-41 through 6-43 show cancer exposures for anglers (for fish other than trout) at the PSA and Rising Pond, and West Cornwall/Bulls Bridge, respectively. Figure 6-44 shows cancer exposure for trout anglers at West Cornwall, and Figure 6-45 shows cancer exposure for bass anglers at Lakes Lillinonah/Zoar. The figures show distributions for exposure calculated with the Monte Carlo simulation (gray line), the dependency bounds analysis (narrow black line), and the probability bounds analysis (thick black line). The MEE Monte Carlo simulation provides a single estimate of the exposure distribution. The dependency bounds are upper and lower bounds on the class of all exposure distributions that could result from relaxing the strict independence assumptions made by the Monte Carlo simulation. The MEE probability bounds analysis relaxes the dependency assumptions and allows for uncertainty around the precise magnitude and distributional form of the input distributions. The probability bounds are upper and lower bounds on the class of all exposure distributions that are consistent with the data used to derive the model inputs.



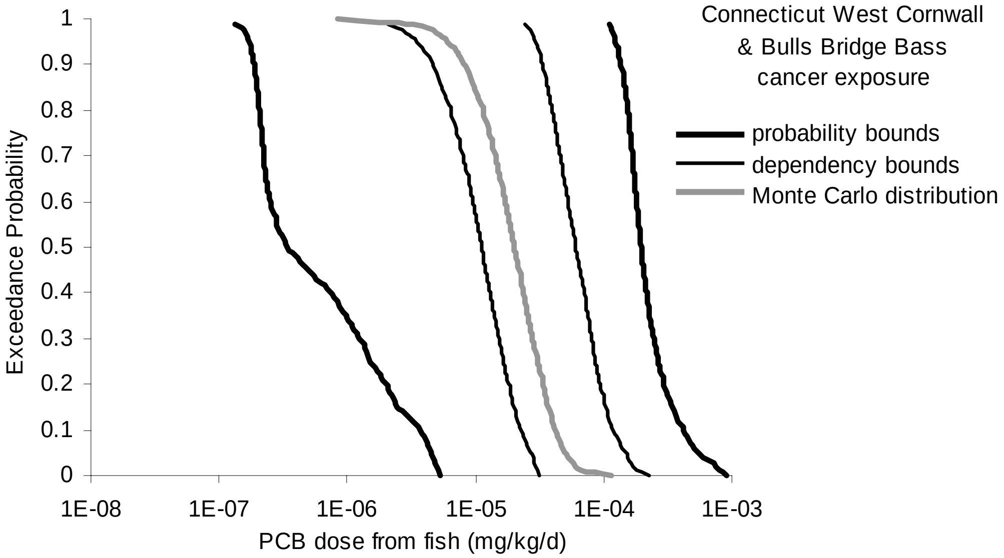
(Note: x-axis is log scaled.)

Figure 6-41 Cancer Exposure to tPCBs from Fish Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



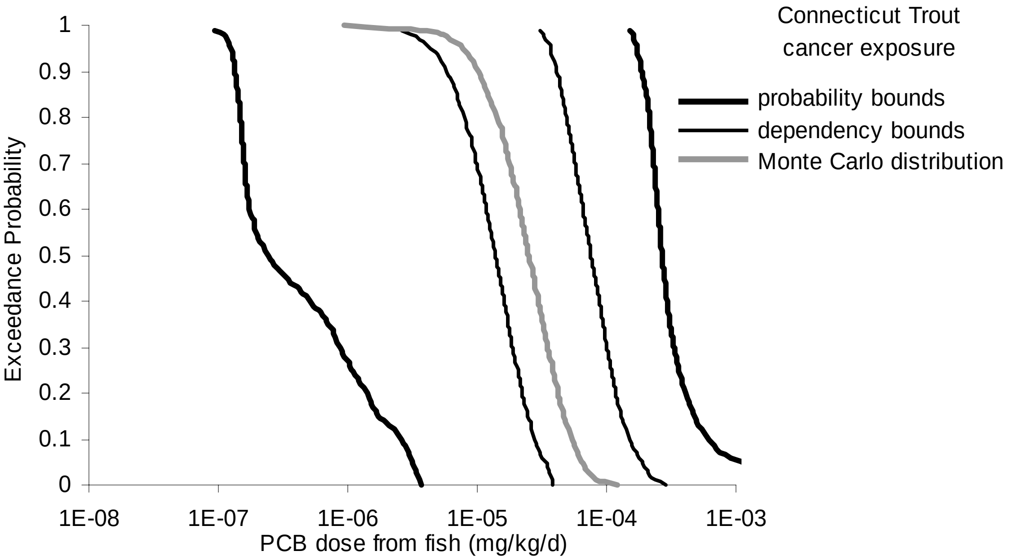
(Note: x-axis is log scaled.)

Figure 6-42 Cancer Exposure to tPCBs from Fish Consumption at Rising Pond—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



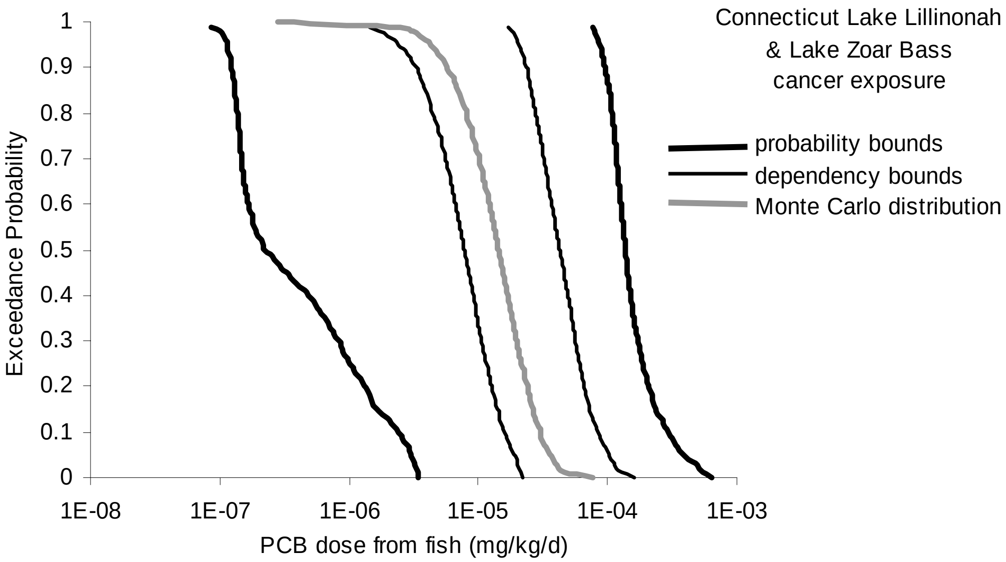
(Note: x-axis is log scaled.)

Figure 6-43 Cancer Exposure to tPCBs from Bass Consumption at West Cornwall/Bulls Bridge—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-44 Cancer Exposure to tPCBs from Trout Consumption at West Cornwall—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

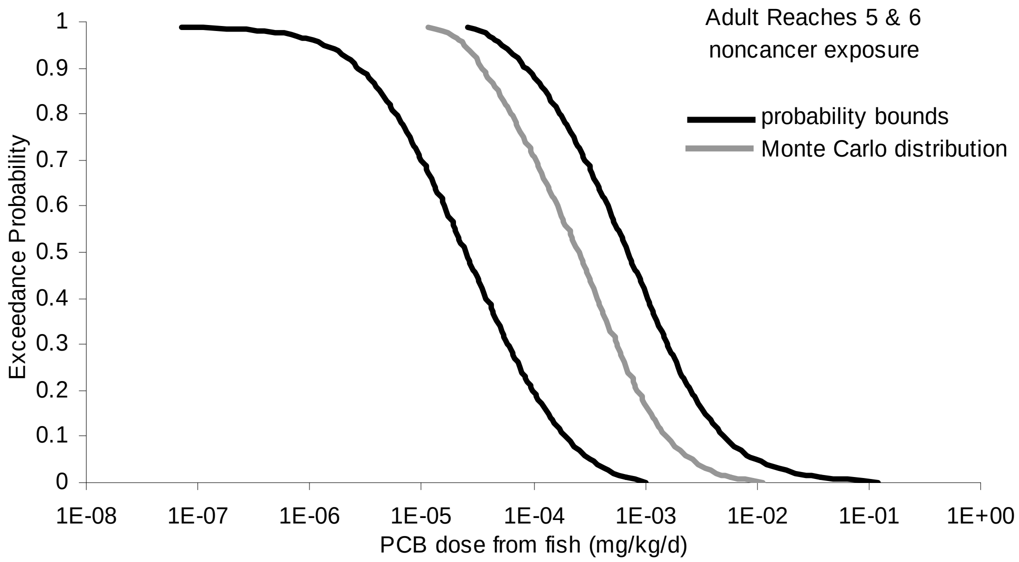


(Note: x-axis is log scaled.)

Figure 6-45 Cancer Exposure to tPCBs from Bass Consumption at Lakes Lillinonah/Zoar—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

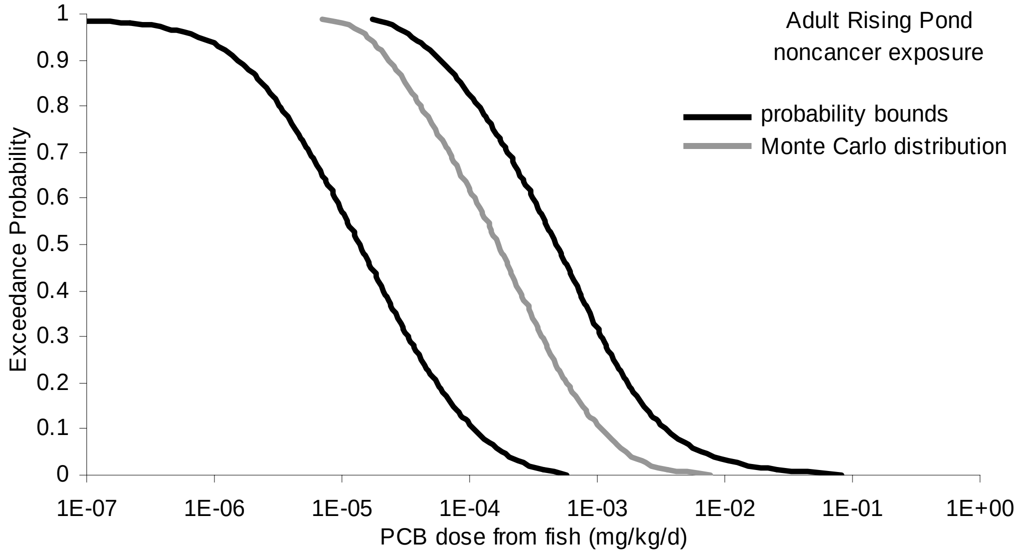
6.6.4.2 Noncancer Models

The MEE noncancer exposure models were calculated for tPCBs for each location. Adult and child receptors were calculated separately. Figures 6-46 through 6-50 show noncancer exposures at each of the four locations for adult anglers (other than trout), and at one location for adult trout anglers. Figures 6-51 through 6-55 show noncancer exposures for children. The figures show distributions for exposure calculated with the MEE Monte Carlo simulation (gray line) and the MEE probability bounds analysis (thick black line). No dependency bounds analysis was conducted for noncancer models because no effect of dependency structure is possible, except for that between body weight and exposure frequency. This latter dependency relationship was assumed independent (Table 6-1).



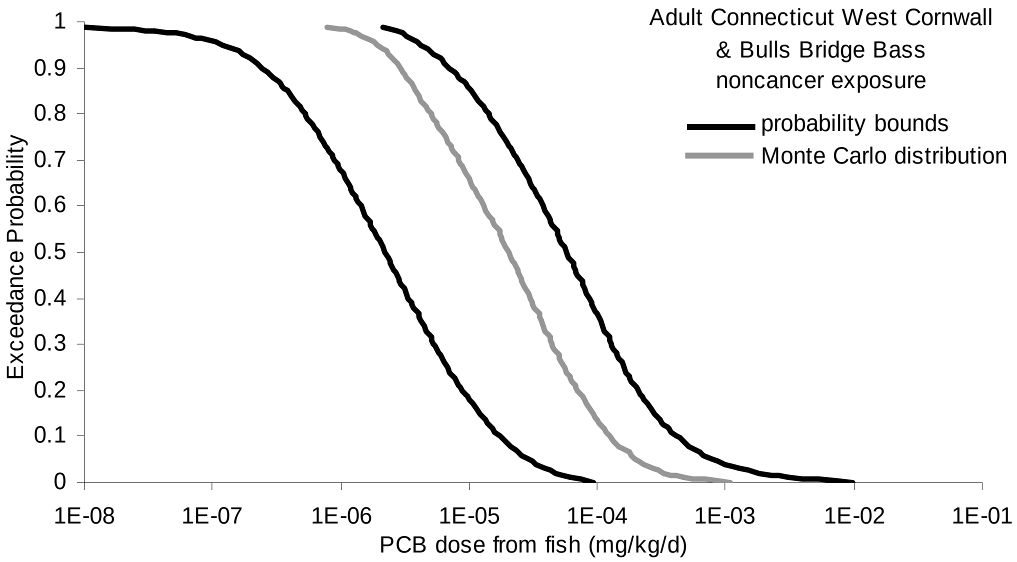
(Note: x-axis is log scaled.)

Figure 6-46 Adult Noncancer Exposure to tPCBs from Fish Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



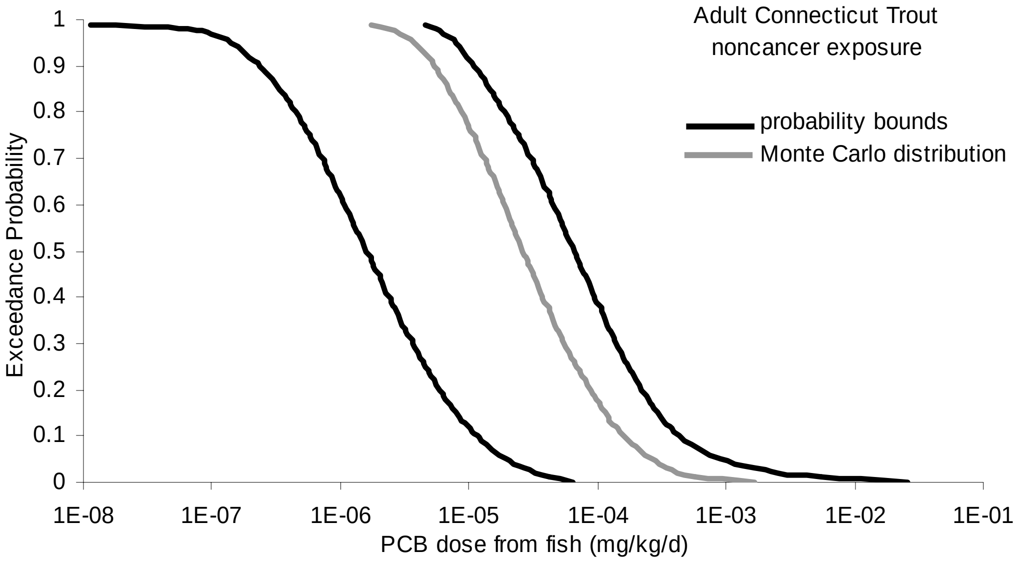
(Note: x-axis is log scaled.)

Figure 6-47 Adult Noncancer Exposure to tPCBs from Fish Consumption at Rising Pond—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



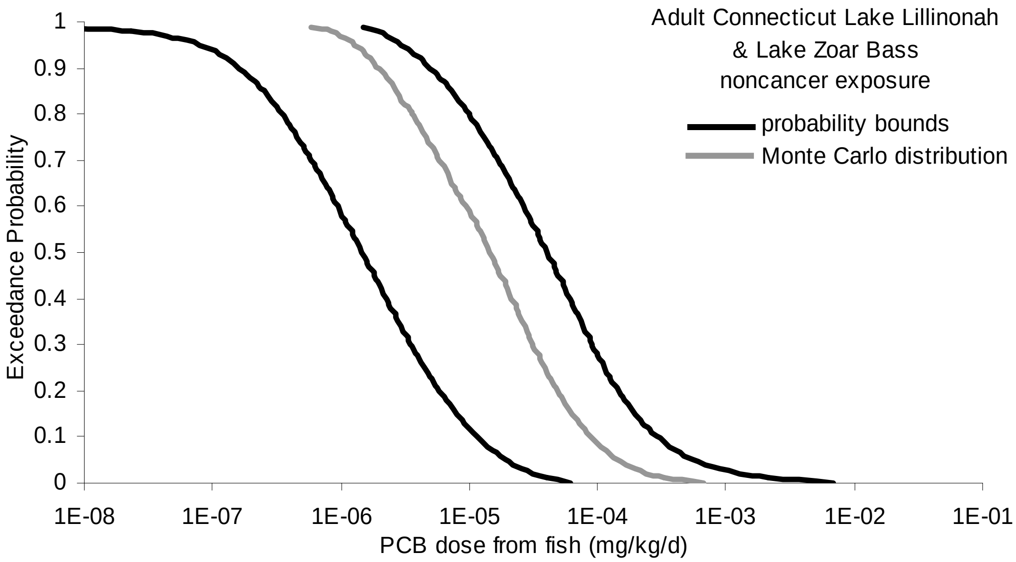
(Note: x-axis is log scaled.)

Figure 6-48 Adult Noncancer Exposure to tPCBs from Bass Consumption at West Cornwall/Bulls Bridge—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



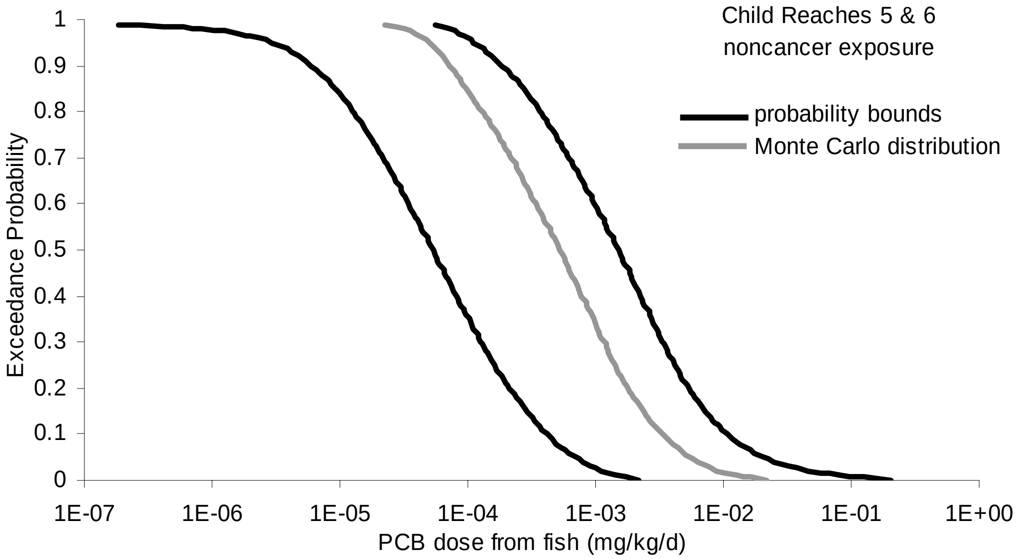
(Note: x-axis is log scaled.)

Figure 6-49 Adult Noncancer Exposure to tPCBs from Trout Consumption at West Cornwall/Bulls Bridge—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



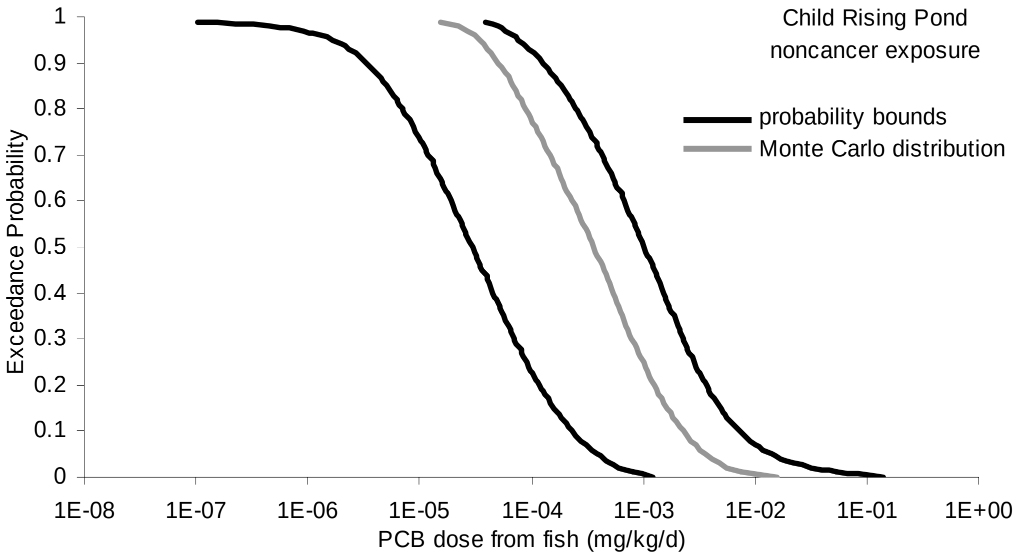
(Note: x-axis is log scaled.)

Figure 6-50 Adult Noncancer Exposure to tPCBs from Bass Consumption at Lakes Lillinonah/Zoar—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



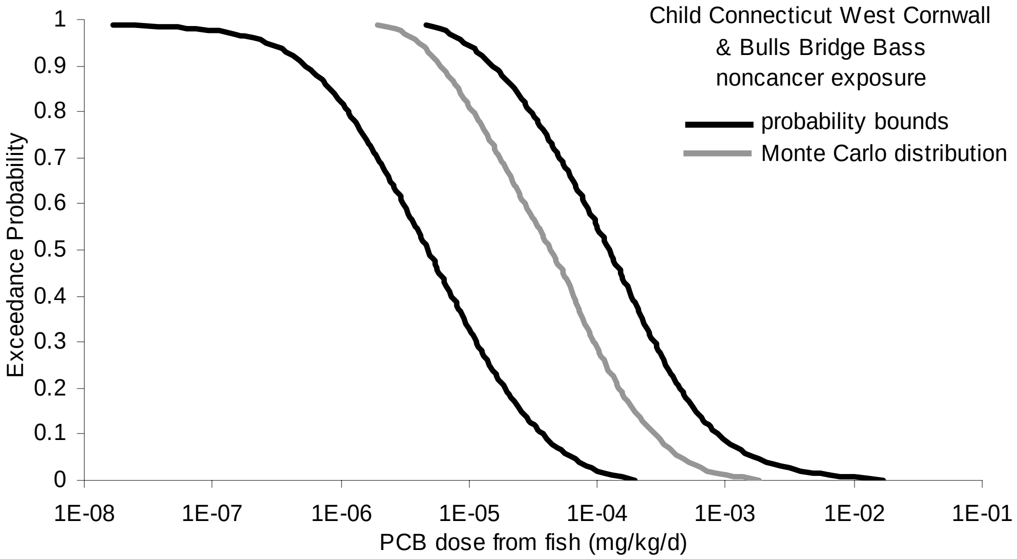
(Note: x-axis is log scaled.)

Figure 6-51 Child Noncancer Exposure to tPCBs from Fish Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



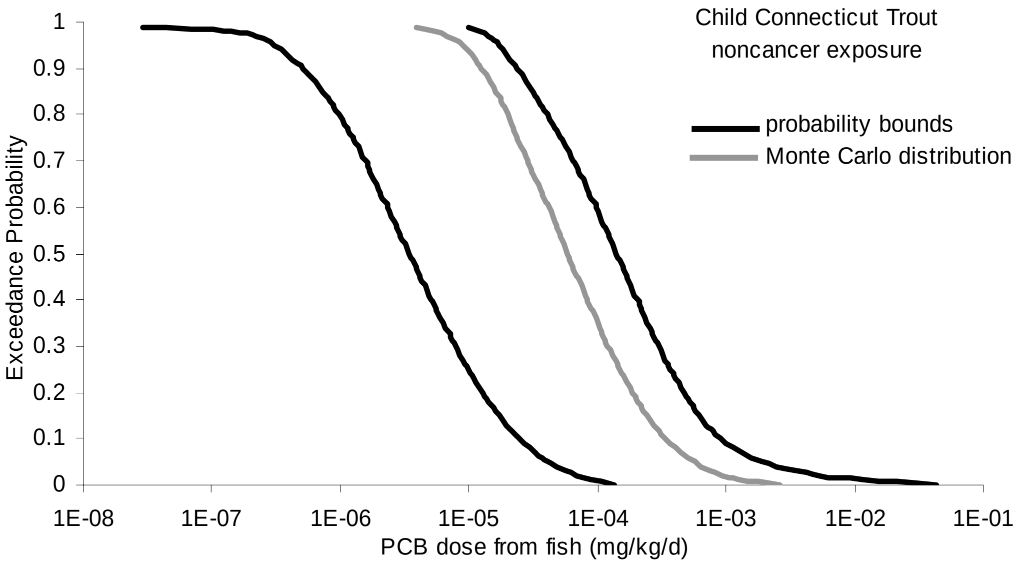
(Note: x-axis is log scaled.)

Figure 6-52 Child Noncancer Exposure to tPCBs from Fish Consumption at Rising Pond—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



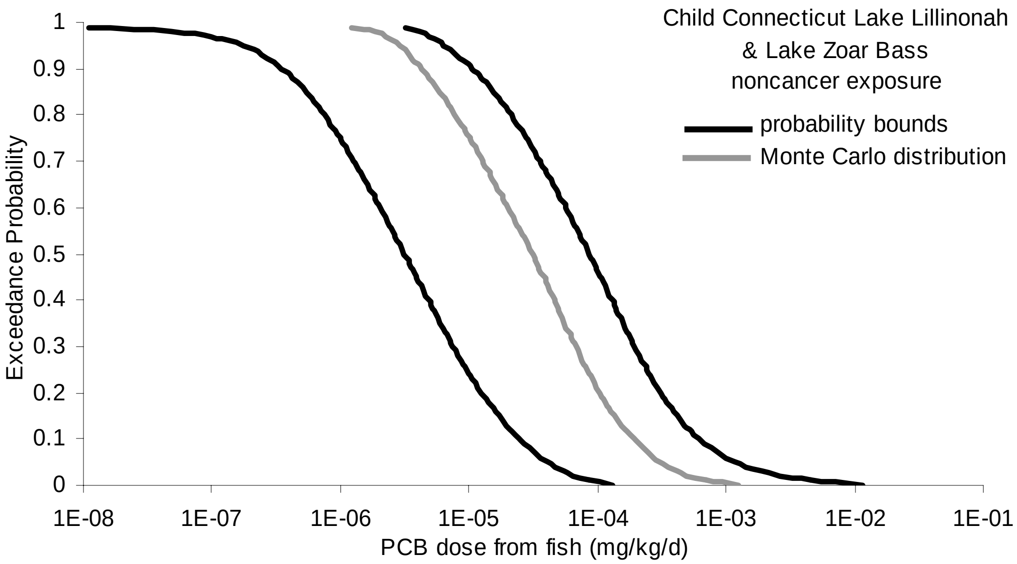
(Note: x-axis is log scaled.)

Figure 6-53 Child Noncancer Exposure to tPCBs from Bass Consumption at West Cornwall/Bulls Bridge—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-54 Child Noncancer Exposure to tPCBs from Trout Consumption at West Cornwall—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

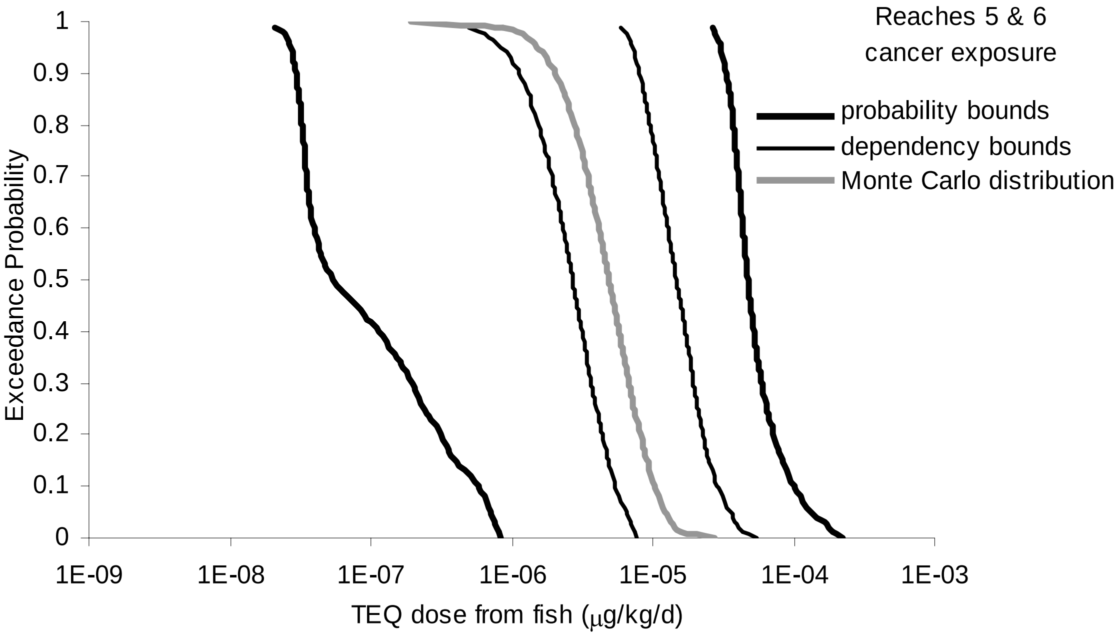


(Note: x-axis is log scaled.)

Figure 6-55 Child Noncancer Exposure to tPCBs from Bass Consumption at Lakes Lillinonah/Zoar—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

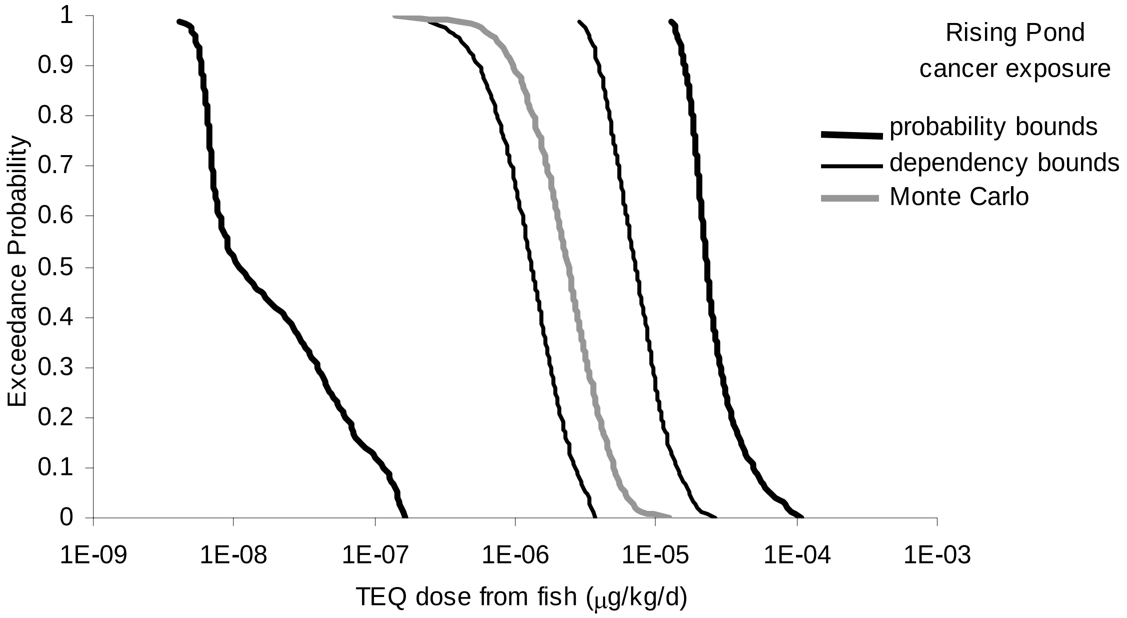
6.6.5 Third-Tier MEE Fish Exposure Model Results for TEQ

The analyses conducted in Section 6.6.4 for tPCBs were repeated using TEQ. The MEE cancer exposure model was calculated for TEQ for the two locations in Massachusetts for which TEQ data are available. Figure 6-56 and Figure 6-57 show MEE TEQ cancer exposures for the PSA and Rising Pond, respectively. The figures show distributions for exposure calculated with the MEE Monte Carlo simulation (gray line), the dependency analysis (narrow black line), and the probability bounds analysis (thick black line).



(Note: x-axis is log scaled.)

Figure 6-56 Cancer Exposure to TEQ from Fish Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-57 Cancer Exposure to TEQ from Fish Consumption at Rising Pond—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

6.7 EXPOSURE DUE TO WATERFOWL CONSUMPTION

6.7.1 Input Variables

Table 6-4 and Table 6-5 summarize the input variables used in the waterfowl exposure assessment. The subsections following discuss each input variable in more detail.

Table 6-4

Summary of All Inputs to the Monte Carlo Simulations of the Waterfowl Exposure Assessment

Variable	Symbol	Units	Min, Max	Central Estimate[a]	Standard Deviation	Distribution Type[b]
tPCB concentration	C_{duck}	mg/kg				
PSA	R56		-	9.73	-	Point estimate
TEQ concentration	QC_{duck}	µg/kg				
PSA			-	1.95	-	Point estimate
Cooking loss	LOSS	unitless				
PSA			-	0.0	-	Point estimate
Ingestion rate	IR	g/meal				
Adult			38, 675	188	113	Lognormal
Child			19, 338	94	57	Lognormal
Exposure frequency	EF	meals/yr				
PSA			1, 52	5.4	10.6	EDF
Exposure duration	ED	yr				
Adult			1, 64	29	20	Lognormal
Child			1, 6	3.5	1.4	Uniform
Body weight	BW	kg				
Adult			39, 119	72	15	Lognormal
Child			12, 23	17	2.3	Lognormal

[a] For point estimates, the central estimate is the point value used in the calculations. For concentrations, this value is the EPC. For EDFs and parametric distributions, the central estimate is the arithmetic mean. Some of the central estimate values differ slightly from the parameter values in the point estimate risk assessment (Sections 4 and 5). The difference is due to the use of slightly different datasets (ED for adult) or EPA point estimate default values (BW).

[b] EDF stands for empirical distribution function; lognormal and uniform are probability distributions and Point estimate is a single point value.

Table 6-5

Summary of All Inputs to the Probability Bounds Analyses for the Waterfowl Exposure Analysis

Variable	Symbol	Units	Min, Max	Central Estimate[a]	Standard Deviation	P-box Type[b]
tPCB concentration	C_{duck}	mg/kg				
PSA	R56		7.1, 9.73	[7.1, 9.73]	-	Interval
TEQ concentration	QC_{duck}	μg/kg				
PSA			0.99, 1.95	[0.99, 1.95]	-	Interval
Cooking loss	LOSS	unitless				
PSA			-	0.0	-	Point estimate
Ingestion rate	IR	g/meal				
Adult			1, 675	188	113	MMMS
Child			0.7, 338	94	57	MMMS
Exposure frequency	EF	meals/yr				
PSA			1, 52	5.4	10.6	MMMS
Exposure duration	ED	yr				
Adult			1, 64	[25, 32]	[18, 24]	MMMS
Child			1, 6	[1, 6]	-	Interval
Body weight	BW	kg				
Adult			39, 119	72	14.8	Lognormal
Child			12, 23	17	2.3	Lognormal

[a] For inputs that are points, the central estimate is used as the point value. For concentrations, this value is the EPC. For EDFs and most parametric distributions, the central estimate is the arithmetic mean. Some of the central estimate values differ slightly from the parameter values in the point estimate risk assessment (Sections 4 and 5). The difference is due to the use of slightly different datasets (ED for adult) or EPA point estimate default values (BW).

[b] Interval stands for an interval input; point estimate is a single precise value; MMMS is a distribution-free p-box formed using the minimum, maximum, mean, and standard deviation; and lognormal is a probability distribution (see text).

6.7.1.1 Concentration in Waterfowl: tPCBs and TEQ

The same procedures as described in Section 6.6.1.2 for fish were used to obtain the concentration inputs for waterfowl. EPCs were calculated for the first-tier point estimate approach analyses (Section 4.6.1, Table 4-37). These same EPC estimates were used as inputs to the second- and third-tier Monte Carlo analyses because EPA guidance (EPA, 2001, Appendix C; EPA, 1992) suggests accounting for sampling uncertainty by using the EPC in place of the sample mean in probabilistic risk analyses. The second- and third-tier probability bounds analyses used an interval with the sample mean and the EPC as left and right endpoints, respectively. Section 6.6.1.2 includes a discussion of the rationale behind using the EPC and the interval ranging from the mean to the EPC in the probabilistic analyses. Table 6-5 shows the probability bounds analysis concentration inputs.

6.7.1.2 Cooking Loss

Cooking loss for waterfowl was assumed to be zero percent (see discussion in Section 4.6.2.2).

6.7.1.3 Waterfowl Ingestion Rate

The ingestion rates for waterfowl were taken from the EPA *Exposure Factors Handbook* (1989, and 1997), which cites Pao et al. (1982). That study used 1977-1978 NFCS data for poultry. Children's ingestion rates were computed as one-half of that of adults as specified and explained in Section 4.6.2.3. For the probability bounds analyses, no rigorous minimum or maximum meal size data were available, so these values were set at a minimum of 1 gram per meal and a maximum of 675 grams per meal. The maximum represents the 99.95th percentile of the lognormal distribution (mean = 188, standard deviation = 113), and was used to promote consistency between the two modeling approaches. Both the Monte Carlo input distribution and the p-box were divided by 0.68 to convert them to precooked weight as recommended in Pao et al. (1982). Figure 6-58 shows adult ingestion rate distributions, and Figure 6-59 shows the distributions used for children.

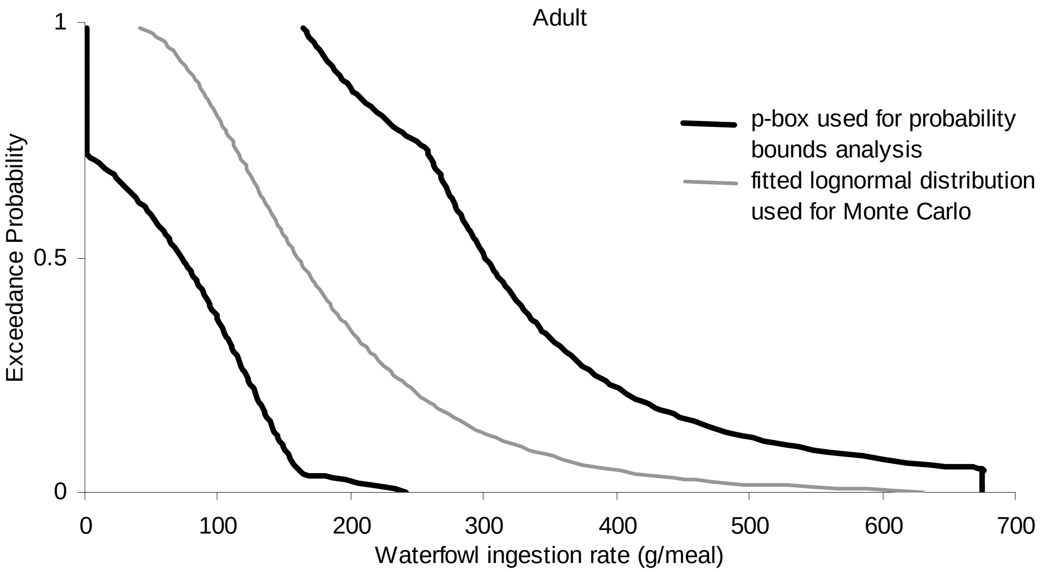


Figure 6-58 Adult Waterfowl Ingestion Rate Input Distribution for the Monte Carlo Simulations and Input P-Box for the Probability Bounds Analysis

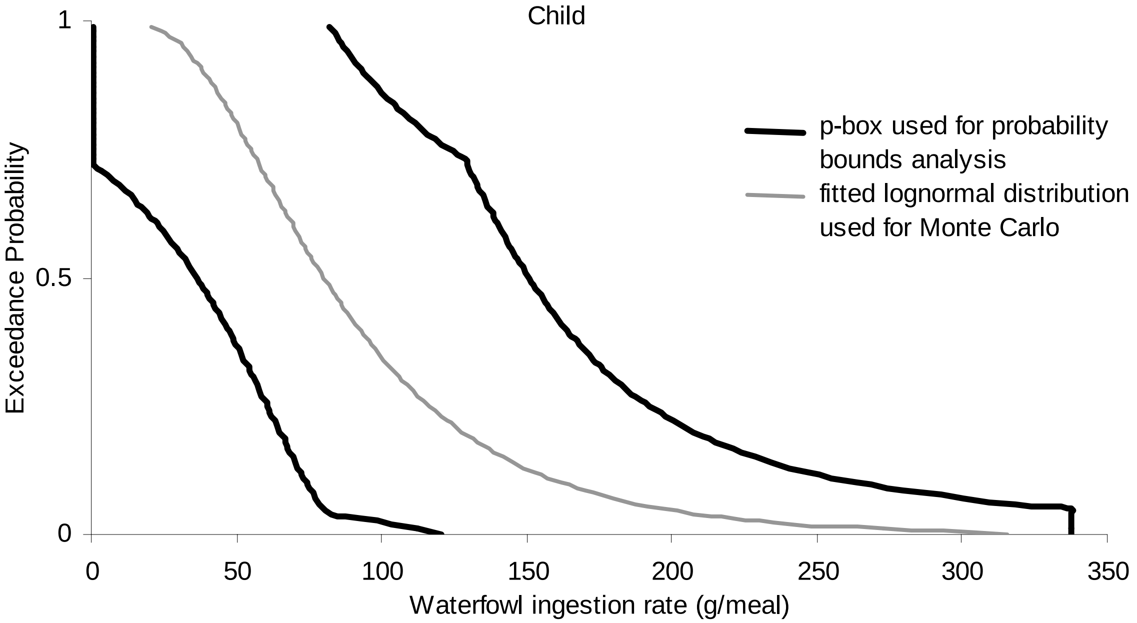


Figure 6-59 Child Waterfowl Ingestion Rate Input Distribution for the Monte Carlo Simulations and Input P-Box for the Probability Bounds Analysis

6.7.1.4 Exposure Frequency

Exposure frequency data were derived from MDPH (2001). The data and summary statistics from that study were used to form the input distributions depicted in Figure 6-60 and for adults and children. For the Monte Carlo exposure frequency input, an empirical distribution function (EDF) specified by the 23 data points from the study (1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 3, 3, 3, 4, 5, 6, 6, 6, 10, 12, 52 meals per year) was used. For the probability bounds analysis, a distribution-free p-box was formed using the minimum, mean, and standard deviation from the study. Children's exposure frequency data were not available separately and were assumed to be identical to data for adults.

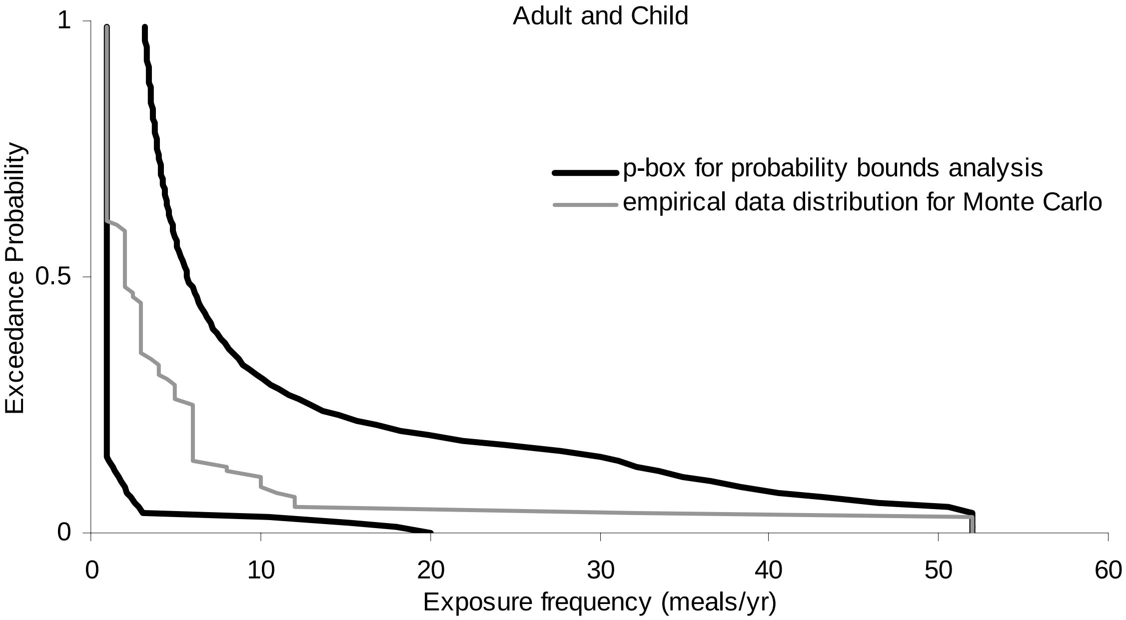


Figure 6-60 Waterfowl Exposure Frequency Input Probability Distribution Used in the Monte Carlo Exposure Analyses and P-Box Used in the Probability Bounds Analyses

6.7.1.5 Exposure Duration

The exposure duration input variable was used only in the cancer exposure model calculations. Exposure duration distributions and p-boxes used for the waterfowl exposure assessment were identical to those used in the fish exposure assessment (see Section 6.6.1.8).

6.7.1.6 Body Weight

The body weight input distributions to the Monte Carlo simulations and probability bounds analyses of the waterfowl exposure assessment model were identical to those used in the fish exposure assessment (see Section 6.6.1.9).

6.7.1.7 Averaging Time

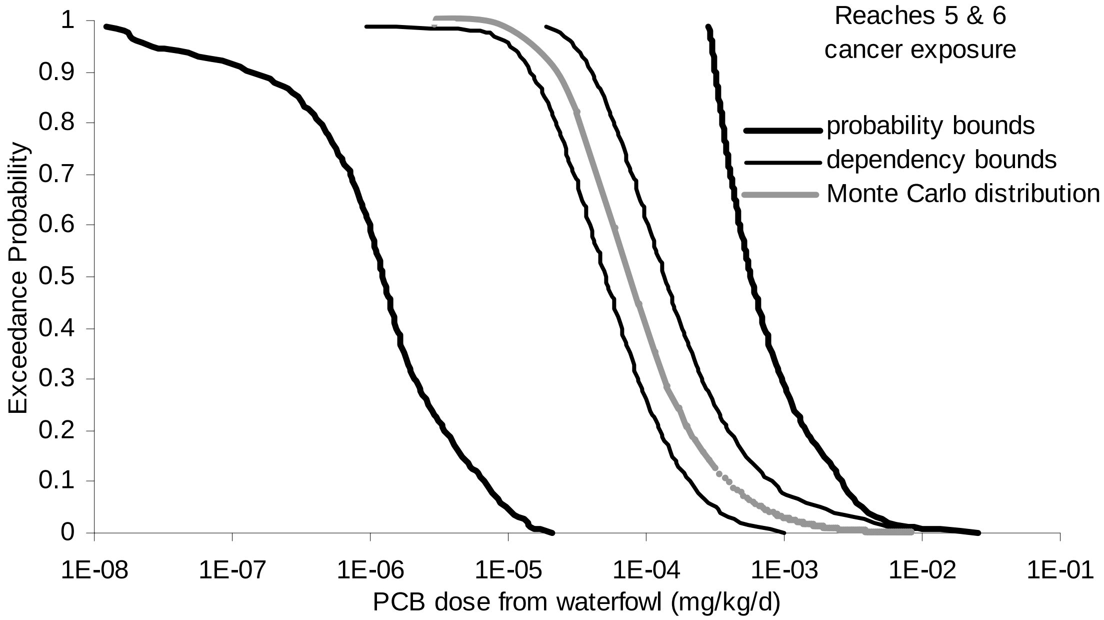
The averaging time variable was used only in the cancer model calculations. Averaging time was set at 70 years (25,550 d) as was done in the fish exposure assessment (see Section 6.6.1.10).

6.7.2 Second Tier One-Dimensional Waterfowl Exposure Model Results for tPCBs

The sections below show the results of the one-dimensional waterfowl exposure models for tPCBs and TEQ.

6.7.2.1 Cancer Models

The one-dimensional waterfowl cancer exposure model was calculated for tPCBs for the PSA, which was the only location for which data were available. Adult and child receptors are combined in the model. Figure 6-61 shows cancer exposures for the PSA. The figure shows distributions for exposure calculated with the Monte Carlo simulation (gray line), the dependency bounds analysis (narrow black line), and the probability bounds analysis (thick black line).

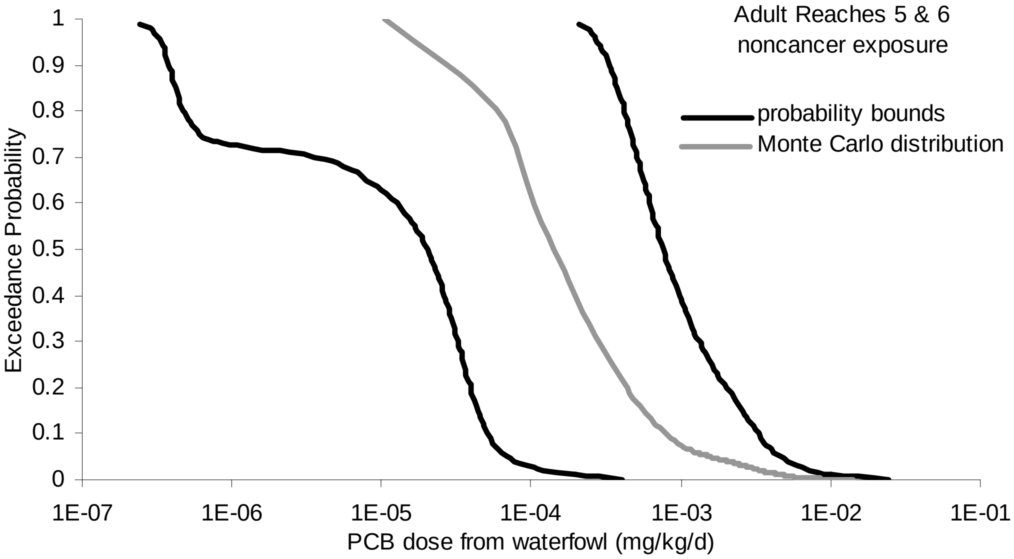


(Note: x-axis is log scaled.)

Figure 6-61 Cancer Exposure to tPCBs from Waterfowl Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

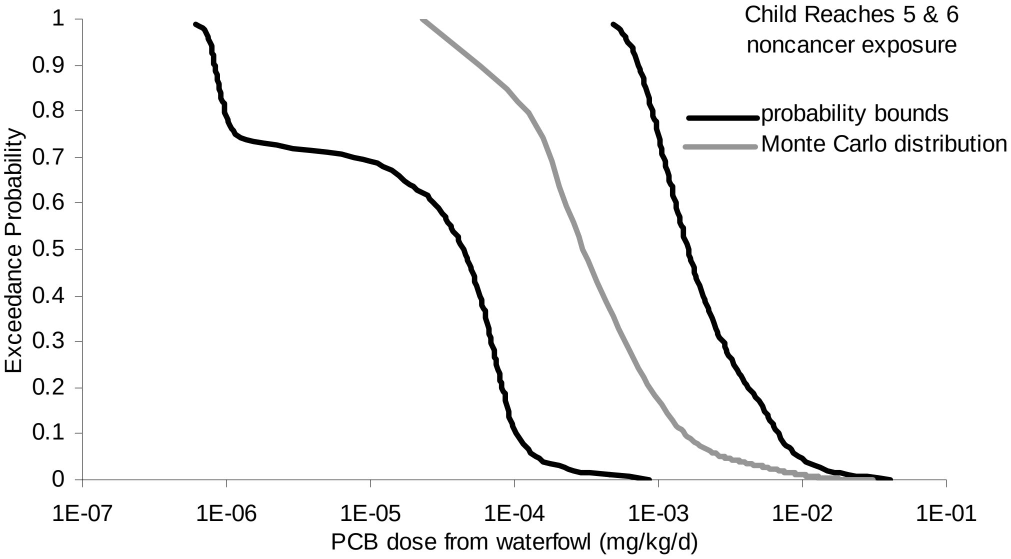
6.7.2.2 Noncancer Models

The noncancer exposure model was calculated for tPCBs. Adult and child receptors were calculated separately. Figure 6-62 and Figure 6-63 show noncancer exposures for adults and children, respectively, at the PSA. The figures show distributions for exposure calculated with the Monte Carlo simulation (gray line) and the probability bounds analysis (thick black line).



(Note: x-axis is log scaled.)

Figure 6-62 Adult Noncancer Exposure to tPCBs from Waterfowl Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

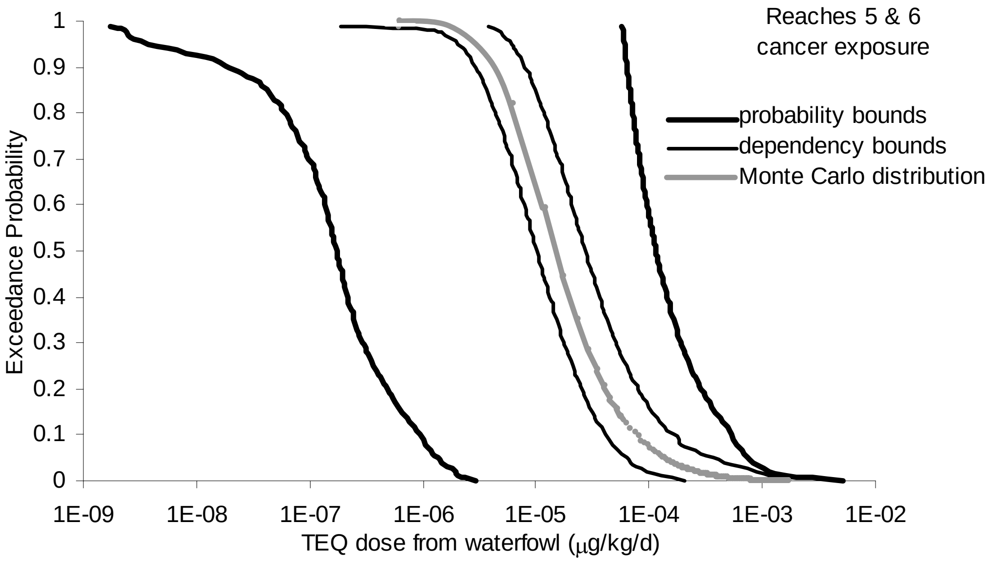


(Note: x-axis is log scaled.)

Figure 6-63 Child Noncancer Exposure to tPCBs from Waterfowl Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

6.7.3 Second-Tier One-Dimensional Waterfowl Cancer Exposure Model Results for TEQ

The waterfowl cancer exposure model was calculated for TEQ for one location: the PSA. Adult and child receptors are combined in the model. Figure 6-64 shows cancer exposure for the PSA. The figure shows distributions for exposure calculated with the Monte Carlo simulation (gray line), the dependency analysis (narrow black line), and the probability bounds analysis (thick black line).



(Note: x-axis is log scaled.)

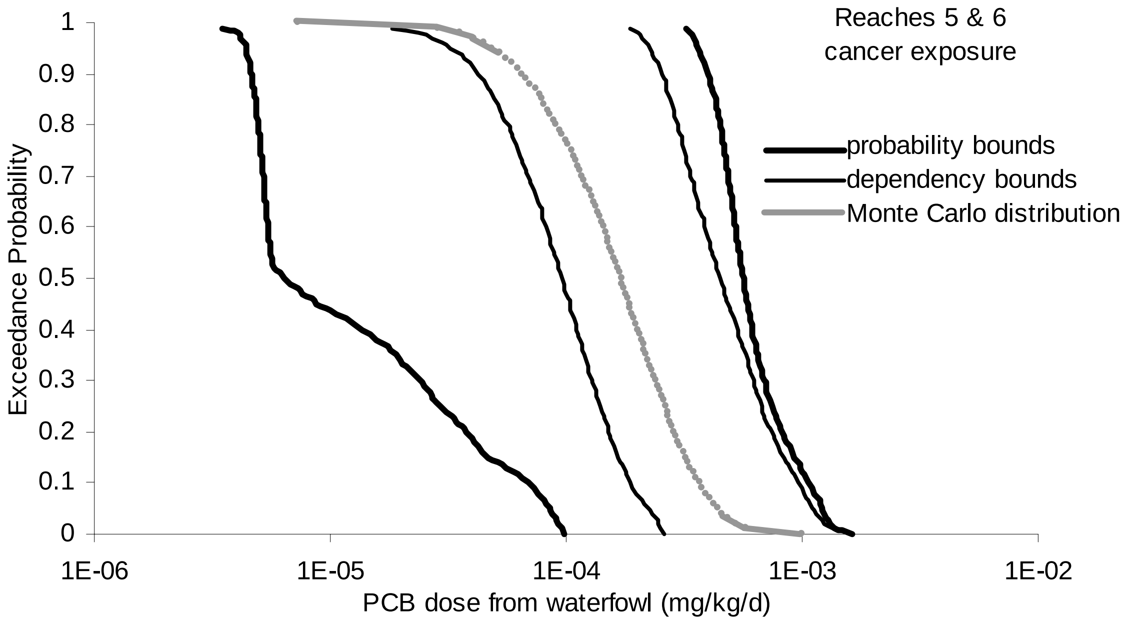
Figure 6-64 Cancer Exposure to TEQ from Waterfowl Consumption at the PSA—Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

6.7.4 Third-Tier MEE Waterfowl Exposure Model Results for tPCBs and TEQ

This section presents the results of the MEE waterfowl exposure models for tPCBs and TEQ.

6.7.4.1 Cancer Model for tPCBs

The MEE waterfowl cancer exposure model was calculated for tPCBs for the PSA. Adult and child receptors are combined in the model. Figure 6-65 shows cancer exposures for the PSA. The figure shows distributions for exposure calculated with the Monte Carlo simulation (gray line), the dependency analysis (narrow black line) and the probability bounds analysis (thick black line).

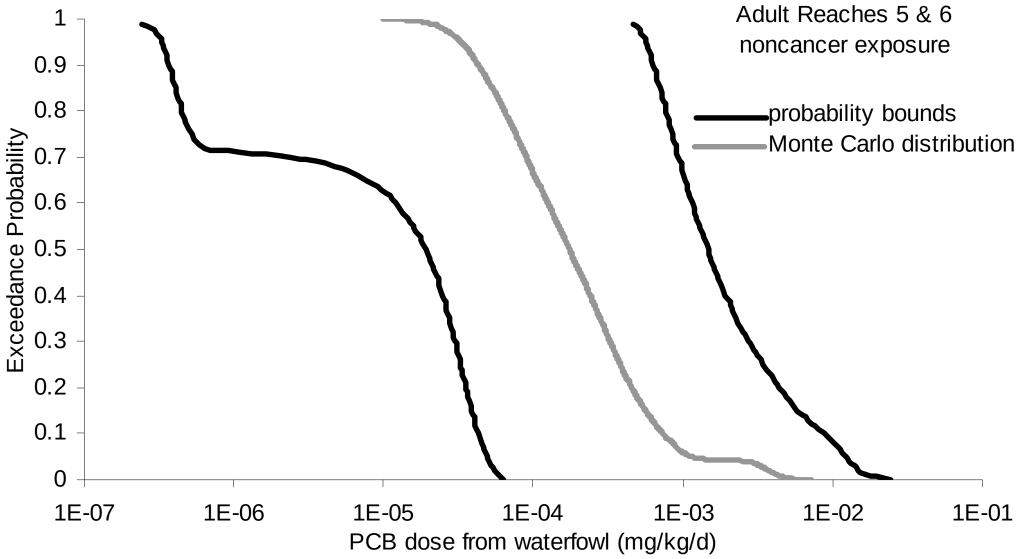


(Note: x-axis is log scaled.)

Figure 6-65 Cancer Exposure to tPCBs from Waterfowl Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

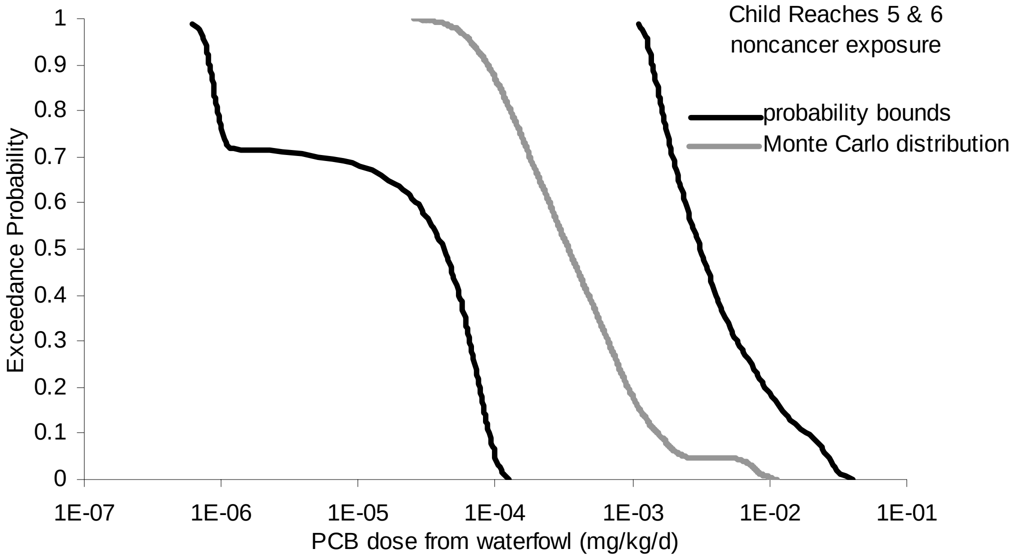
6.7.4.2 Noncancer Models for tPCBs

The MEE noncancer exposure model was calculated for tPCBs. Adult and child receptors were calculated separately. Figure 6-66 and Figure 6-67 show noncancer exposures for adults and children, respectively, at the PSA. The figures show distributions for exposure calculated with the Monte Carlo simulation (gray line) and the probability bounds analysis (thick black line).



(Note: x-axis is log scaled.)

Figure 6-66 Adult Noncancer Exposure to tPCBs from Waterfowl Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

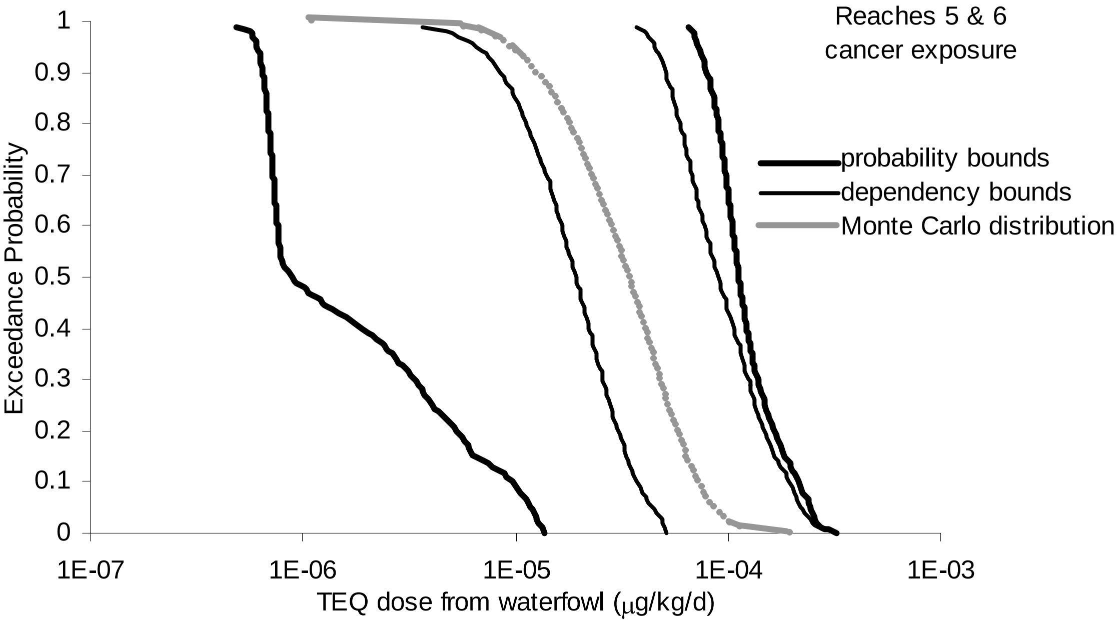


(Note: x-axis is log scaled.)

Figure 6-67 Child Noncancer Exposure to tPCBs from Waterfowl Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

6.7.4.3 Cancer Model for TEQ

The waterfowl MEE cancer exposure model was calculated for TEQ at the PSA. Adult and child receptors are combined in the model. Figure 6-68 shows cancer exposure. The figure shows a distribution for exposure calculated with the Monte Carlo simulation (gray line), the dependency analysis (narrow black line), and the probability bounds analysis (thick black line).



(Note: x-axis is log scaled.)

Figure 6-68 Cancer Exposure to TEQ from Waterfowl Consumption at the PSA—Results of the MEE Monte Carlo Simulation and Probability Bounds Analysis

6.8 RISK CHARACTERIZATION

This section presents the risk characterization based upon the exposure analysis. Results are summarized in tabular format (Tables 6-6 through 6-13), and details of each risk distribution at each location for each model and exposure pathway are presented in figures. The RME, or highest exposure reasonably likely to occur (EPA, 1989), is generally between the 90th and 99.9th percentile of the probabilistic risk distribution. Three percentiles (90th, 95th, and 99th) are presented in Tables 6-6 through 6-13.

6.8.1 Cancer Risk from Fish Ingestion Calculated with One-Dimensional Models

Cancer risks were calculated for the Monte Carlo analyses by multiplying exposure distributions by the Cancer Slope Factor (CSF). The CSF used for tPCBs was 2 $(mg/kg\text{-}d)^{-1}$ (see Table 3-1). The TEQ CSF used was 1.5E-5 $(mg/kg\text{-}d)^{-1}$ (or 150 $(\mu g/kg\text{-}d)^{-1}$; see Section 3.2.3). As in the first-tier point estimate approach, the cancer risks that result from this calculation are unitless, and represent excess (over background) cancer risks over a 70-year lifetime.

Table 6-6 shows cancer risks by selected percentiles. Each cell of the table shows the results of the one-dimensional Monte Carlo analysis (MCA), dependency bounds analysis (DBA, in brackets), and probability bounds analysis (PBA, in brackets). For example, in the 95th percentile at the PSA, Monte Carlo analysis calculates a cancer risk of 2E-3, the dependency bounds analysis calculates that cancer risk resides in the interval [1E-3, 5E-3], and the probability bounds analysis calculates that cancer risk resides in the interval [6E-5, 3E-2]. The dependency bounds indicate the range of values that cancer risk could take given any of the possible dependencies between variables in the model allowed for in Table 6-1. The probability bounds indicate the range of values that cancer risk could take given both the dependencies allowed for by the dependency bounds analysis and the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions.

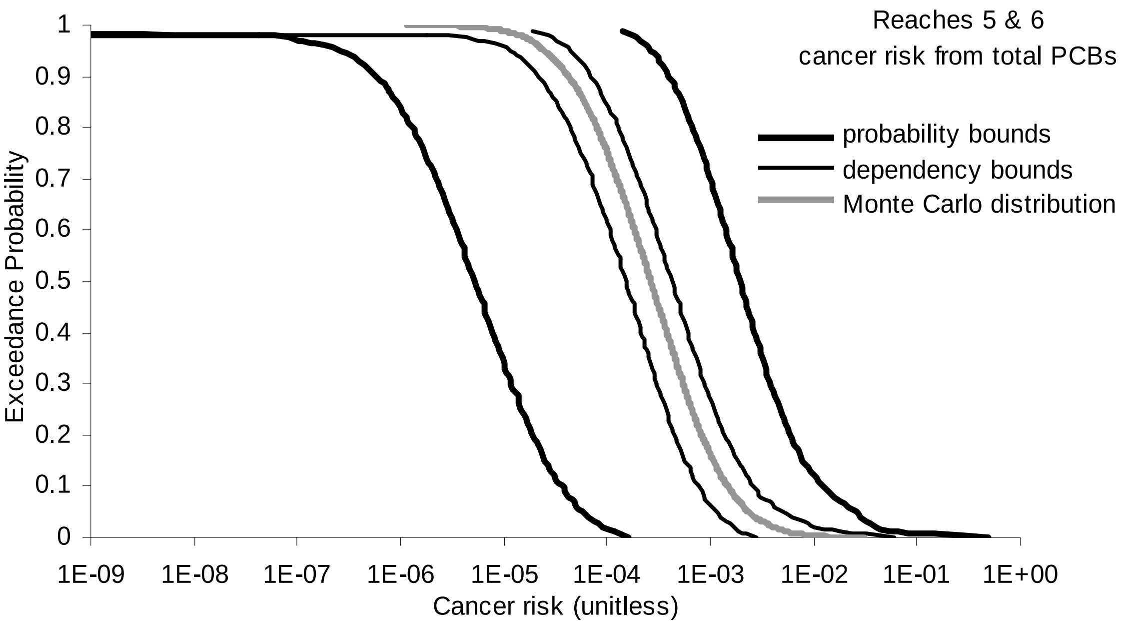
Cancer risk from fish ingestion is better displayed graphically because all percentiles can be shown. Figures 6-69 through 6-73 show the cancer risks from tPCBs in cumulative exceedance form for non-trout (bass) anglers at the four locations, and for trout anglers at one location. Figure 6-74 and Figure 6-75 show the cancer risks from TEQ for the PSA and Rising Pond, respectively. Because exceedance probabilities are presented as a complementary cumulative plot, the risk percentiles greater than or equal to the 90th are found by following a horizontal line from 0.1 on the y-axis to the Monte Carlo risk distribution or probability bounds line and reading the corresponding risk on the x-axis (see Section 6.6.1.3 for an additional explanation of the interpretation of exceedance probabilities.) In Figure 6-69, for example, the probability bounds around the risk at the 90th percentile (0.1 on the y-axis) range from about 4E-5 to 1E-2. This means that 10% percent of the population is exposed to risks between 4E-5 and 1E-2. Section 8 and Figure 8-1 and accompanying text provide more detailed discussion of interpreting the exposure and risk figures.

Table 6-6

Cancer Risk Results of the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Risk Analysis for Fish Ingestion Exposure

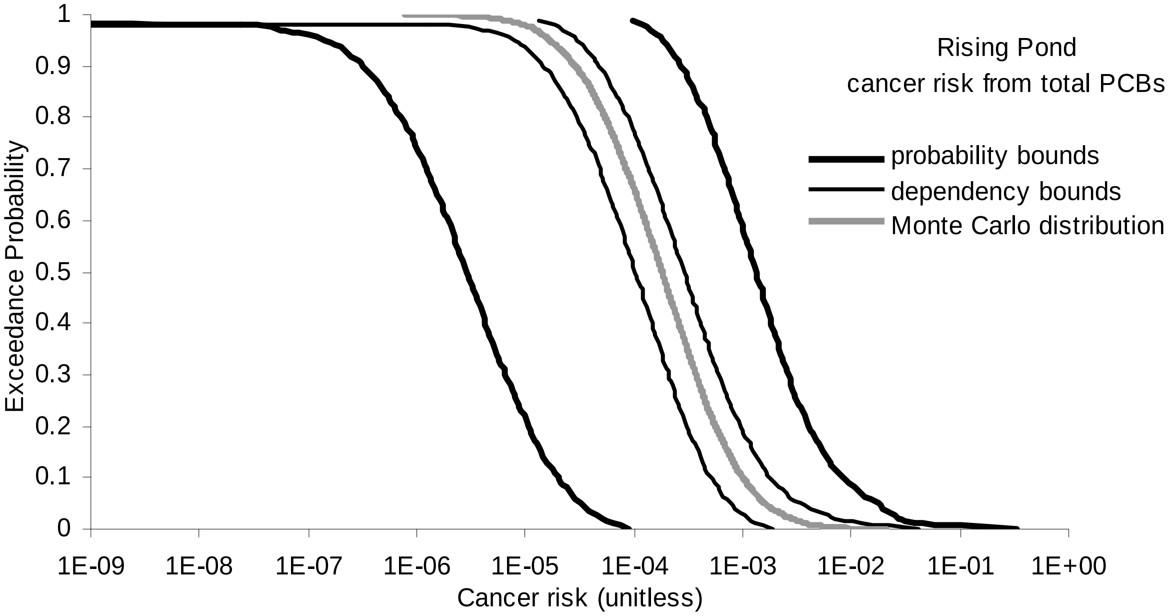
PCB measure	Site	Analysis	Cancer risk percentiles					
						RME range		
			25%	50%	75%	90%	95%	99%
Total	Reaches 5 & 6	MCA	1E-4	3E-4	7E-4	1E-3	2E-3	6E-3
		DBA	[6E-5, 2E-4]	[2E-4, 4E-4]	[4E-4, 1E-3]	[8E-4, 3E-3]	[1E-3, 5E-3]	[2E-3, 2E-2]
		PBA	[2E-6, 8E-4]	[5E-6, 2E-3]	[1E-5, 5E-3]	[4E-5, 1E-2]	[6E-5, 3E-2]	[1E-4, 6E-2]
	Rising Pond	MCA	7E-5	2E-4	4E-4	1E-3	2E-3	4E-3
		DBA	[4E-5, 1E-4]	[1E-4, 3E-4]	[3E-4, 7E-4]	[5E-4, 2E-3]	[8E-4, 3E-3]	[1E-3, 1E-2]
		PBA	[1E-6, 6E-4]	[3E-6, 1E-3]	[8E-6, 3E-3]	[2E-5, 8E-3]	[3E-5, 2E-2]	[6E-5, 4E-2]
	West Cornwall/ Bulls Bridge Bass	MCA	8E-6	2E-5	5E-5	1E-4	2E-4	5E-4
		DBA	[5E-6, 1E-5]	[1E-5, 3E-5]	[3E-5, 9E-5]	[7E-5, 2E-4]	[9E-5, 4E-4]	[2E-4, 1E-3]
		PBA	[2E-7, 7E-5]	[5E-7, 2E-4]	[1E-6, 4E-4]	[3E-6, 1E-3]	[5E-6, 2E-3]	[1E-5, 5E-3]
	West Cornwall Trout	MCA	1E-5	3E-5	6E-5	1E-4	2E-4	6E-4
		DBA	[6E-6, 2E-5]	[1E-5, 4E-5]	[4E-5, 1E-4]	[7E-5, 3E-4]	[1E-4, 5E-4]	[2E-4, 2E-3]
		PBA	[1E-7, 9E-5]	[3E-7, 2E-4]	[9E-7, 4E-4]	[2E-6, 1E-3]	[4E-6, 3E-3]	[7E-6, 1E-2]
	Lake Lillinonah & Lake Zoar Bass	MCA	6E-6	2E-5	4E-5	8E-5	1E-4	3E-4
		DBA	[3E-6, 9E-6]	[8E-6, 2E-5]	[2E-5, 6E-5]	[4E-5, 1E-4]	[6E-5, 3E-4]	[9E-5, 1E-3]
		PBA	[1E-7, 5E-5]	[3E-7, 1E-4]	[9E-7, 3E-4]	[2E-6, 7E-4]	[3E-6, 1E-3]	[7E-6, 3E-3]
TEQ	Reaches 5 & 6	MCA	2E-4	4E-4	1E-3	2E-3	3E-3	9E-3
		DBA	[8E-5, 2E-4]	[2E-4, 6E-4]	[5E-4, 2E-3]	[1E-3, 4E-3]	[2E-3, 7E-3]	[3E-3, 3E-2]
		PBA	[2E-6, 1E-3]	[5E-6, 3E-3]	[2E-5, 7E-3]	[4E-5, 2E-2]	[6E-5, 4E-2]	[1E-4, 9E-2]
	Rising Pond	MCA	7E-5	2E-4	5E-4	1E-3	2E-3	4E-3
		DBA	[4E-5, 1E-4]	[1E-4, 3E-4]	[3E-4, 8E-4]	[5E-4, 2E-3]	[8E-4, 4E-3]	[1E-3, 1E-2]
		PBA	[4E-7, 6E-4]	[1E-6, 1E-3]	[3E-6, 3E-3]	[8E-6, 9E-3]	[1E-5, 2E-2]	[2E-5, 4E-2]

“MCA” = Monte Carlo analysis, “DBA” = dependency bounds analysis, and “PBA” = probability bounds analysis. Values in square brackets are intervals.



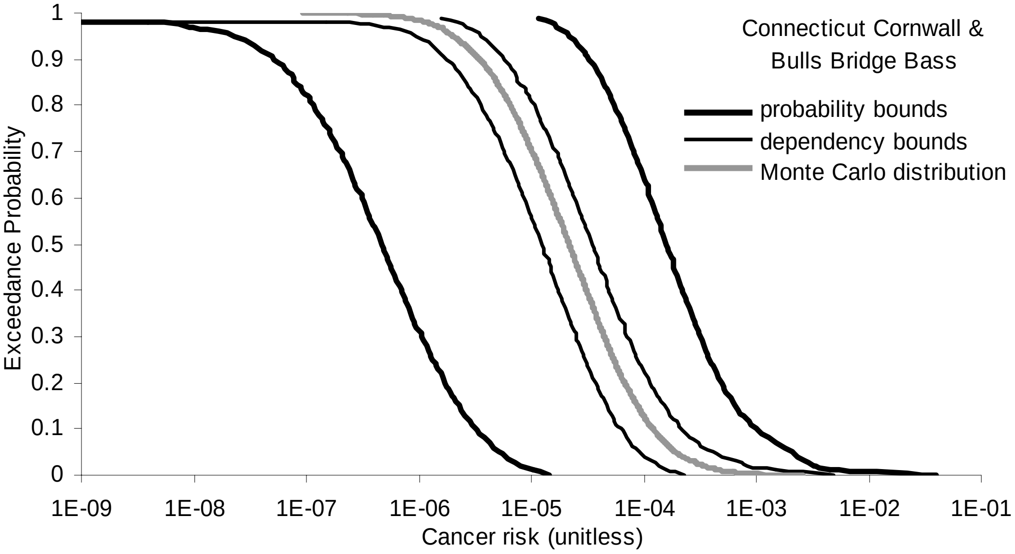
(Note: x-axis is log scaled.)

Figure 6-69 Total PCB Cancer Risk for Fish Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



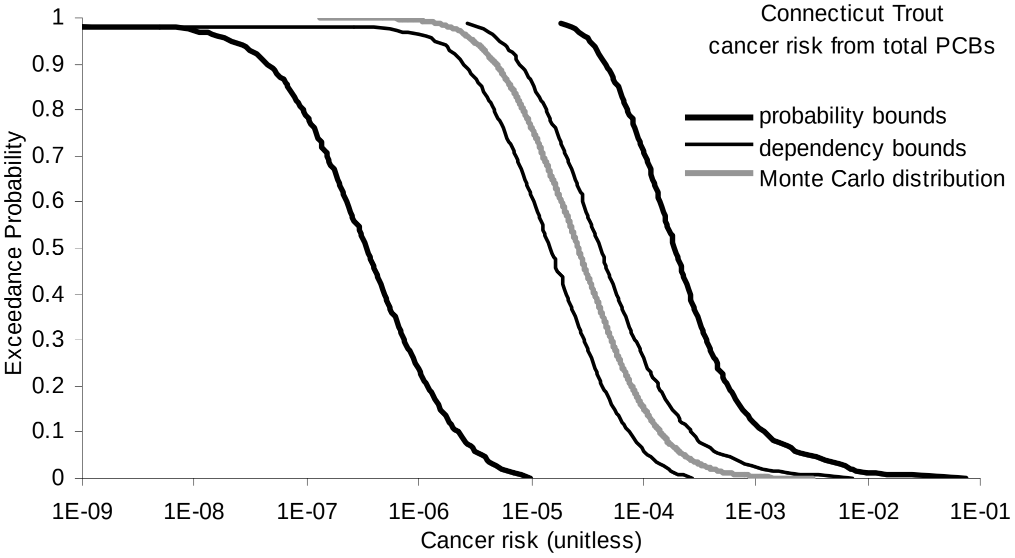
(Note: x-axis is log scaled.)

Figure 6-70 Total PCB Cancer Risk for Fish Ingestion at Rising Pond—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



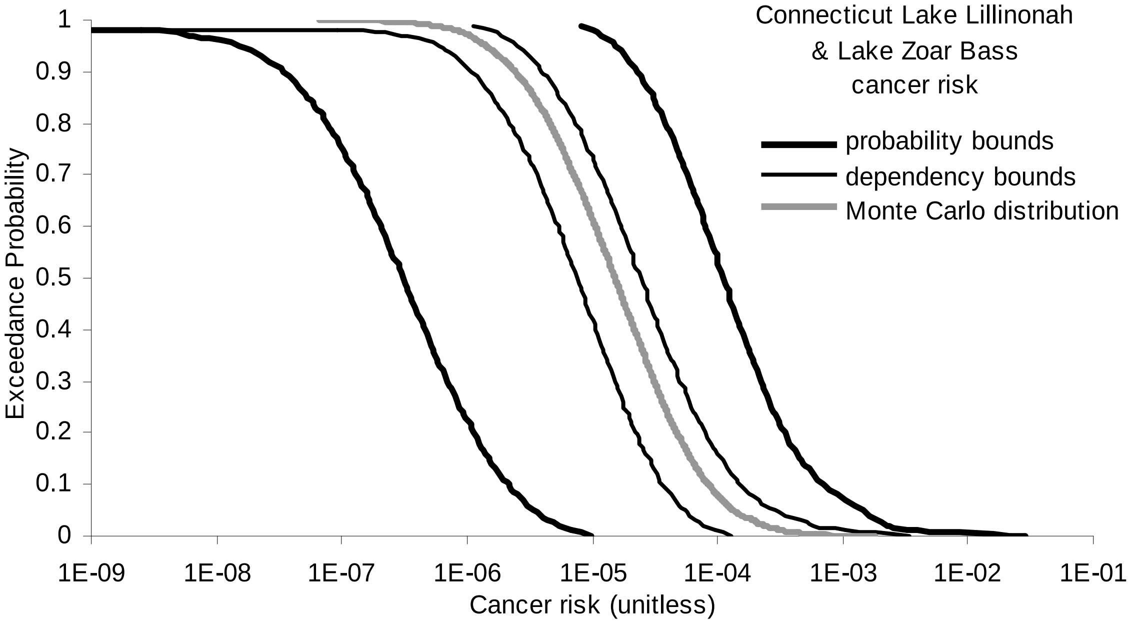
(Note: x-axis is log scaled.)

Figure 6-71 Total PCB Cancer Risk for Bass Ingestion at West Cornwall/Bulls Bridge—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



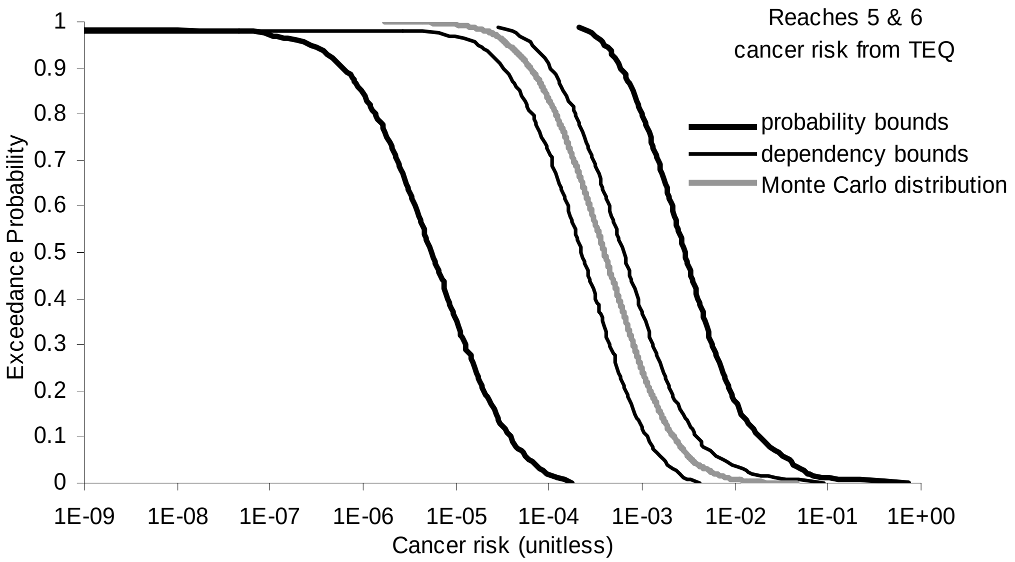
(Note: x-axis is log scaled.)

Figure 6-72 Total PCB Cancer Risk for Trout Ingestion at West Cornwall—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



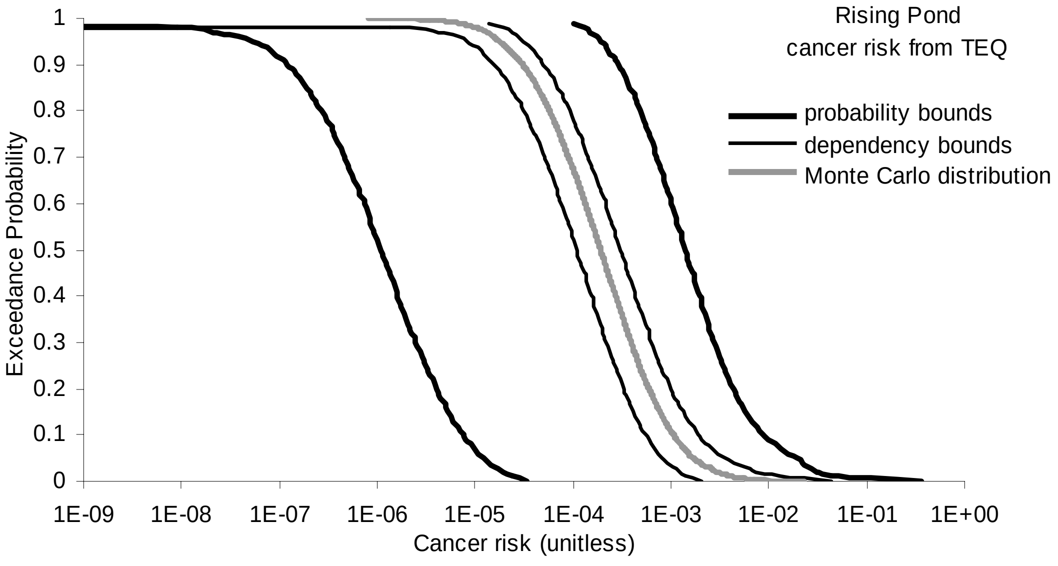
(Note: x-axis is log scaled.)

Figure 6-73 Total PCB Cancer Risk for Bass Ingestion at Lakes Lillinonah/Zoar—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-74 TEQ Cancer Risk for Fish Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-75 TEQ Cancer Risk for Fish Ingestion at Rising Pond—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis

6.8.2 Noncancer Hazard Quotients from Fish Ingestion Calculated with One-Dimensional Models

Hazard quotients for tPCBs were calculated by receptor and location for the one-dimensional noncancer Monte Carlo simulations and probability bounds analyses by dividing the exposure distributions or p-boxes by the Reference Dose (RfD). An RfD of 0.00002 (2E-05) mg/kg-d was used (Section 3.3.2). Table 6-7 gives the resulting hazard quotients for adult and child receptors by location for selected percentiles. Each cell of the table shows the results of the one-dimensional Monte Carlo analysis (MCA) and the probability bounds analysis (PBA, in brackets). The probability bounds indicate the range of values that the hazard quotients could take given the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions. Figures 6-76 through 6-80 show hazard quotient distributions for adult (non-trout) anglers at each of the four locations, and for adult trout anglers at one location. Figures 6-81 through 6-85 show the results for children.

6.8.3 Cancer Risk from Fish Ingestion Calculated with MEE Models

For exposure distributions calculated with the MEE models (Section 6.6.4.1), cancer risks were calculated for tPCBs by multiplying by the CSF = 2 $(mg/kg\text{-}d)^{-1}$. The CSF used for TEQ, was 1.5E-5 $(mg/kg\text{-}d)^{-1}$. Table 6-8 shows cancer risks by selected percentiles. Each cell of the table shows the results of the MME Monte Carlo analysis (MCA), dependency bounds analysis (DBA, in brackets), and probability bounds analysis (PBA, in brackets).

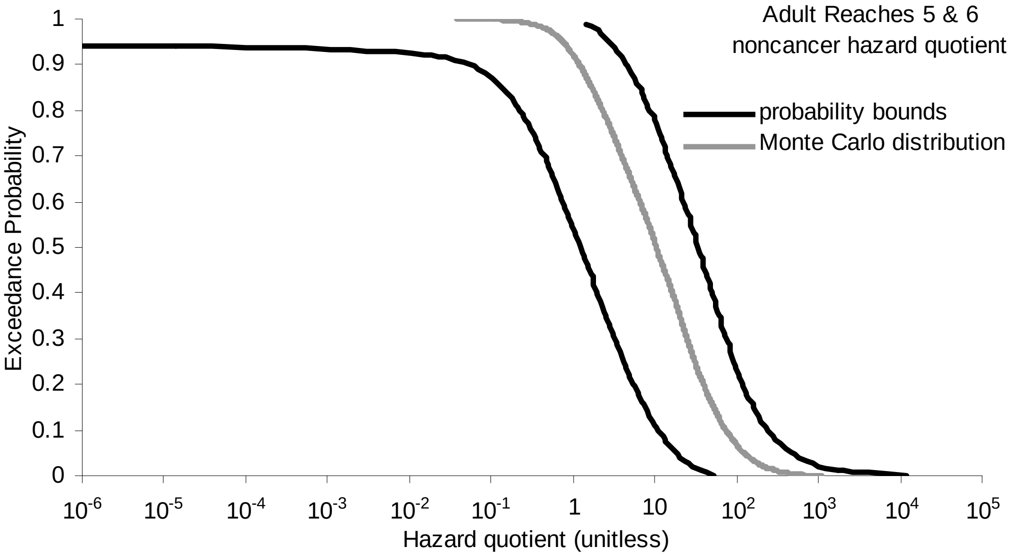
For the microexposure Monte Carlo simulations and probability bounds analyses, Figures 6-86 through 6-90 show the cancer risks from tPCBs in cumulative exceedance form for non-trout anglers at the four locations, and for trout anglers at one location. Figure 6-91 and Figure 6-92 show the cancer risks using the TEQ CSF for the PSA and Rising Pond, respectively.

Table 6-7

Noncancer Hazard Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Risk Analysis for Fish Ingestion Exposure

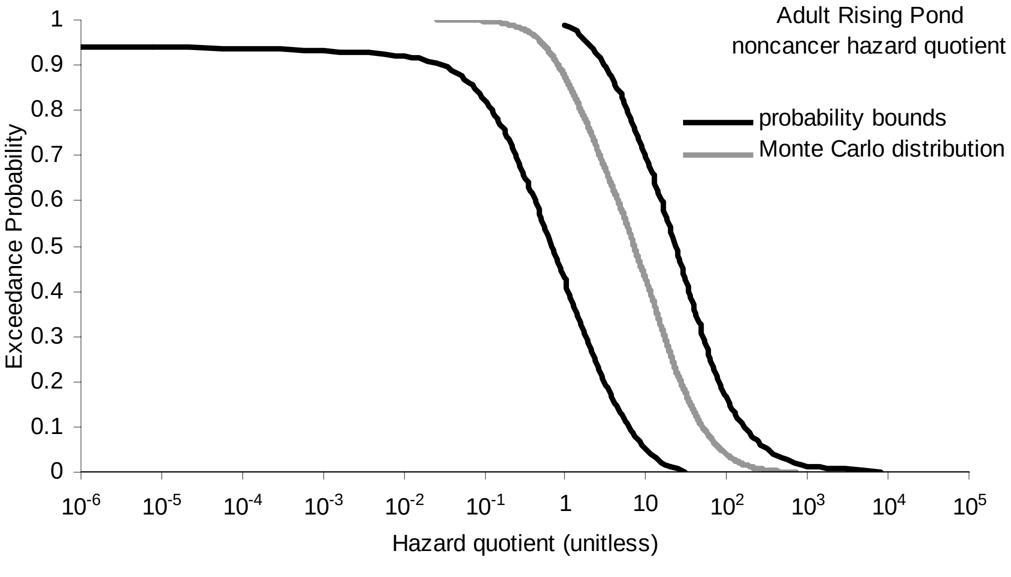
			Hazard quotient percentiles					
						RME range		
Receptor	Site	Analysis	25%	50%	75%	90%	95%	99%
Adult	Reaches 5 & 6	MCA	3.1	10	31	74	122	308
		PBA	[0.33, 11]	[1.2, 34]	[4.2, 93]	[11, 238]	[18, 461]	[54, 11638]
	Rising Pond	MCA	2.1	7.1	21	50	83	210
		PBA	[0.18, 7.7]	[0.69, 23]	[2.3, 63]	[6.1, 162]	[10, 315]	[20, 1218]
	West Cornwall/ Bulls Bridge Bass	MCA	0.25	0.85	2.5	6.0	10	25
		PBA	[0.029, 0.93]	[0.11, 2.8]	[0.37, 7.6]	[1.0, 20]	[1.6, 38]	[3.3, 144]
	West Cornwall Trout	MCA	0.36	1.0	3.0	6.9	12	33
		PBA	[0.026, 1.3]	[0.084, 3.4]	[0.26, 8.8]	[0.66, 22]	[1.1, 45]	[2.2, 292]
	Lake Lillinonah & Lake Zoar Bass	MCA	0.18	0.60	1.8	4.2	7.0	18
		PBA	[0.019, 0.65]	[0.073, 2.0]	[0.25, 5.3]	[0.65, 14]	[1.1, 27]	[2.2, 101]
Child	Reaches 5 & 6	MCA	6.6	23	65	153	258	656
		PBA	[0.70, 24]	[2.7, 72]	[8.9, 197]	[24, 501]	[38, 974]	[78, 3666]
	Rising Pond	MCA	4.5	15	44	104	176	447
		PBA	[0.39, 17]	[1.5, 49]	[4.9, 134]	[13, 341]	[21, 665]	[43, 2528]
	West Cornwall/ Bulls Bridge Bass	MCA	0.5	1.9	5.3	13	21	54
		PBA	[0.063, 2.0]	[0.24, 5.9]	[0.80, 16]	[2.1, 41]	[3.4, 80]	[6.9, 300]
	West Cornwall Trout	MCA	0.78	2.2	6.2	15	24	66
		PBA	[0.057, 2.8]	[0.18, 7.4]	[0.56, 19]	[1.4, 45]	[2.3, 95]	[4.6, 592]
	Lake Lillinonah & Lake Zoar Bass	MCA	0.38	1.3	3.7	8.8	15	38
		PBA	[0.042, 1.4]	[0.16, 4.2]	[0.53, 11]	[1.4, 29]	[2.3, 56]	[4.6, 210]

“MCA” = Monte Carlo analysis and “PBA” = probability bounds analysis. Values in square brackets are intervals.



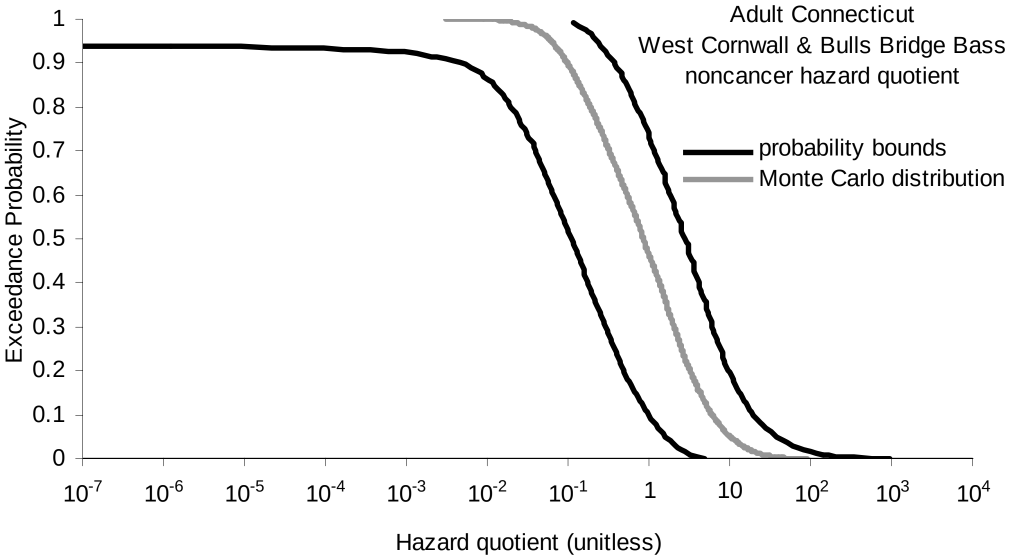
(Note: x-axis is log scaled.)

Figure 6-76 Adult Noncancer Hazard for tPCBs from Fish Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



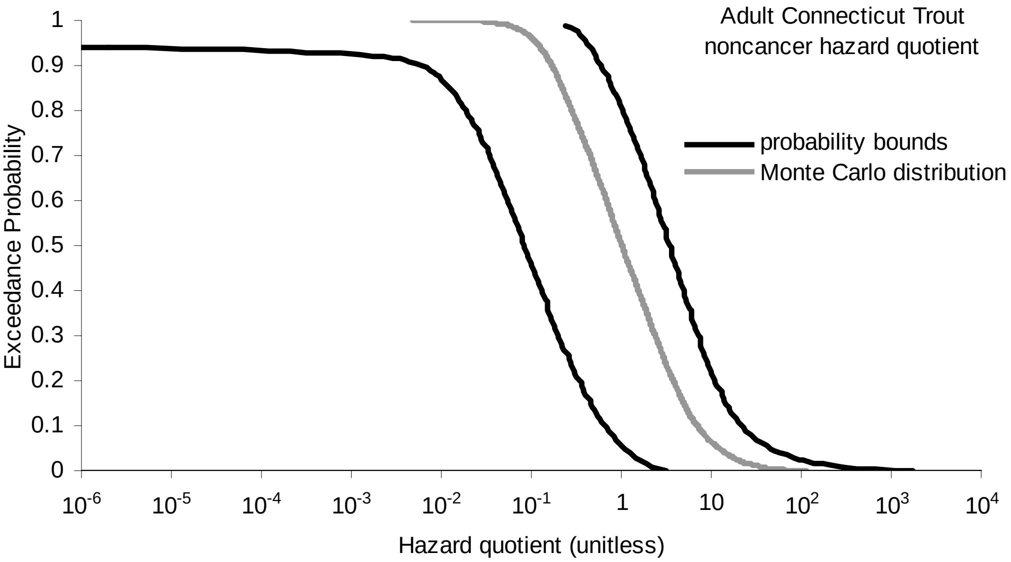
(Note: x-axis is log scaled.)

Figure 6-77 Adult Noncancer Hazard for tPCBs from Fish Ingestion at Rising Pond—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



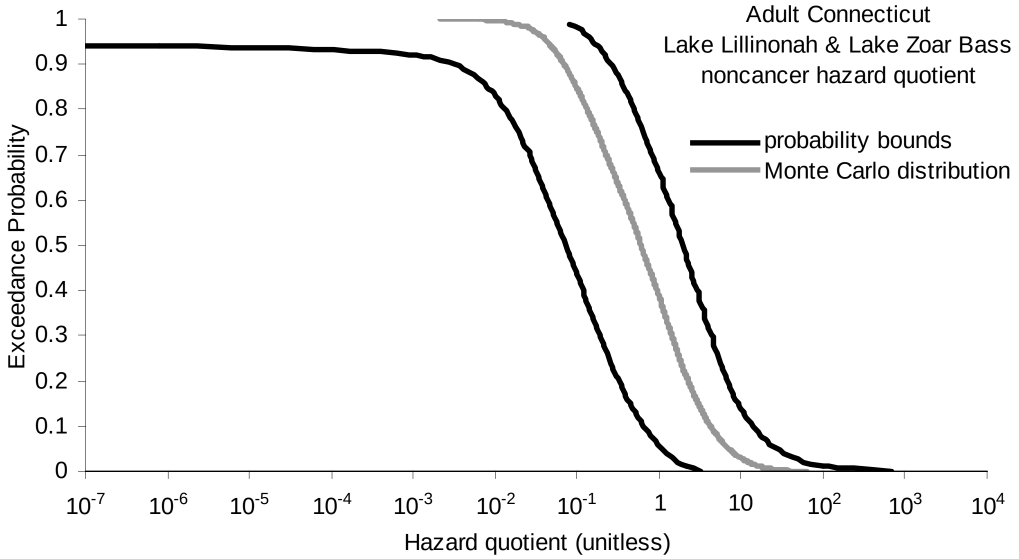
(Note: x-axis is log scaled.)

Figure 6-78 Adult Noncancer Hazard for tPCBs from Bass Ingestion at West Cornwall/Bulls Bridge—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



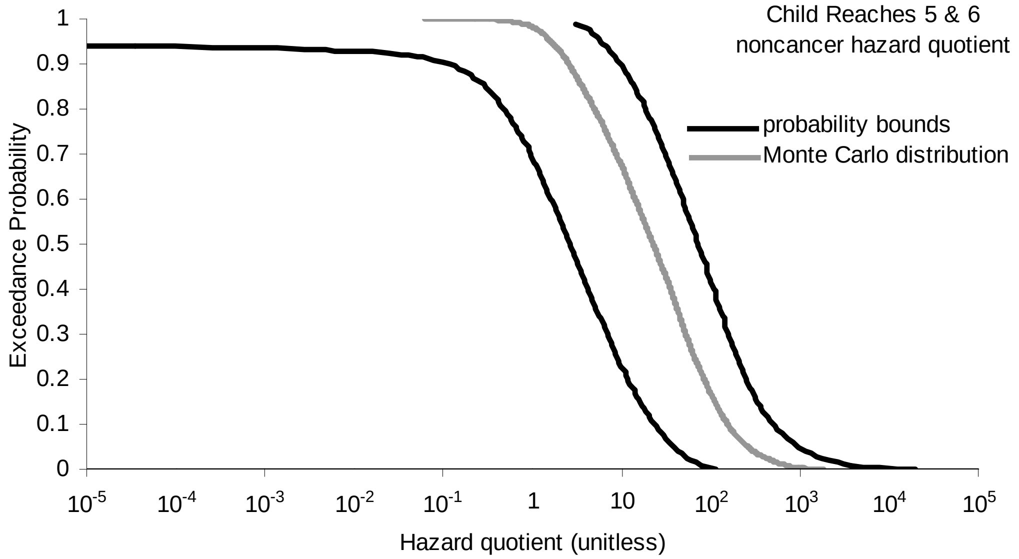
(Note: x-axis is log scaled.)

Figure 6-79 Adult Noncancer Hazard for tPCBs from Trout Ingestion at West Cornwall—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



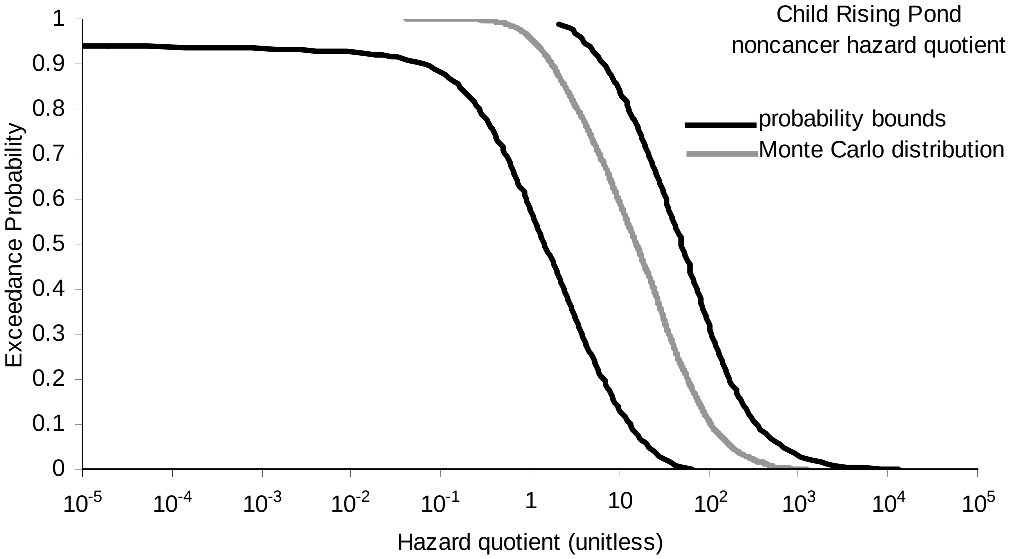
(Note: x-axis is log scaled.)

Figure 6-80 Adult Noncancer Hazard for tPCBs from Bass Ingestion at Lakes Lillinonah/Zoar—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



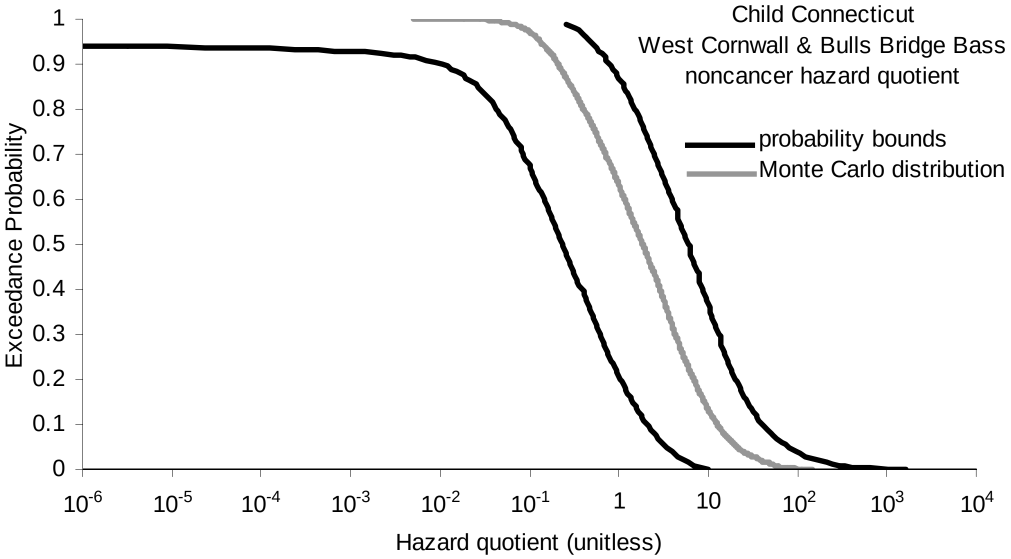
(Note: x-axis is log scaled.)

Figure 6-81 Child Noncancer Hazard for tPCBs from Fish Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



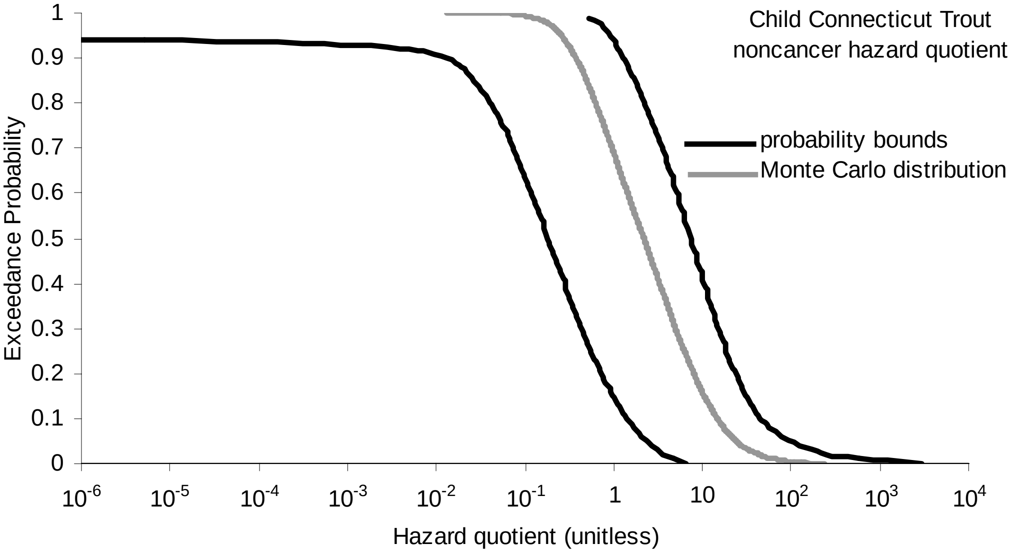
(Note: x-axis is log scaled.)

Figure 6-82 Child Noncancer Hazard for tPCBs from Fish Ingestion at Rising Pond—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



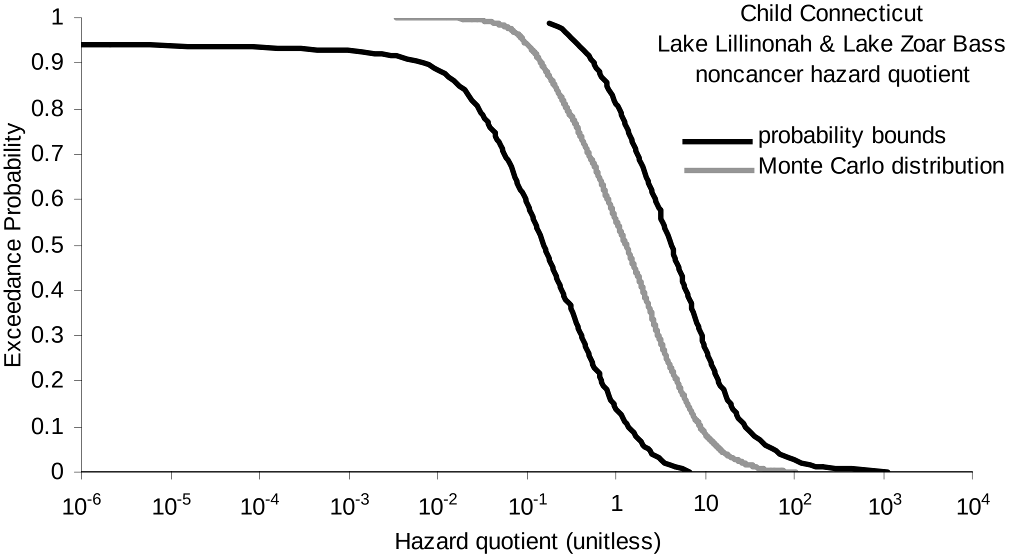
(Note: x-axis is log scaled.)

Figure 6-83 Child Noncancer Hazard for tPCBs from Bass Ingestion at West Cornwall/Bulls Bridge—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-84 Child Noncancer Hazard for tPCBs from Trout Ingestion at West Cornwall—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

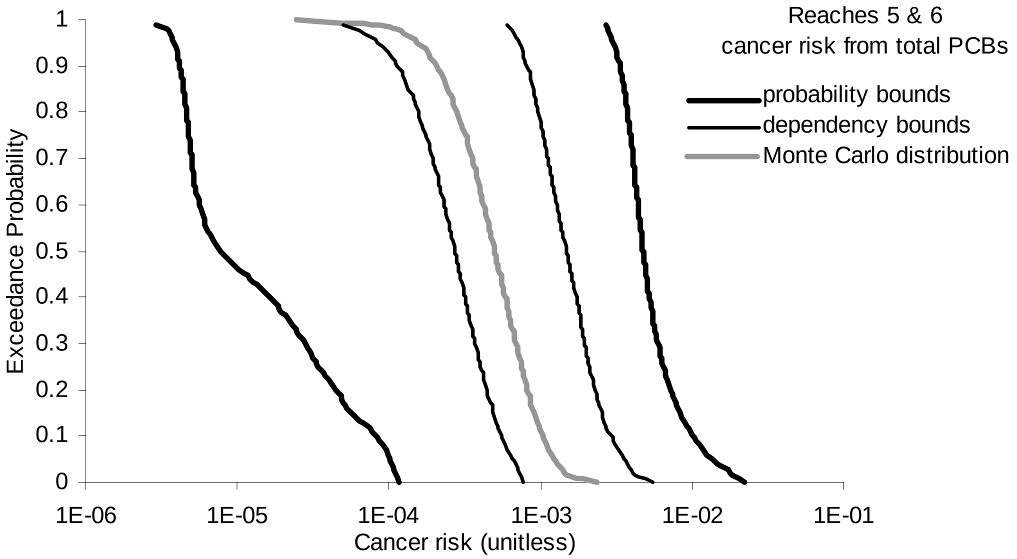
Figure 6-85 Child Noncancer Hazard for tPCBs from Bass Ingestion at Lakes Lillinonah/Zoar—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

Table 6-8

Fish Ingestion Cancer Risk Results of the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Risk Analysis

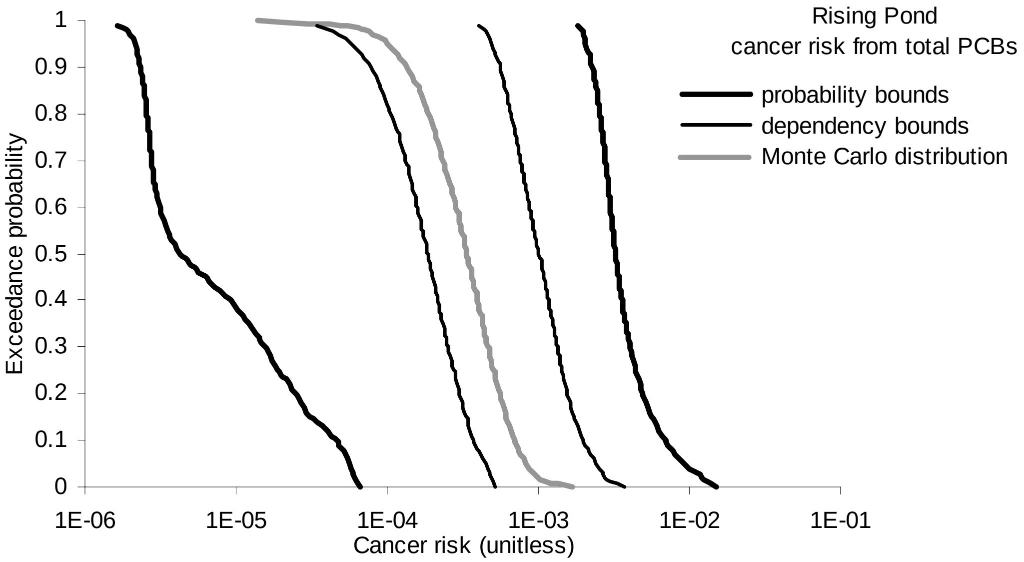
PCB measure	Site	Analysis	Cancer risk percentiles					
						RME range		
			25%	50%	75%	90%	95%	99%
Total	Reaches 5 & 6	MCA	3E-4	5E-4	8E-4	1E-3	1E-3	2E-3
		DBA	[2E-4, 1E-3]	[3E-4, 1E-3]	[4E-4, 2E-3]	[5E-4, 3E-3]	[7E-4, 4E-3]	[7E-4, 4E-3]
		PBA	[5E-6, 4E-3]	[8E-6, 5E-3]	[3E-5, 6E-3]	[8E-5, 1E-2]	[1E-4, 1E-2]	[1E-4, 2E-2]
	Rising Pond	MCA	2E-4	3E-4	5E-4	7E-4	8E-4	1E-3
		DBA	[1E-4, 7E-4]	[2E-4, 1E-3]	[3E-4, 1E-3]	[4E-4, 2E-3]	[4E-4, 2E-3]	[5E-4, 3E-3]
		PBA	[3E-6, 3E-3]	[4E-6, 3E-3]	[2E-5, 4E-3]	[5E-5, 7E-3]	[6E-5, 9E-3]	[6E-5, 1E-2]
	West Cornwall/ Bulls Bridge Bass	MCA	3E-5	4E-5	6E-5	9E-5	1E-4	1E-4
		DBA	[1E-5, 9E-5]	[2E-5, 1E-4]	[3E-5, 2E-4]	[5E-5, 2E-4]	[5E-5, 3E-4]	[6E-5, 4E-4]
		PBA	[4E-7, 3E-4]	[7E-7, 4E-4]	[3E-6, 5E-4]	[8E-6, 9E-4]	[9E-6, 1E-3]	[1E-5, 2E-3]
	West Cornwall Trout	MCA	3E-5	5E-5	8E-5	1E-4	1E-4	2E-4
		DBA	[2E-5, 1E-4]	[3E-5, 2E-4]	[4E-5, 2E-4]	[6E-5, 3E-4]	[7E-5, 4E-4]	[8E-5, 5E-4]
		PBA	[3E-7, 4E-4]	[5E-7, 5E-4]	[2E-6, 7E-4]	[5E-6, 1E-3]	[6E-6, 2E-3]	[7E-6, 4E-3]
	Lake Lillinonah & Lake Zoar Bass	MCA	2E-5	3E-5	4E-5	6E-5	7E-5	9E-5
		DBA	[1E-5, 6E-5]	[2E-5, 9E-5]	[2E-5, 1E-4]	[3E-5, 2E-4]	[4E-5, 2E-4]	[4E-5, 3E-4]
		PBA	[3E-7, 2E-4]	[5E-7, 3E-4]	[2E-6, 4E-4]	[5E-6, 6E-4]	[6E-6, 8E-4]	[7E-6, 1E-3]
TEQ	Reaches 5 & 6	MCA	5E-4	7E-4	1E-3	2E-3	2E-3	2E-3
		DBA	[3E-4, 2E-3]	[4E-4, 2E-3]	[6E-4, 3E-3]	[8E-4, 4E-3]	[1E-3, 5E-3]	[1E-3, 7E-3]
		PBA	[5E-6, 6E-3]	[8E-6, 7E-3]	[4E-5, 1E-2]	[9E-5, 2E-2]	[1E-4, 2E-2]	[1E-4, 3E-2]
	Rising Pond	MCA	2E-4	4E-4	5E-4	8E-4	9E-4	1E-3
		DBA	[1E-4, 8E-4]	[2E-4, 1E-3]	[3E-4, 2E-3]	[4E-4, 2E-3]	[5E-4, 3E-3]	[5E-4, 3E-3]
		PBA	[1E-6, 3E-3]	[2E-6, 3E-3]	[7E-6, 5E-3]	[2E-5, 7E-3]	[2E-5, 1E-2]	[2E-5, 1E-2]

"MCA" = Monte Carlo analysis, "DBA" = dependency bounds analysis, and "PBA" = probability bounds analysis. Values in square brackets are intervals.



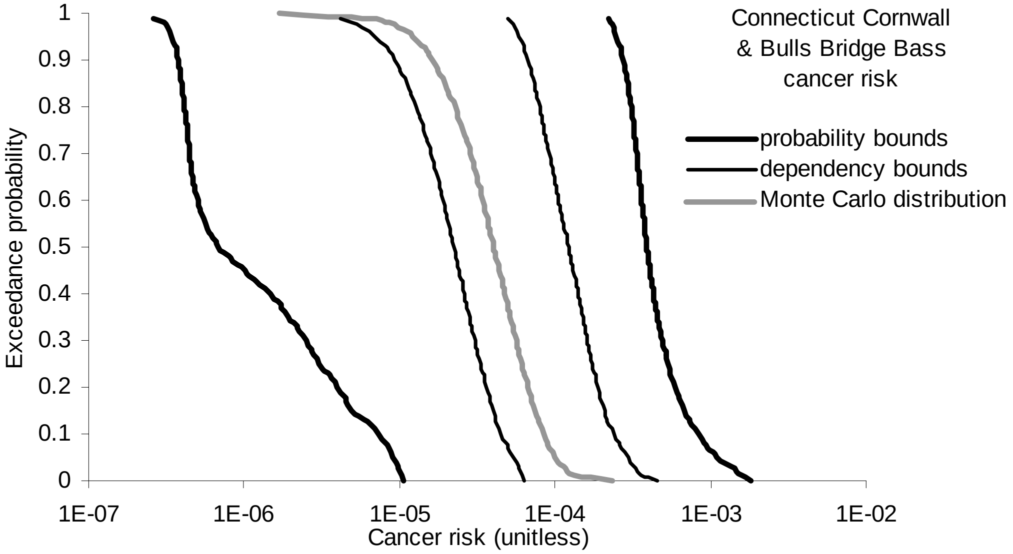
(Note: x-axis is log scaled.)

Figure 6-86 Total PCB Cancer Risk for Fish Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



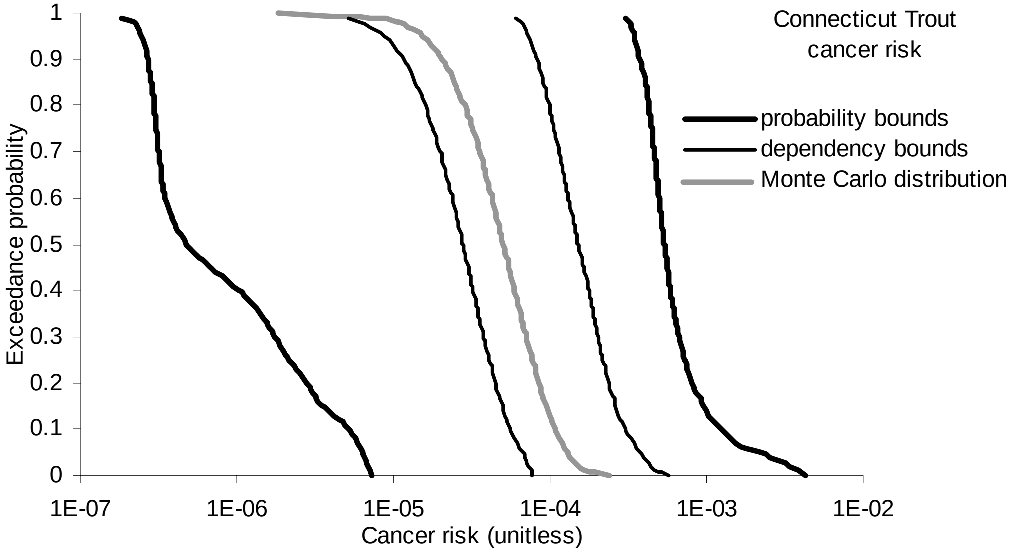
(Note: x-axis is log scaled.)

Figure 6-87 Total PCB Cancer Risk for Fish Ingestion at Rising Pond—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



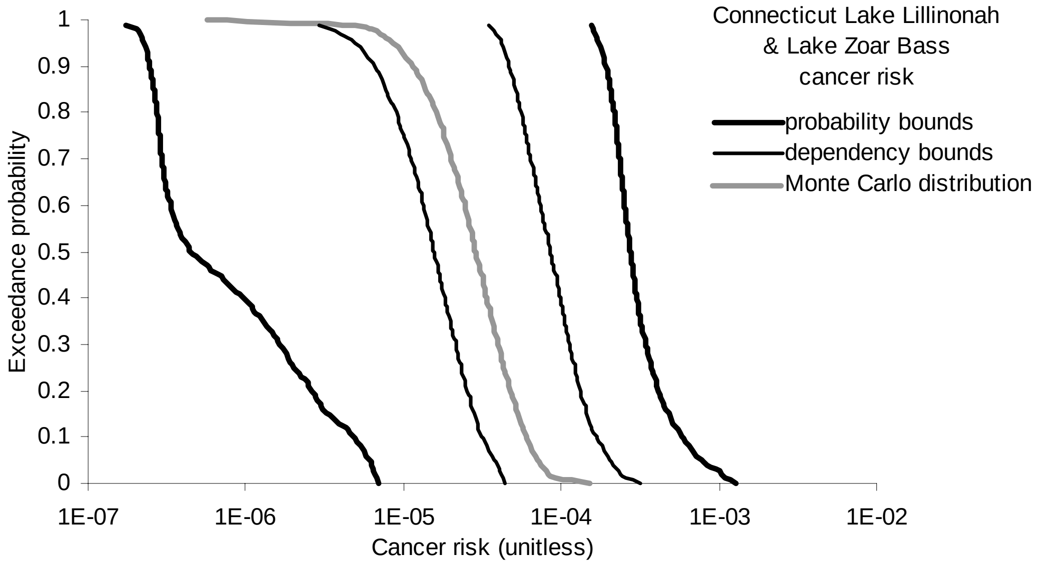
(Note: x-axis is log scaled.)

Figure 6-88 Total PCB Cancer Risk for Bass Ingestion at West Cornwall/Bulls Bridge—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



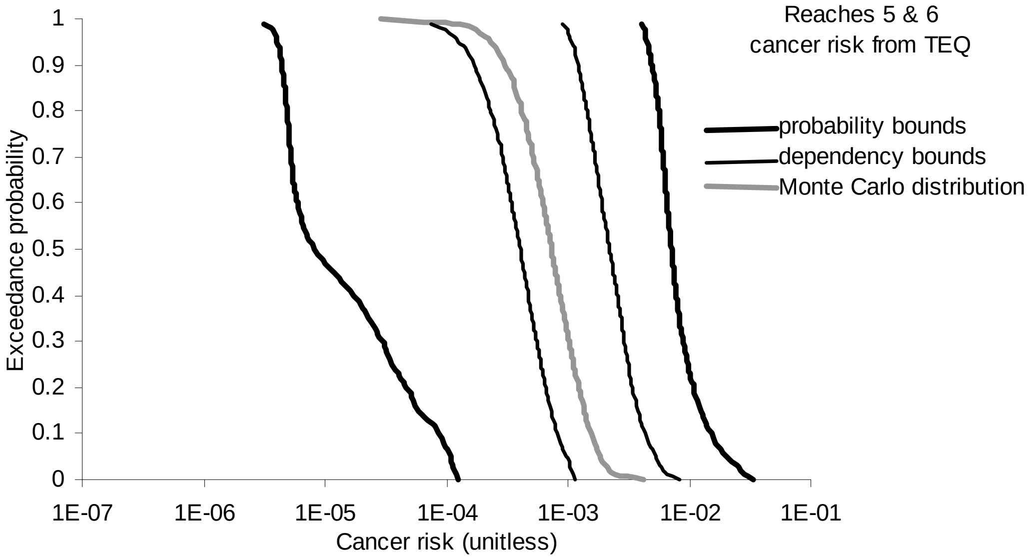
(Note: x-axis is log scaled.)

Figure 6-89 Total PCB Cancer Risk for Trout Ingestion at West Cornwall—Risk assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



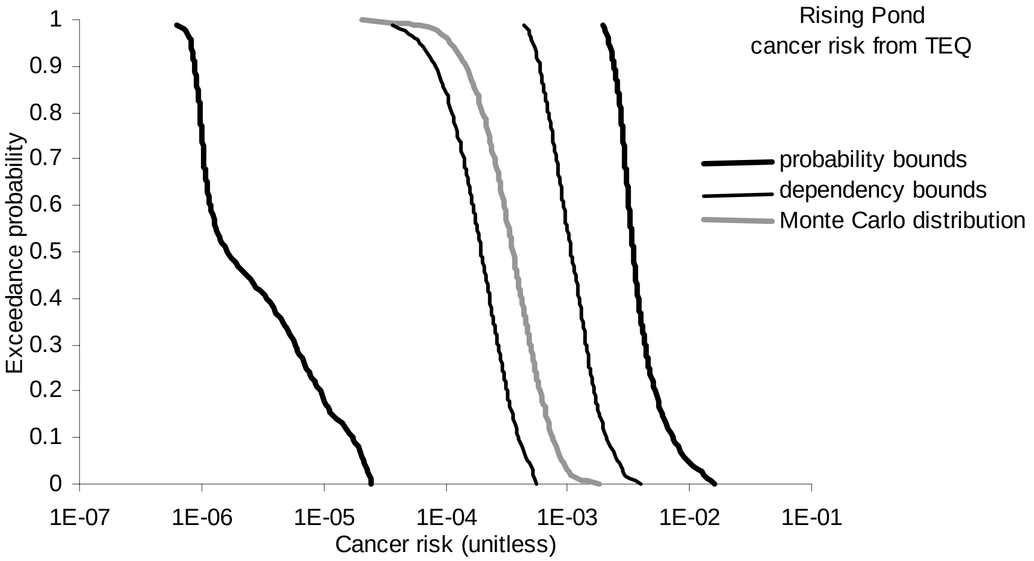
(Note: x-axis is log scaled.)

Figure 6-90 Total PCB Cancer Risk for Bass Ingestion at Lakes Lillinonah/Zoar—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-91 TEQ Cancer Risk for Fish Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-92 TEQ Cancer Risk for Fish Ingestion at Rising Pond—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis

6.8.4 Noncancer Hazard Quotients from Fish Ingestion Calculated with MEE Models

Hazard quotients for tPCBs were calculated by percentile and location for the MEE noncancer Monte Carlo simulations and probability bounds analyses by dividing the exposure distributions or p-boxes by the Reference Dose (RfD). An RfD of 0.00002 (2E-05) mg/kg-d was used (Section 3.3.2). Table 6-9 gives the resulting hazard quotients for adult and child receptors by location for selected percentiles. Each cell of the table shows the results of the MEE Monte Carlo analysis (MCA) and the probability bounds analysis (PBA, in brackets). The probability bounds indicate the range of values that the hazard quotients could take given the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions. Figures 6-93 through 6-97 show hazard quotient distributions for adult non-trout (bass) anglers at each of the four locations, and for adult trout anglers at one location. Figures 6-98 through 6-102 show the results for children. Figures 6-91 through 6-95 show results for adults and children.

6.8.5 Cancer Risk from Waterfowl Ingestion Calculated with One-Dimensional Models

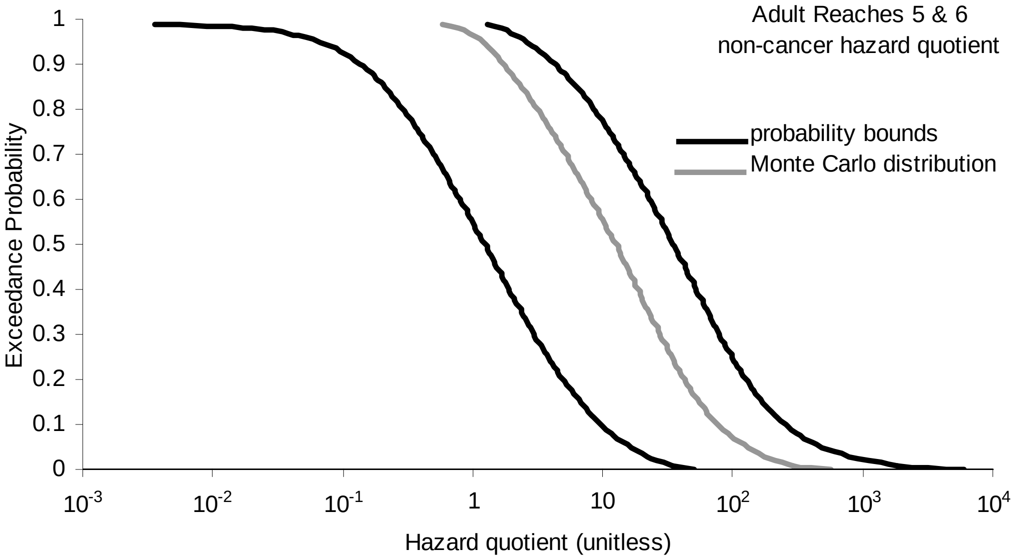
Cancer risk from waterfowl ingestion was calculated for the one-dimensional Monte Carlo model in the same manner as for fish (Section 6.8.1). Table 6-10 shows cancer risk by select percentiles for the tPCB and TEQ. Each cell of the table shows the results of the Monte Carlo analysis (MCA), the dependency bounds analysis (DBA, in brackets), and the probability bounds analysis (PBA, in brackets). The dependency bounds indicate the range of values that cancer risk could take given any of the possible dependencies between variables in the model allowed for in Table 6-1. The probability bounds indicate the range of values that cancer risk could take given both the dependencies allowed for by the dependency bounds analysis and the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions. Figures 6-103 and 6-104 show the cancer risk distributions for tPCB and TEQ.

Table 6-9

Fish Ingestion Noncancer Hazard Results of the MEE Monte Carlo Simulation and Probability Bounds Risk Analysis

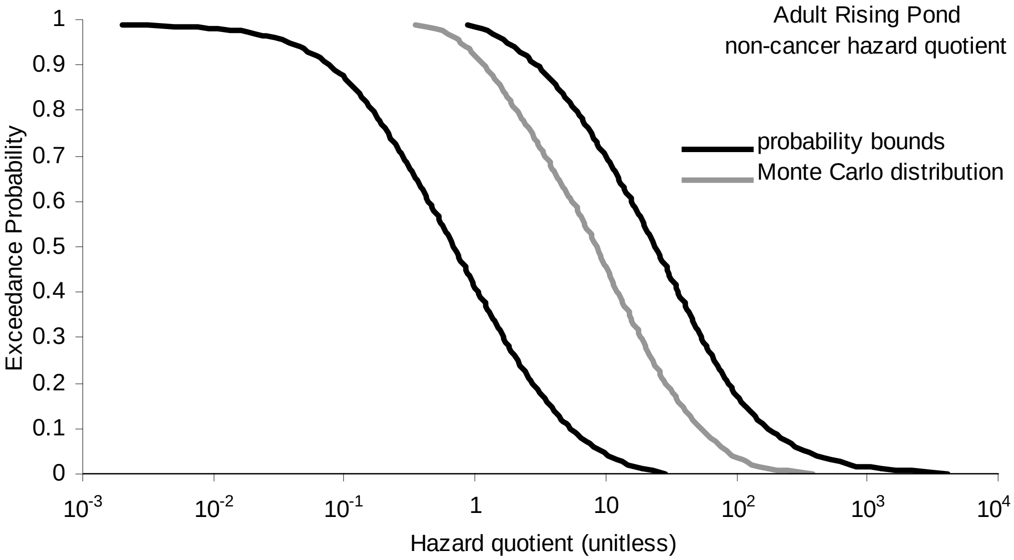
			Hazard quotient percentiles					
						RME range		
Receptor	Site	Analysis	25%	50%	75%	90%	95%	99%
Adult	Reaches 5 & 6	MCA	4.1	13	34	76	132	288
		PBA	[0.39, 11]	[1.2, 35]	[3.8, 99]	[10, 254]	[16, 486]	[34, 1853]
	Rising Pond	MCA	2.7	8.4	23	53	83	175
		PBA	[0.22, 7.7]	[0.69, 24]	[2.1, 67]	[5.4, 173]	[9.1, 332]	[19, 1264]
	West Cornwall/ Bulls Bridge Bass	MCA	0.33	1.0	2.8	6.3	10	23
		PBA	[0.035, 0.93]	[0.11, 2.9]	[0.34, 8.1]	[0.87, 21]	[1.5, 40]	[3.0, 152]
	West Cornwall Trout	MCA	0.54	1.3	3.4	7.9	13	29
		PBA	[0.029, 1.2]	[0.080, 3.3]	[0.23, 8.7]	[0.58, 22]	[1.0, 45]	[2.1, 272]
	Lake Lillinonah & Lake Zoar Bass	MCA	0.23	0.73	1.9	4.4	7.2	17
		PBA	[0.023, 0.65]	[0.073, 2.0]	[0.22, 5.7]	[0.57, 15]	[1.0, 28]	[2.0, 107]
Child	Reaches 5 & 6	MCA	8.6	26	71	167	271	624
		PBA	[0.84, 24]	[2.7, 75]	[8.1, 209]	[21, 534]	[35, 1024]	[73, 3949]
	Rising Pond	MCA	5.7	18	50	113	177	379
		PBA	[0.47, 17]	[1.5, 51]	[4.5, 142]	[12, 364]	[19, 699]	[40, 2693]
	West Cornwall/ Bulls Bridge Bass	MCA	0.68	2.2	5.9	14	22	50
		PBA	[0.075, 2.0]	[0.24, 6.2]	[0.72, 17]	[1.9, 44]	[3.1, 84]	[6.5, 324]
	West Cornwall Trout	MCA	1.2	2.9	7.5	17	29	62
		PBA	[0.063, 2.6]	[0.17, 7.0]	[0.49, 18]	[1.2, 45]	[2.1, 95]	[4.4, 569]
	Lake Lillinonah & Lake Zoar Bass	MCA	0.51	1.6	4.2	10	15	35
		PBA	[0.049, 1.4]	[0.16, 4.3]	[0.48, 12]	[1.2, 31]	[2.1, 59]	[4.3, 227]

"MCA" = Monte Carlo analysis and "PBA" = probability bounds analysis. Values in square brackets are intervals.



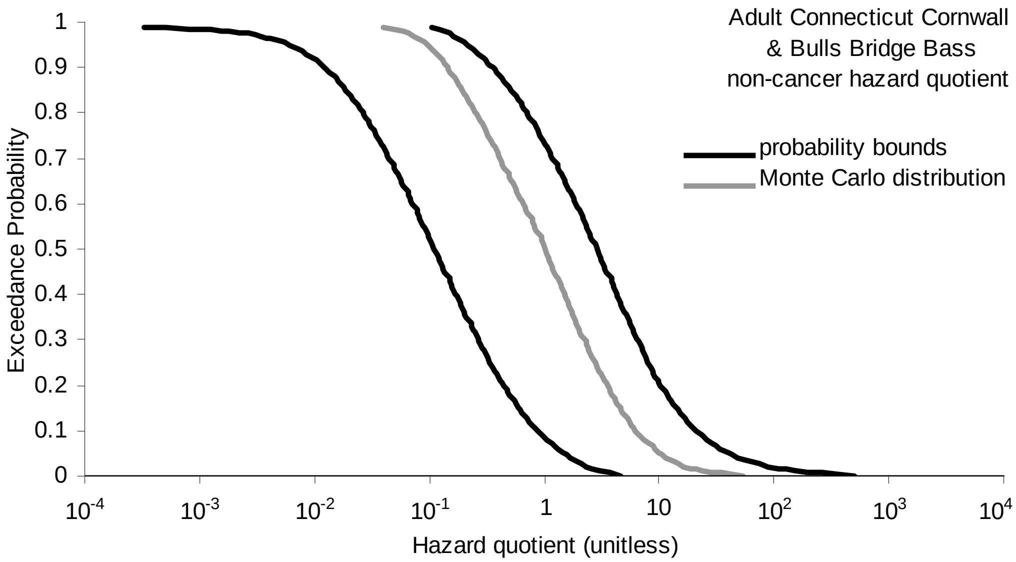
(Note: x-axis is log scaled.)

Figure 6-93 Adult Noncancer Hazard for tPCBs from Fish Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



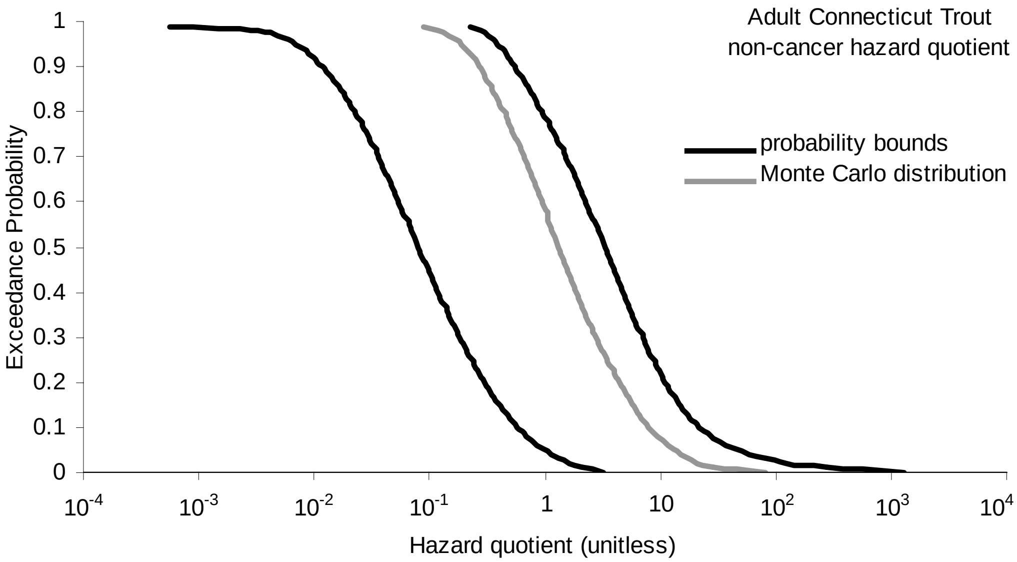
(Note: x-axis is log scaled.)

Figure 6-94 Adult Noncancer Hazard for tPCBs from Fish Ingestion at Rising Pond—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



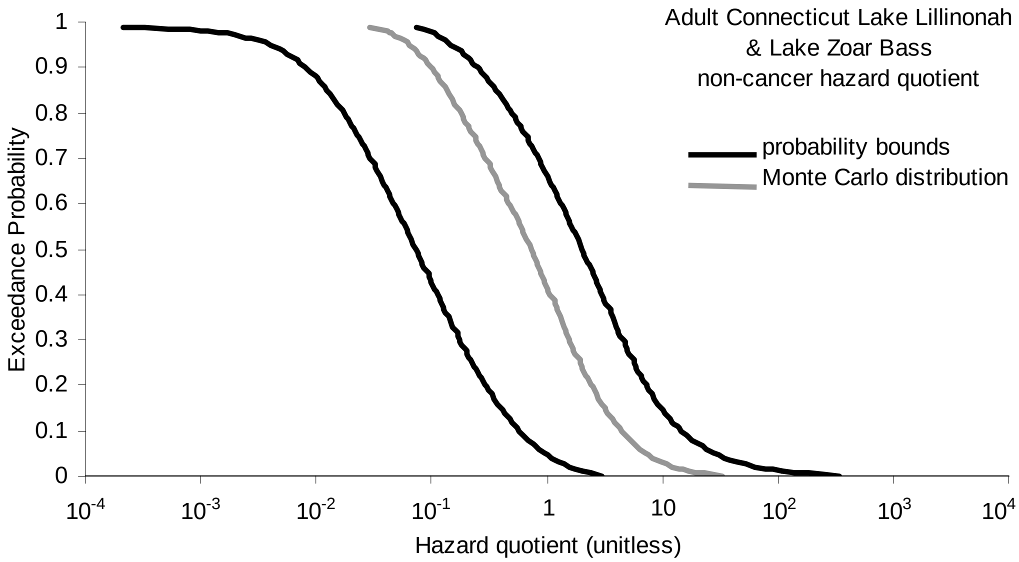
(Note: x-axis is log scaled.)

Figure 6-95 Adult Noncancer Hazard for tPCBs from Bass Ingestion at West Cornwall/Bulls Bridge—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



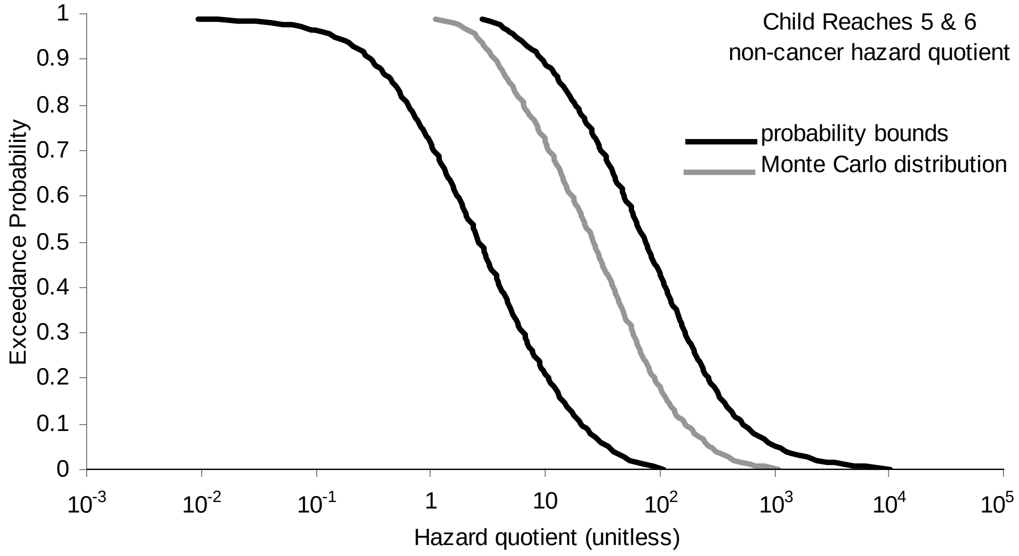
(Note: x-axis is log scaled.)

Figure 6-96 Adult Noncancer Hazard for tPCBs from Trout Ingestion at West Cornwall—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



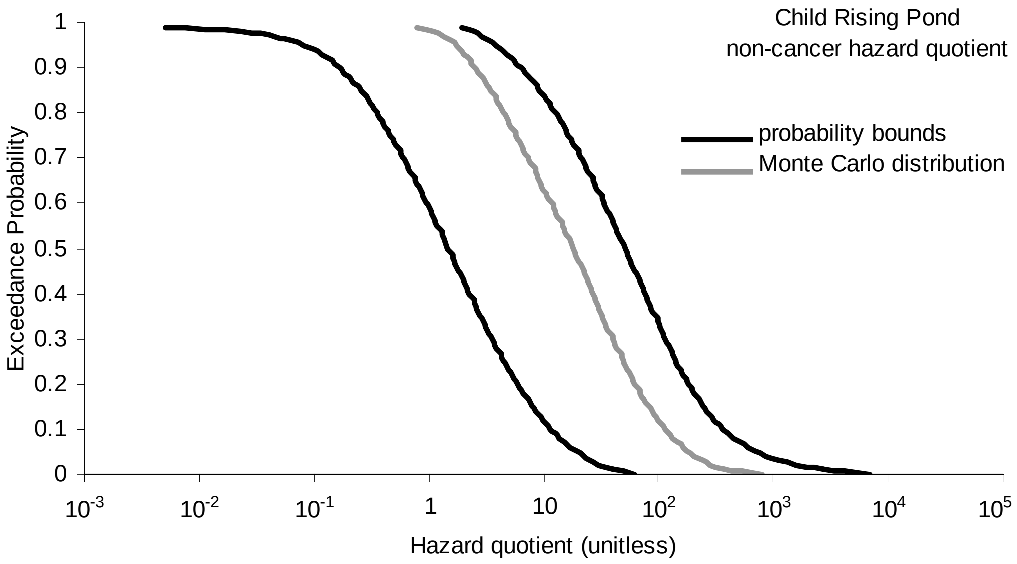
(Note: x-axis is log scaled.)

Figure 6-97 Adult Noncancer Hazard for tPCBs from Bass Ingestion at Lakes Lillinonah/Zoar—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



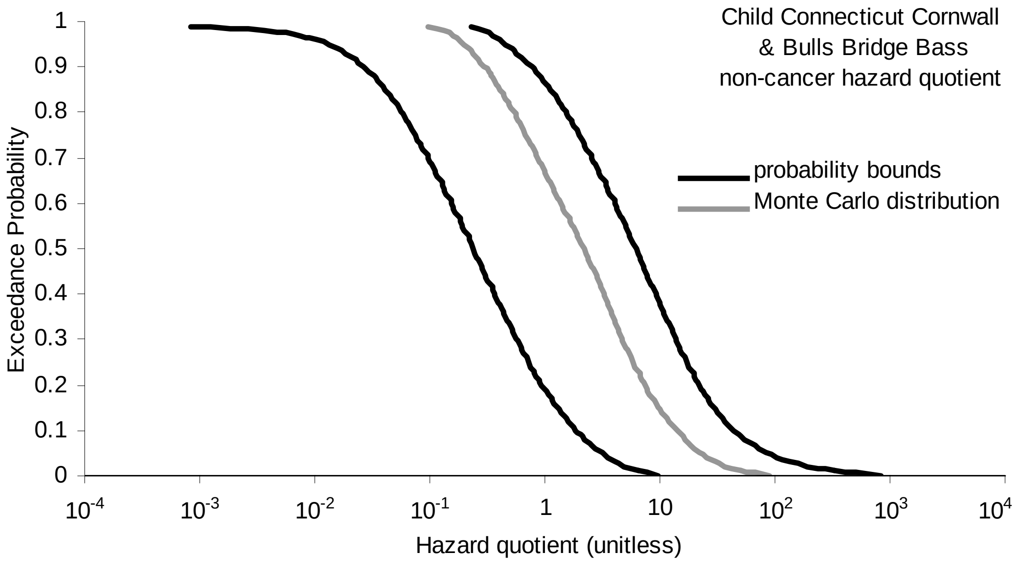
(Note: x-axis is log scaled.)

Figure 6-98 Child Noncancer Hazard for tPCBs from Fish Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



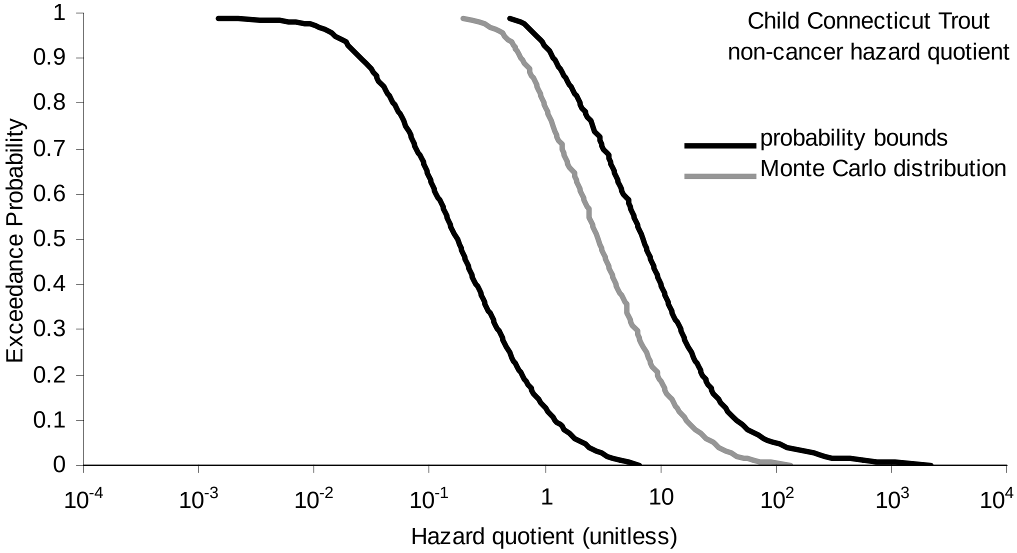
(Note: x-axis is log scaled.)

Figure 6-99 Child Noncancer Hazard for tPCBs from Fish Ingestion at Rising Pond—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



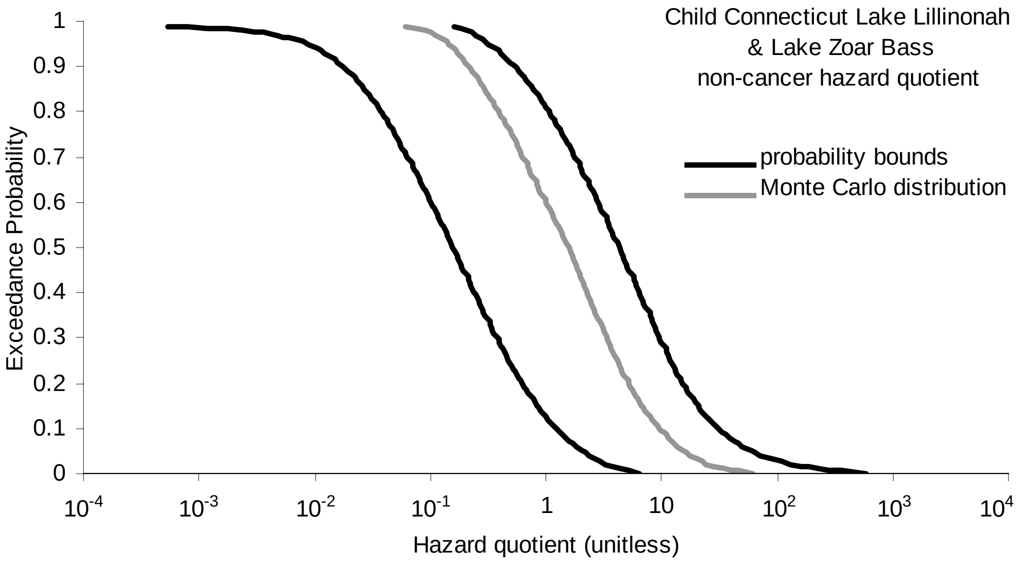
(Note: x-axis is log scaled.)

Figure 6-100 Child Noncancer Hazard for tPCBs from Bass Ingestion at West Cornwall/Bulls Bridge—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-101 Child Noncancer Hazard for Trout Ingestion at West Cornwall—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

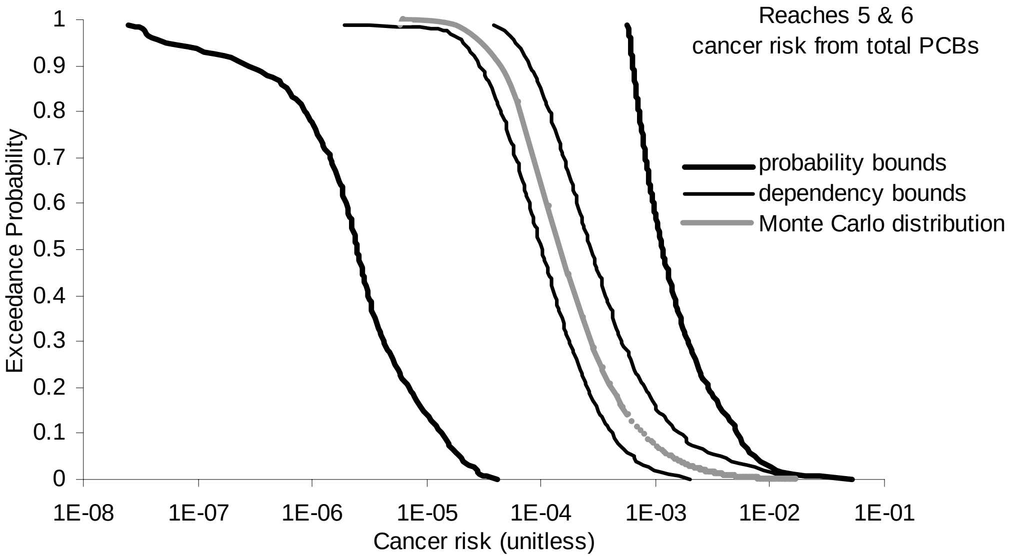
Figure 6-102 Child Noncancer Hazard for tPCBs from Bass Ingestion at Lakes Lillinonah/Zoar—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis

Table 6-10

Cancer Risk Results of the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Risk Analysis for Waterfowl Exposure

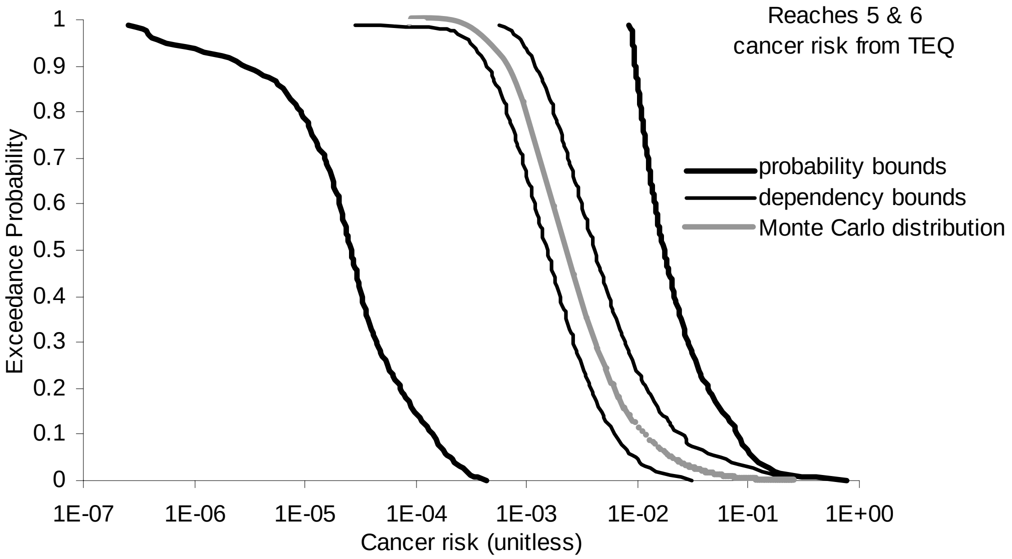
			Cancer risk percentiles					
						RME range		
PCB measure	Site	Analysis	25%	50%	75%	90%	95%	99%
Total	Reaches 5 & 6	MCA	8E-05	2E-04	3E-04	8E-04	1E-03	4E-03
		DBA	[5E-5, 1E-4]	[1E-4, 3E-4]	[2E-4, 6E-4]	[4E-4, 2E-3]	[6E-4, 4E-3]	[1E-3, 1E-2]
		PBA	[1E-6, 8E-4]	[2E-6, 1E-3]	[5E-6, 2E-3]	[1E-5, 5E-3]	[2E-5, 7E-3]	[3E-5, 2E-2]
TEQ	Reaches 5 & 6	MCA	1E-03	2E-03	5E-03	1E-02	2E-02	6E-02
		DBA	[8E-4, 2E-3]	[2E-3, 4E-3]	[3E-3, 9E-3]	[6E-3, 2E-2]	[1E-2, 6E-2]	[2E-2, 2E-1]
		PBA	[1E-5, 1E-2]	[3E-5, 2E-2]	[6E-5, 3E-2]	[1E-4, 8E-2]	[2E-4, 1E-1]	[3E-4, 2E-1]

"MCA" = Monte Carlo analysis, "DBA" = dependency bounds analysis, and "PBA" = probability bounds analysis. Values in square brackets are intervals.



(Note: x-axis is log scaled.)

Figure 6-103 Total PCB Cancer Risk for Waterfowl Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-104 TEQ Cancer Risk for Waterfowl Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis

6.8.6 Noncancer Hazard Quotients from Waterfowl Ingestion Calculated with One-Dimensional Models

Hazard quotients for tPCBs from waterfowl ingestion were calculated for the one-dimensional Monte Carlo analyses and probability bounds analyses. Table 6-11 shows hazard quotients by select percentiles for adults and children. Each cell of the table shows the results of the one-dimensional Monte Carlo analysis (MCA) and the probability bounds analysis (PBA, in brackets). The probability bounds indicate the range of values that the hazard quotients could take given the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions. Figures 6-105 and 6-106 show the hazard quotient distributions for adults and children, respectively.

6.8.7 Cancer Risk from Waterfowl Ingestion Calculated with MEE Models

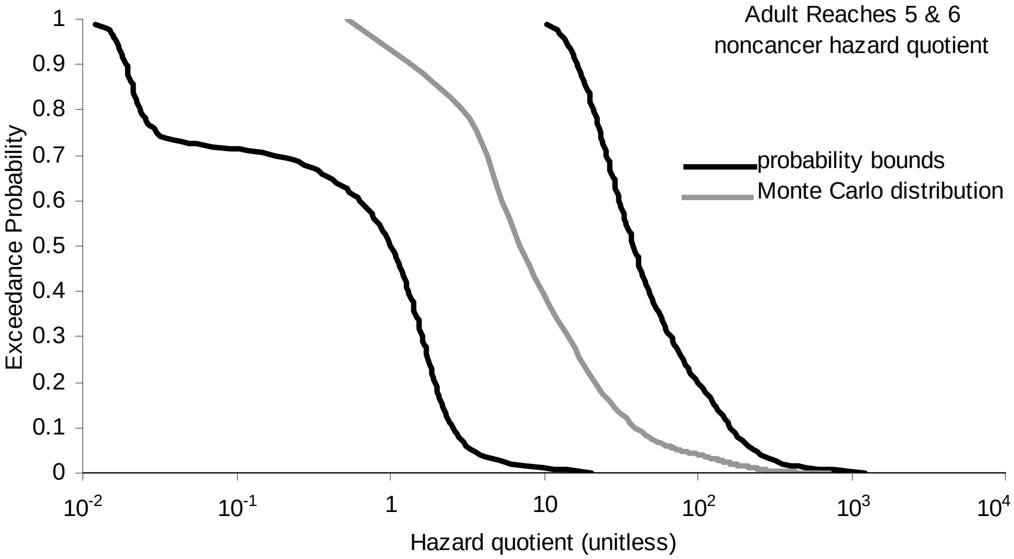
Cancer risk from waterfowl ingestion was calculated with the MEE Monte Carlo model. Table 6-12 shows cancer risk by select percentiles for the tPCB and TEQ measures. Each cell of the table shows the results of the Monte Carlo analysis (MCA), the dependency bounds analysis (DBA, in brackets), and the probability bounds analysis (PBA, in brackets). The dependency bounds indicate the range of values that cancer risk could take given any of the possible dependencies between variables in the model allowed for in Table 6-1. The probability bounds indicate the range of values that cancer risk could take given both the dependencies allowed for by the dependency bounds analysis and the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions. Figures 6-107 and 6-108 show the cancer risk distributions for tPCB and TEQ.

Table 6-11

Noncancer Hazard: Results of the One-Dimensional Monte Carlo Simulation and Probability Bounds Risk Analysis for Waterfowl Ingestion Exposure

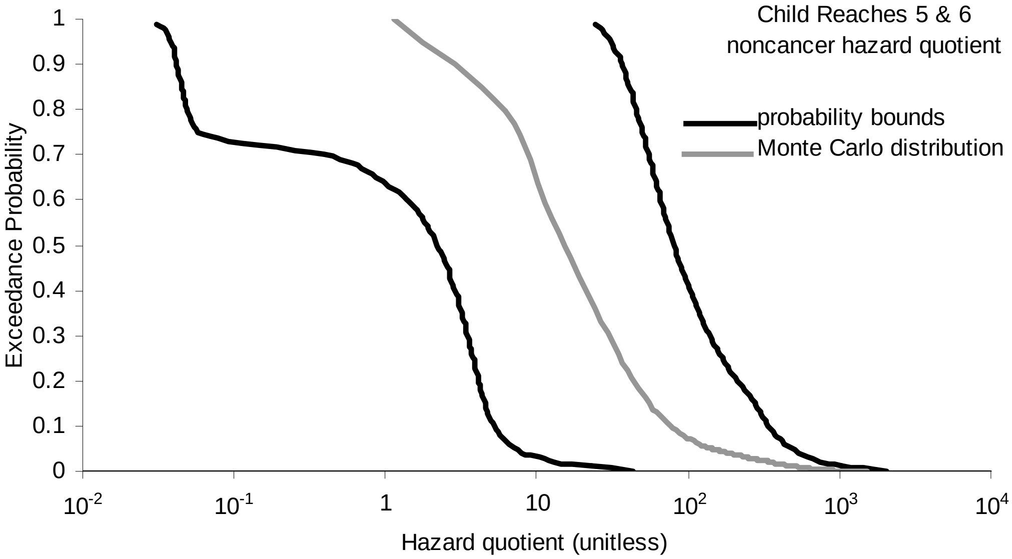
			Hazard quotient percentiles					
						RME range		
Receptor	Site	Analysis	25%	50%	75%	90%	95%	99%
Adult	Reaches 5 & 6	MCA	3.5	7.2	17	40	76	242
		PBA	[0.030, 23]	[1.0, 38]	[1.8, 80]	[2.6, 164]	[3.4, 229]	[9.8, 497]
Child	Reaches 5 & 6	MCA	7.4	15	36	77	139	528
		PBA	[0.058, 50]	[2.2, 80]	[3.8, 169]	[5.2, 341]	[7.1, 476]	[23, 1032]

“MCA” = Monte Carlo analysis and “PBA” = probability bounds analysis. Values in square brackets are intervals.



(Note: x-axis is log scaled.)

Figure 6-105 Adult Noncancer Hazard for tPCBs from Waterfowl Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

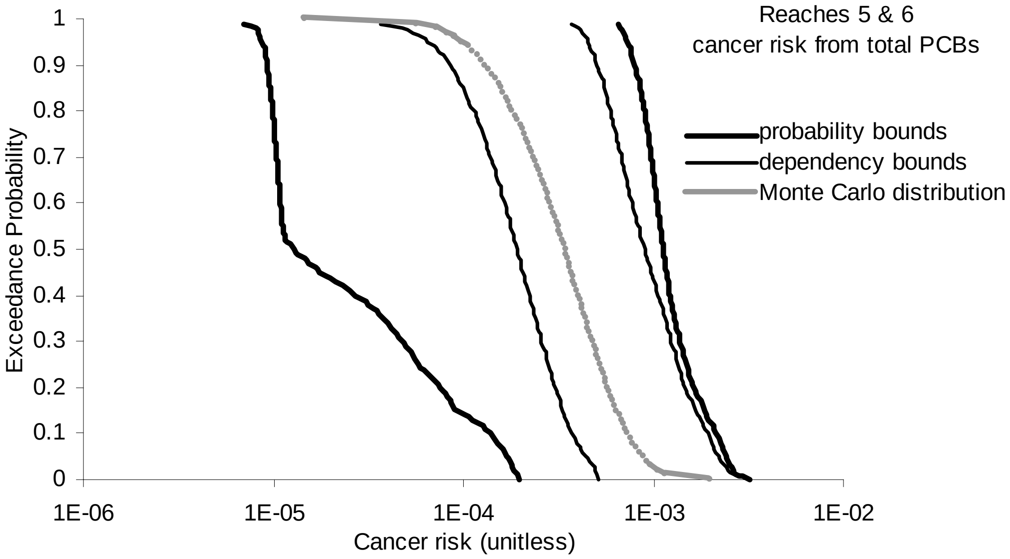
Figure 6-106 Child Noncancer Hazard for tPCBs from Waterfowl Ingestion at the PSA—Risk Assessment Results from the One-Dimensional Monte Carlo Simulation and Probability Bounds Analysis

Table 6-12

Cancer Risk Results of the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Risk Analysis for Waterfowl Exposure

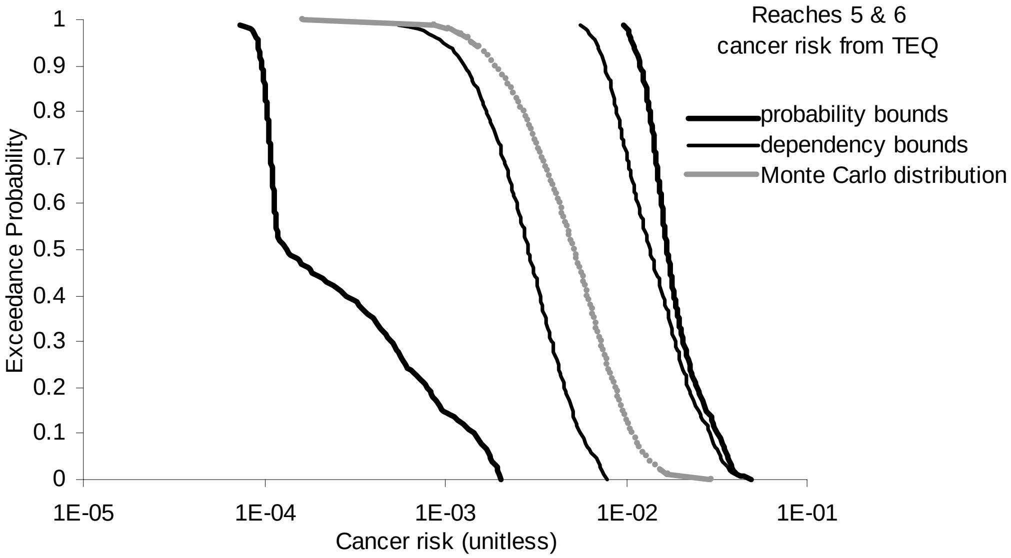
			Cancer risk percentiles					
						RME range		
PCB measure	Site	Analysis	25%	50%	75%	90%	95%	99%
Total	Reaches 5 & 6	MCA	2E-4	3E-4	5E-4	7E-4	9E-4	1E-3
		DBA	[1E-4, 6E-4]	[2E-4, 9E-4]	[3E-4, 1E-3]	[4E-4, 2E-3]	[4E-4, 2E-3]	[5E-4, 3E-3]
		PBA	[1E-5, 9E-4]	[1E-5, 1E-3]	[6E-5, 1E-3]	[1E-4, 2E-3]	[2E-4, 2E-3]	[2E-4, 3E-3]
TEQ	Reaches 5 & 6	MCA	3E-3	5E-3	8E-3	1E-2	1E-2	2E-2
		DBA	[2E-3, 1E-2]	[3E-3, 1E-2]	[4E-3, 2E-2]	[6E-3, 3E-2]	[7E-3, 3E-2]	[8E-3, 4E-2]
		PBA	[1E-4, 1E-2]	[1E-4, 2E-2]	[6E-4, 2E-2]	[1E-3, 3E-2]	[2E-3, 4E-2]	[2E-3, 4E-2]

“MCA” = Monte Carlo analysis, “DBA” = dependency bounds analysis, and “PBA” = probability bounds analysis. Values in square brackets are intervals.



(Note: x-axis is log scaled.)

Figure 6-107 Total PCB Cancer Risk for Waterfowl Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-108 TEQ Cancer Risk for Waterfowl Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation, Dependency Bounds, and Probability Bounds Analysis

6.8.8 Noncancer Hazard Quotients from Waterfowl Ingestion Calculated with MEE Models

Hazard quotients for tPCBs from waterfowl ingestion were calculated with the MEE Monte Carlo simulations and probability bounds analyses. Table 6-13 shows hazard quotients by select percentiles for adults and children. Each cell of the table shows the results of the one-dimensional Monte Carlo analysis (MCA) and the probability bounds analysis (PBA, in brackets). The probability bounds indicate the range of values that the hazard quotients could take given the uncertainty regarding the magnitudes and precise distributional shapes of the various input distributions. Figure 6-109 and Figure 6-110 show the hazard quotient distributions for adults and children, respectively.

6.9 SENSITIVITY ANALYSES

Analyses of the sensitivity of the results to variability and uncertainty in the input variables in the Monte Carlo simulations and probability bounds analyses are presented in the subsections that follow. An input variable contributes significantly to uncertainty in the output risk distribution if it is both highly uncertain and its uncertainty propagates through the algebraic risk equation to the model output (i.e., risk estimate). Changes to the distribution or to the characterization of the uncertainty for a variable with a high sensitivity could have a large impact on the risk estimate, whereas even large changes to the variability or uncertainty of a variable with low sensitivity may have a minimal impact on the final result. Information from sensitivity analysis can be important when interpreting the reliability of model results and making risk management decisions. EPA guidance on conducting probabilistic risk assessments (EPA, 2001, Appendix A) and Attachment 5 of the HHRA include more-detailed discussions of sensitivity analyses.

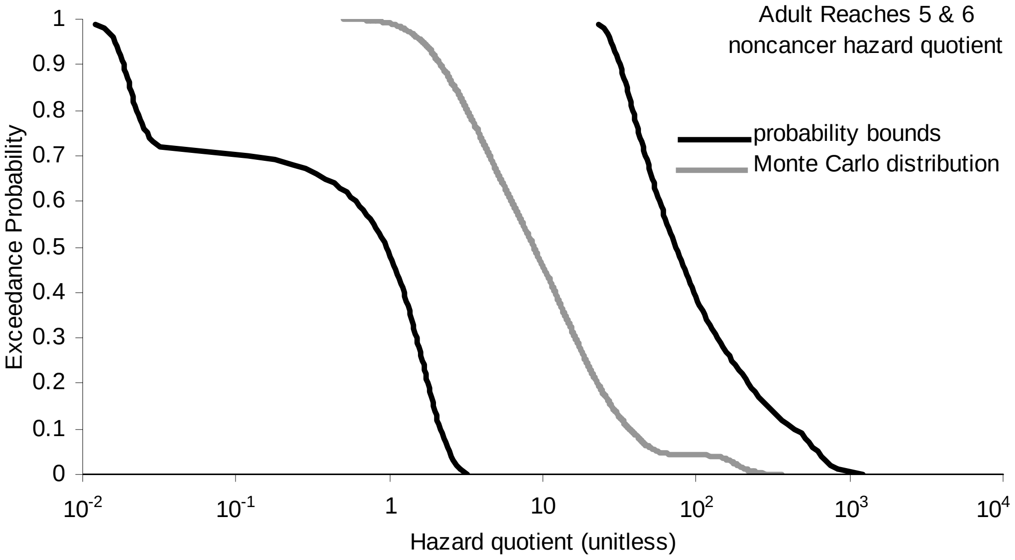
For each risk model at each location and for fish and waterfowl, the risk estimate calculated with Monte Carlo simulation was subjected to correlation analysis. In particular, the coefficient of determination (r^2) was calculated for each input variable with respect to risk. This coefficient estimates the contribution of each input variable to variability in the risk distribution. These coefficients were converted to normalized percentages. Spearman rank correlation coefficients

Table 6-13

Noncancer Hazard: Results of the MEE Monte Carlo Simulation and Probability Bounds Risk Analysis for Waterfowl Ingestion Exposure

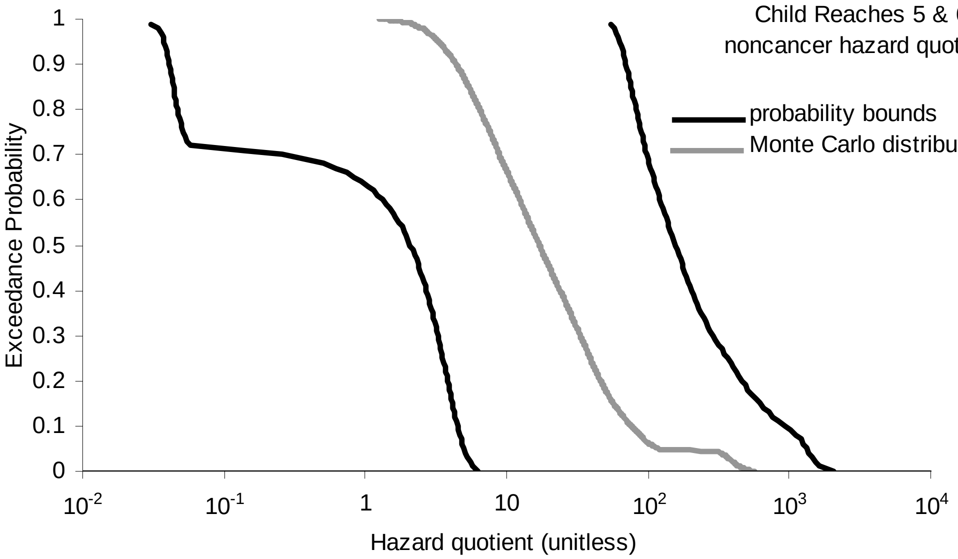
			Hazard quotient percentiles					
						RME range		
Receptor	Site	Analysis	25%	50%	75%	90%	95%	99%
Adult	Reaches 5 & 6	MCA	3.8	8.7	19	37	57	216
		PBA	[0.026, 42]	[1.0, 73]	[1.6, 172]	[2.1, 437]	[2.4, 613]	[2.9, 836]
Child	Reaches 5 & 6	MCA	7.6	17	39	76	118	445
		PBA	[0.051, 90]	[2.1, 156]	[3.5, 367]	[4.5, 922]	[5.0, 1324]	[5.8, 1639]

"MCA" = Monte Carlo analysis and "PBA" = probability bounds analysis. Values in square brackets are intervals.



(Note: x-axis is log scaled.)

Figure 6-109 Adult Noncancer Hazard for tPCBs from Waterfowl Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis



(Note: x-axis is log scaled.)

Figure 6-110 Child Noncancer Hazard for tPCBs from Waterfowl Ingestion at the PSA—Risk Assessment Results from the MEE Monte Carlo Simulation and Probability Bounds Analysis

were used for the one-dimensional Monte Carlo simulation results, and Pearson correlation coefficients were used for the MEE Monte Carlo simulation results. EPA guidance (2001, Appendix A) discusses this method of sensitivity analysis in more detail.

For the probability bounds analysis, to determine the effect of uncertainty in a variable on the overall uncertainty in the model, each variable containing uncertainty was "pinched," in turn, to the precise probability distribution used in the Monte Carlo simulation. The area between the resulting probability bounds (a measure of uncertainty) was divided by the area between the probability bounds from the un-pinched ("base case," see Attachment 5 to the HHRA) model result to determine the proportional effect of uncertainty in each variable on the model. Because many of the variables in the probability bounds analysis contain both variability (i.e., the shape of the distribution is specified, and the parameters may or may not contain uncertainty) and uncertainty, each variable in the probability bounds analysis was next replaced, in turn, by a point estimate (the arithmetic mean of probability distributions and p-boxes, the point estimate analysis value for intervals), and the ratio of the areas between the bounds was again calculated. For each of these relative uncertainty analyses, the results were expressed as 1 minus the computed ratio and converted to a percentage. This allows the value to be interpreted as a measure of the importance of the uncertainty and variability of each variable to the uncertainty in result. Attachment 5 of Volume I of the HHRA discusses these probability bounds sensitivity analysis methods in more detail and provides several numerical examples.

The complete results of the sensitivity analyses are presented in Tables 6-14 through 6-16 for the one-dimensional cancer model, adult noncancer model, and child noncancer model, respectively. Tables 6-17 through 6-19 present the sensitivity analysis results for the MEE cancer model, adult noncancer model, and child noncancer model, respectively. The values in the table are percentages, as described above. Sensitivity analyses based on correlation analysis of the Monte Carlo risk results are presented in the left third of each table. The middle third of each table shows the results of reducing the input p-boxes to the probability distribution inputs used in the Monte Carlo simulations. The last third of each table shows the results of reducing the input p-boxes to point estimates.

Table 6-14

Sensitivity Analyses for the One-Dimensional Probabilistic Cancer Model

Cancer 1-dimensional Model	Monte Carlo						Probability bounds											
	Contribution to variability Site						Remove uncertainty Site						Remove uncertainty and variability Site					
Variable	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W
concentration in fish (mg/kg)							0.2	0.4	0.1	0.3	0.1	1.5						
adult intake rate (g/meal)						14						24						62
child intake rate (g/meal)						3.0						9.5						49
adult body weight (kg)	1.2	1.2	1.2	1.2	1.2	2.0							30	30	30	31	30	10
child body wieght (kg)	0.1	0.1	0.1	0.0	0.1	0.1							3.1	3.1	3.1	3.3	3.1	0.8
adult exposure duration (yr)	6.4	6.4	6.4	7.7	6.4	16	11	11	11	9.5	11	18	46	45	46	45	46	45
child exposure duration (yr)	1.1	1.1	1.1	1.2	1.1	2.6	2.1	2.1	2.1	1.6	2.1	4.4	6.6	6.6	6.6	6.3	6.6	15
adult exposure frequency (meals/yr)						49						19						45
child exposure frequency (meals/yr)						14						1.9						7.2
fraction ingested (unitless)	17	17	17	20	17		14	14	14	12	14		42	42	42	43	42	
adult EFxIR (g/yr)	60	60	60	57	60		58	58	58	64	58		65	65	65	70	65	
child EFxIR (g/yr)	11	11	11	11	11		11	11	11	13	11		14	14	14	17	14	
cooking loss (unitless)	1.3	1.3	1.3	1.3	1.3		5.2	5.2	5.2	4.0	5.2		18	18	18	18	18	

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = Waterfowl

Values are percentages. Monte Carlo contribution to variability values are scaled to add to 1. Probability bounds percentages need not add to 1.

Table 6-15

Sensitivity Analyses for the One-Dimensional Probabilistic Noncancer Model for Adults

Non-cancer 1-dimensional Model	Monte Carlo						Probability bounds											
Adults	Contribution to variability						Remove uncertainty						Remove uncertainty and variability					
	Site						Site						Site					
Variable	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W
concentration in fish (mg/kg)							0.6	1.1	0.4	0.5	0.5	3.8						
intake rate (g/meal)						23						56						82
adult body weight (kg)	1.7	1.7	1.7	2.1	1.7	3.4							28	28	28	33	28	7.4
adult exposure frequency (meals/yr)						74						44						61
fraction ingested (unitless)	11.5	11.5	11.5	14.2	11.5		17	17	18	15	17		46	46	46	48	46	
adult EFxIR (g/yr)	85	85	85	82	85		70	70	70	76	70		77	76	78	82	77	
cooking loss (unitless)	0.8	0.8	0.8	0.8	0.8		8.1	8	8.2	6.2	8.2		25	25	25	26	25	

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = Waterfowl

Values are percentages. Monte Carlo contribution to variability values are scaled to add to 1. Probability bounds percentages need not add to 1.

Table 6-16

Sensitivity Analyses for the One-Dimensional Probabilistic Noncancer Model for Children

Non-cancer 1-dimensional Model Children	Monte Carlo						Probability bounds											
	Contribution to variability Site						Remove uncertainty Site						Remove uncertainty and variability Site					
Variable	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W
concentration in fish (mg/kg)							0.7	1.2	0.5	0.6	0.6	4.1						
intake rate (g/meal)						24						61						82
child body weight (kg)	0.6	0.6	0.6	1.1	0.6	1.2							17	17	17	21	17	4.2
child exposure frequency (meals/yr)						75						45						60
fraction ingested (unitless)	11	11	11	14	11		19	19	19	17	19		47	46	47	48	47	
child EFxIR (g/yr)	87	87	87	83	87		68	67	68	74	68		75	74	76	80	75	
cooking loss (unitless)	0.6	0.6	0.6	0.7	0.6		9.0	8.8	9.1	7	9.0		25	25	25	26	25	

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = Waterfowl

Values are percentages. Monte Carlo contribution to variability values are scaled to add to 1. Probability bounds percentages need not add to 1.

Table 6-17

Sensitivity Analyses for the MEE Probabilistic Cancer Model

Cancer Microexposure Model	Monte Carlo						Probability bounds											
	Contribution to variability						Remove uncertainty						Remove uncertainty and variability					
	Site						Site						Site					
Variable	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W
concentration in fish (mg/kg)							0.1	0.2	0.1	0.1	0.1	14						
adult intake rate (g/meal)	0.1	0.0	0.2	0.2	0.0	0.0	15	15	15	15	15	0.0	15	15	15	15	15	0.0
child intake rate (g/meal)	0.3	0.0	0.1	0.4	0.1	0.3	16	16	16	16	16	0.0	16	16	16	16	16	0.0
adult body weight (kg)	11	9.0	7.3	8	7.0	14							11	11	11	11	11	9.2
child body wieght (kg)	0.1	0.4	1.3	2.2	0.1	0.3							15	15	15	16	15	0.9
adult exposure duration (yr)	77	79	86	80	84	78	15	15	15	14	15	36	28	28	29	27	29	72
child exposure duration (yr)	5.9	0.8	2.2	2.5	3.3	3.0	0.0	0.0	0.0	0.0	0.0	11	22	22	22	22	22	47
adult exposure frequency (meals/yr)	0.1	0.6	1.5	1.1	0.1	1.4	23	23	23	27	23	0.0	23	23	23	27	23	0.0
child exposure frequency (meals/yr)	3.4	9.6	1.4	4.8	2.3	3.3	42	42	42	46	42	11	46	46	46	49	46	17
fraction ingested (unitless)	1.5	0.6	0.2	0.5	2.0		0.0	0.0	0.0	0.0	0.0		1.5	1.5	1.5	1.5	1.5	
cooking loss (unitless)	0.8	0.2	0.0	0.1	0.9		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = Waterfowl

Values are percentages. Monte Carlo contribution to variability values are scaled to add to 1. Probability bounds percentages need not add to 1.

Table 6-18

Sensitivity Analyses for the MEE Probabilistic Noncancer Model for Adults

Non-cancer Microexposure Model Adults	Monte Carlo						Probability bounds											
	Contribution to variability Site						Remove uncertainty Site						Remove uncertainty and variability Site					
Variable	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W
concentration in fish (mg/kg)							0.7	1.1	0.5	0.6	0.6	48						
intake rate (g/meal)	0.1	0.0	0.0	0.3	0.0	0.5	33	32	33	32	33	0.0	33	32	33	32	33	0.0
adult body weight (kg)	2.6	0.8	1.5	2.5	1.4	1.8							20	20	20	28	20	7.8
adult exposure frequency (meals/yr)	83	85	86	87	81	98	55	54	55	68	55	78	63	62	63	74	63	87
fraction ingested (unitless)	14	14	13	10	17		26	25	26	17	26		44	44	45	44	44	
cooking loss (unitless)	0.1	0.0	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = Waterfowl

Values are percentages. Monte Carlo contribution to variability values are scaled to add to 1. Probability bounds percentages need not add to 1.

Table 6-19

Sensitivity Analyses for the MEE Probabilistic Noncancer Model for Children

Non-cancer Microexposure Model Children	Monte Carlo Contribution to variability Site						Probability bounds											
							Remove uncertainty Site						Remove uncertainty and variability Site					
Variable	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W	R56	RP	CB	CT	L	W
concentration in fish (mg/kg)							0.7	1.2	0.5	0.6	0.7	55						
intake rate (g/meal)	0.5	0.0	0.0	0.0	0.3	0.2	33	33	33	32	33	0	33	33	33	32	33	0.0
child body weight (kg)	0.1	1.5	2.5	1.4	0.5	0.0							11	11	11	17	11	4.0
child exposure frequency (meals/yr)	82	83	82	85	84	100	54	53	54	66	54	80	60	59	60	70	60	87
fraction ingested (unitless)	18	16	15	13	15		28	28	29	19	28		44	43	44	45	44	
cooking loss (unitless)	0.3	0.0	0.0	1.1	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = Waterfowl

Values are percentages. Monte Carlo contribution to variability values are scaled to add to 1. Probability bounds percentages need not add to 1.

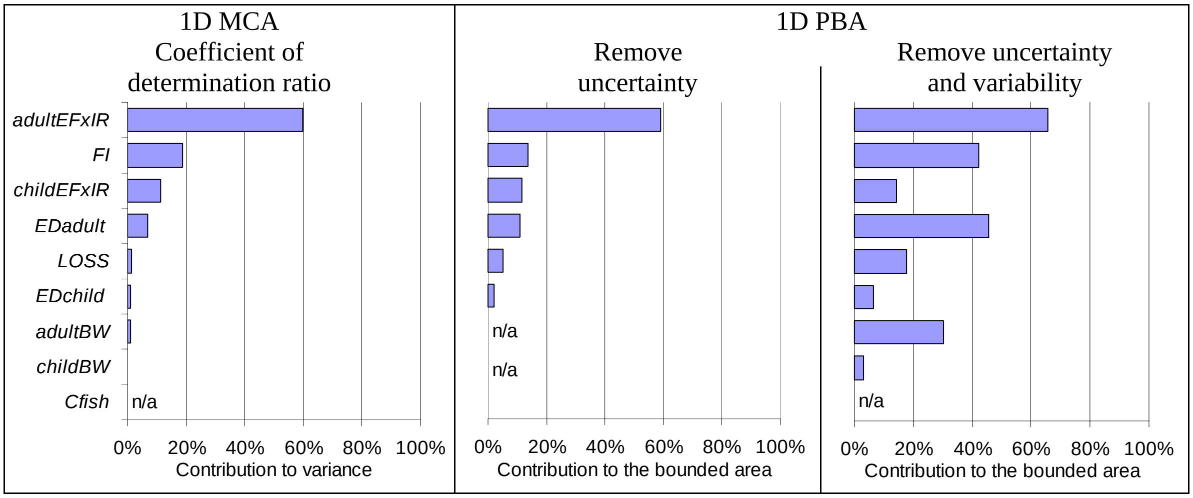
For the Monte Carlo simulations, if variability in an input variable had negligible consequences on the variability of the resulting risk, the value for that variable in the left third of each table would be close to zero. The higher the number, the more important variability in that variable is for the variability of the calculated risk distribution. Likewise, if replacing an input variable p-box with a precise distribution in the probability bounds analyses had little effect on the ratio of the bounded areas in the risk results, the values in the middle third of each table will be close to zero. The higher the number in the table, the more important uncertainty in that variable is to the uncertainty in the calculated risk p-box. The last third of each table, which shows the ratio of risk p-boxes after replacing in turn each input p-box with a point estimate, shows the importance of uncertainty and variability in each input on the probability bounds results. Again, the higher the number, the more important uncertainty and variability in that variable is to the variability and uncertainty in the result.

6.9.1 Discussion of Sensitivity Analyses

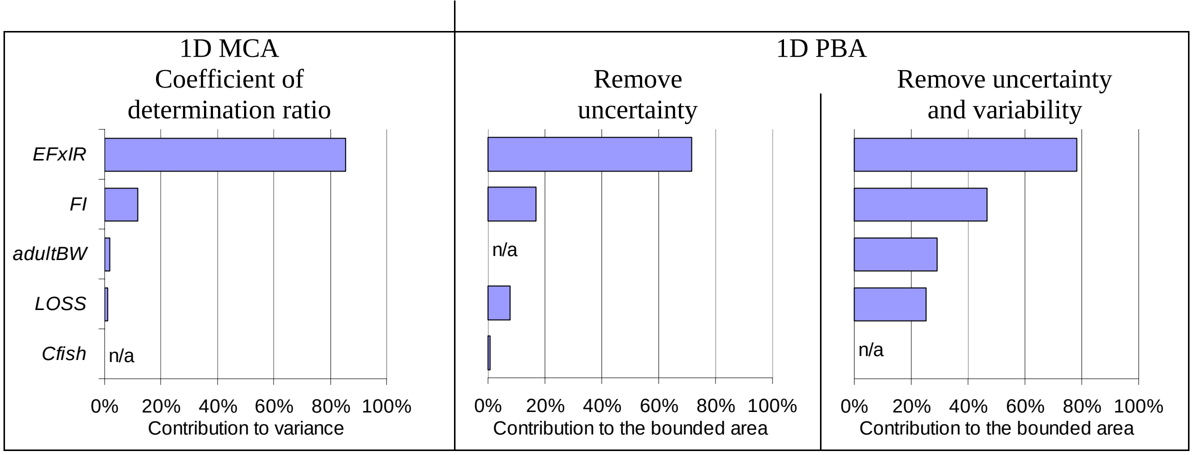
6.9.1.1 Fish Exposure Pathway

Figures 6-111 and 6-112 present graphical summaries of the sensitivity analysis results shown in Tables 6-14 through 6-19. The bars in the figures represent average percent contributions to variability (in the case of the MCA models) or area between probability bounds (in the case of PBA models). These average percent contributions were calculated as the mean of the results for the five locations (i.e., the PSA, Rising Pond, West Cornwall/Bulls Bridge Bass, West Cornwall/Bulls Bridge Trout, and Lake Lillinonah/Zoar). The use of averages across locations is supported by the similarity in percentages seen across locations for each variable in the tables.

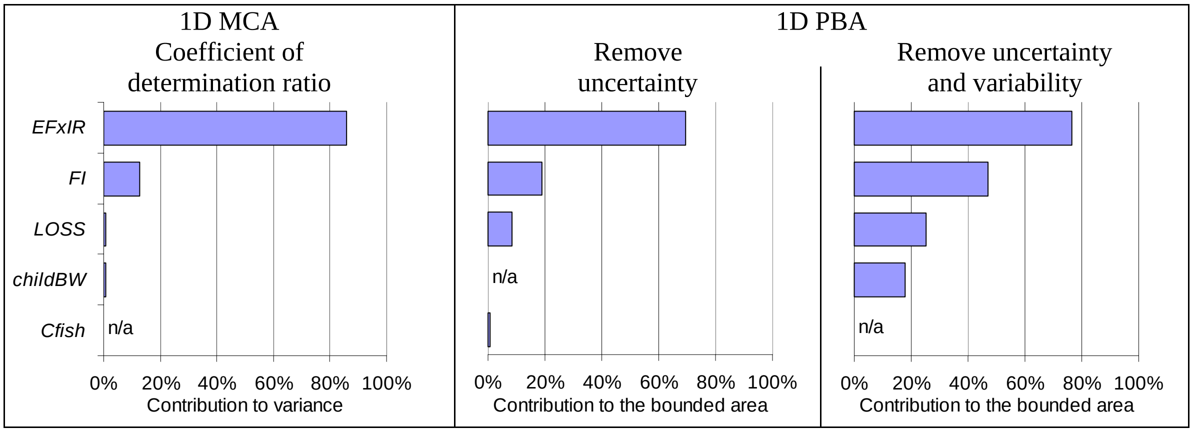
Figures 6-111 and 6-112 provide summary graphics for the sensitivity analyses for the 1-D models and MEE models, respectively. Each figure consists of three panels. The first panel shows sensitivity analysis summary graphics for the cancer endpoint models. The next two panels (B and C) show sensitivity analysis results for the noncancer endpoints for adults and children, respectively. As in Tables 6-14 through 6-19, the figures present the average results of the MCA sensitivity analyses on the left, and the PBA sensitivity analyses are shown to the right.



Panel A. 1D cancer model of exposure from fish consumption



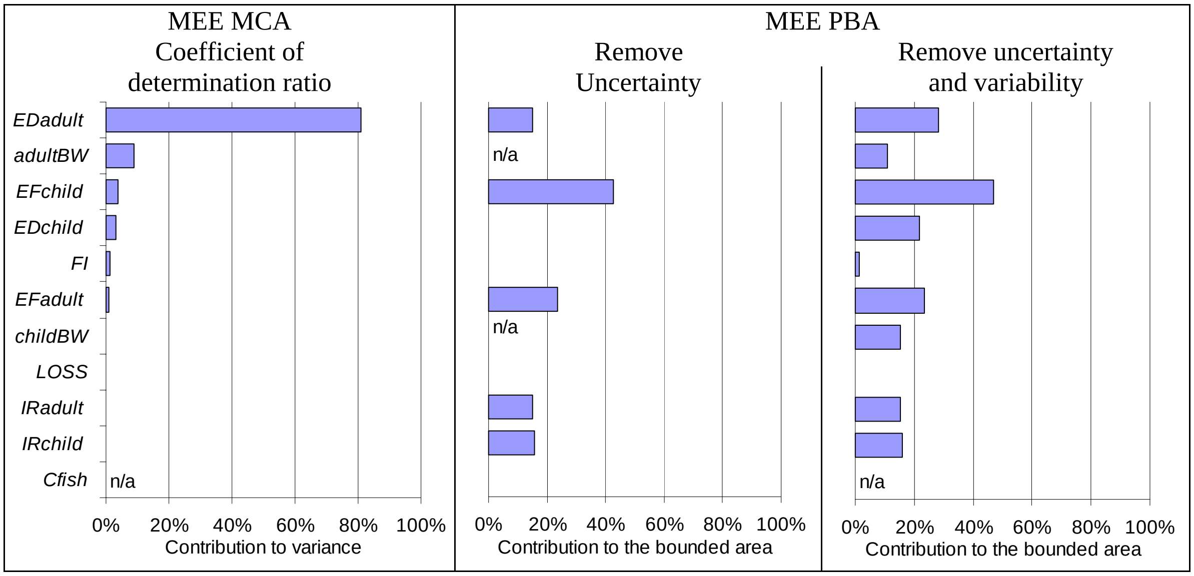
Panel B. 1D adult noncancer model of exposure from fish consumption



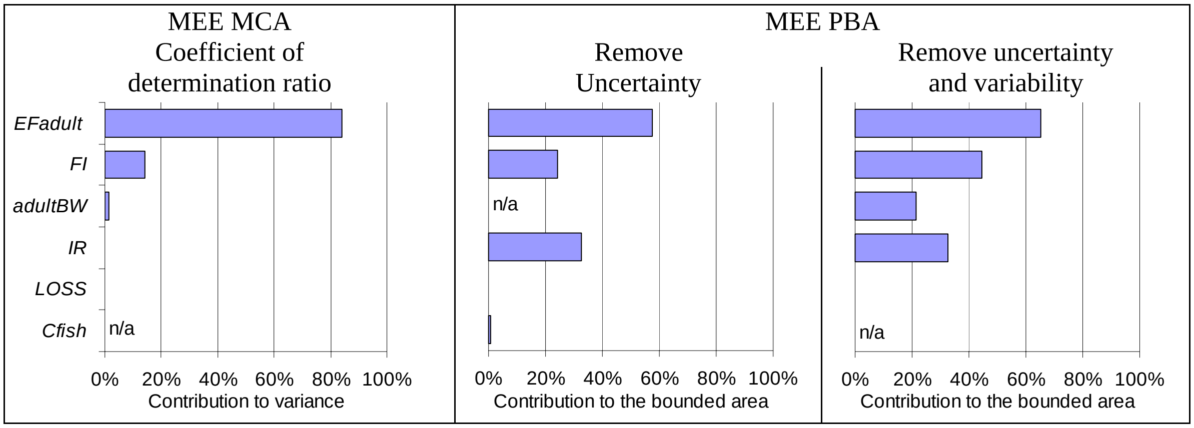
Panel C. 1D child noncancer model of exposure from fish consumption

Note: Percent contributions shown are averages across all five locations.

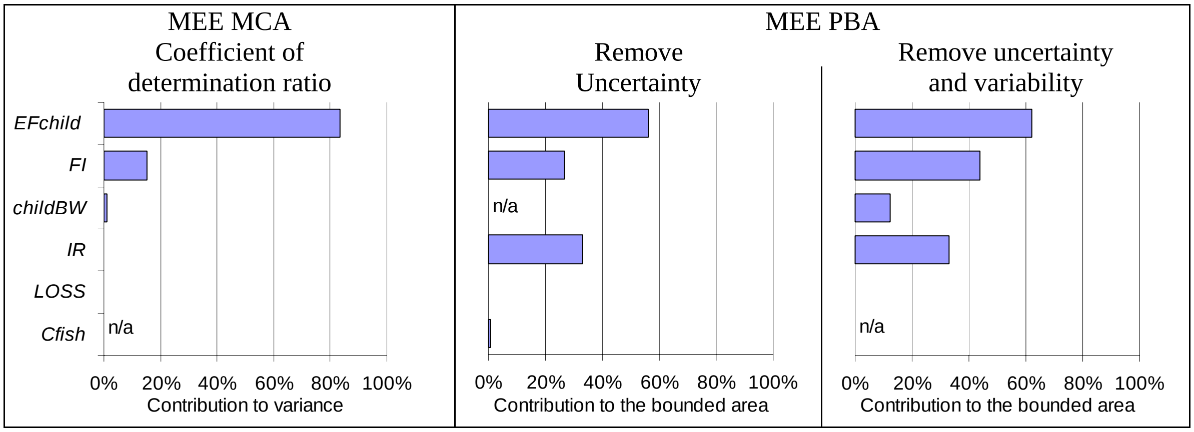
Figure 6-111 Summary of Sensitivity Analyses for the 1-D Exposure Models



Panel A. MEE cancer model of exposure from fish consumption



Panel B. MEE adult noncancer model of exposure from fish consumption



Panel C. MEE child noncancer model of exposure from fish consumption

Note: Percent contributions shown are averages across all five locations.

Figure 6-112 Summary of Sensitivity Analyses for the MME Exposure Models

In each figure, the leftmost panel depicts the sensitivity analysis for the MCA based on the coefficient of determination (r^2), which is a measure of the proportion of the variability in the result that is explained by the input parameters. The figure shows the average ratio of the r^2 for each input variable divided by the total r^2; thus, the bars in each of these graphs sum to 100%.

In the PBA sensitivity analysis summary graphs, the bars represent the average ratio of areas between probability bounds before and after pinching each input variable singly to either a precise probability distribution or to a point estimate. This provides an estimate of each input variable's contribution to the variability and uncertainty in the model output; however, the percentages need not sum to 100%.

In Figure 6-111 and Figure 6-112, "n/a" denotes cases where a variable lacked uncertainty, variability, or both, and one or more of the three sensitivity analyses (i.e., correlation, pinching to probability distribution, or pinching to point estimate) could not be performed. For example, in Figure 6-111, Panel B, C_{fish} is characterized as a point in all MCA simulations, precluding the calculation of a correlation. For the PBA, C_{fish} is an interval containing uncertainty but no variability. When uncertainty is removed, this interval pinches to a point (middle graph in Panel B) and a percentage contribution effect is reported. However, no further reduction is possible and "n/a" is reported in the rightmost graph in Panel B for this variable. Similarly, adult body weight was modeled with variability but no uncertainty. Therefore the middle graph in Panel B is marked "n/a" for adult body weight because there is no uncertainty to pinch. The effect of pinching variability in body weight is shown in the rightmost graph.

The one-dimensional sensitivity analyses for the cancer risk results (Figure 6-111, Panel A) indicate that variability in adult ingestion rate (*EF×IR*) explains the largest amount of variance in risk, for the Monte Carlo simulation, and the largest change in area bounded, for the PBA. The one-dimensional noncancer hazard sensitivity analyses for both adults and children (Figure 6-111, Panel B and Panel C) also show ingestion rate (*EF×IR [meal size]*) to be the major contributor to variability in the hazard result. Uncertainty in fraction ingested is consistently second in importance in both noncancer and cancer models. Adult exposure duration contributes significantly to cancer models as well. The impact of uncertainty in concentration is minimal.

In the MEE Monte Carlo simulation of cancer risk (Figure 6-112, Panel A), adult exposure duration contributes more to variability in the risk estimates than exposure frequency. When uncertainty is removed from the probability bounds analyses of the same model, child and adult exposure frequency have the largest influence on the variability of the risk estimate. The sensitivity analysis of the MEE Monte Carlo noncancer models is dominated by the importance of both uncertainty and variability in exposure frequency. Uncertainty and variability in fraction ingested also affect uncertainty and variability in the risk estimate. In addition, the PBA MEE noncancer models indicate both variability and uncertainty in ingestion rate to be important. Uncertainty in concentration has negligible effects.

6.9.1.2 Waterfowl Exposure Pathway

For waterfowl, sensitivity analyses of the one-dimensional Monte Carlo simulations of cancer risk indicate exposure frequency and ingestion rate are important (Table 6-14). In the waterfowl models, ingestion rate is a distribution based on site-specific data. In the MEE Monte Carlo simulations, variability in ingestion rate explains the vast majority of variability in the risk distribution (Table 6-17). Removing uncertainty from the probability bounds analyses also indicates ingestion rate and exposure frequency are important in the one-dimensional model, while exposure duration has a larger impact on variability in risk in the MEE model. This is similar to the pattern seen in the fish cancer risk sensitivity analysis, and the elevation of exposure duration over exposure frequency in importance is likely due to the nesting of exposure frequency within the exposure duration loop in the MEE model, which de-emphasizes variability in exposure frequency.

Noncancer waterfowl one-dimensional and MEE Monte Carlo simulations of cancer hazard indicate that exposure frequency contributes most to variability in the hazard result (Table 6-15, Table 6-16, Table 6-18, and Table 6-19). Probability bounds analyses hazard results are most sensitive to ingestion rate (calculated as EF x IR [meal size]) in the one-dimensional model case, and exposure frequency for the MEE analysis. The hazard distribution also displays some sensitivity to uncertainty in the concentration input variable.

6.9.1.3 Summary of Fish and Waterfowl Exposure Parameter Sensitivity Analyses

- Exposure frequency, fraction ingested, and exposure duration are consistently the most influential input variables with respect to cancer risk results.

- Exposure frequency and fraction ingested are consistently the most influential input variables with respect to noncancer hazard results.

- The sensitivity model results are similar across locations and broadly consistent across one-dimensional and MEE models.

- The one-dimensional and MEE cancer models differ with respect to the degree to which their risk and hazard distributions are sensitive to exposure frequency versus exposure duration. This result was expected because the purpose of the MEE model is to emphasize average exposure frequency values over the extremes of the exposure frequency distribution.

6.9.2 Model Uncertainty: One-Dimensional and MEE Models Compared

Comparing the results of the one-dimensional model with the MEE model permits the exploration of the sensitivity of the cancer risk or noncancer hazard distributions to the choice of model. As discussed in Section 6.3, MEE models remove the possibility that an individual will be simulated who eats the maximum amount of fish and waterfowl using the cooking method that results in the least loss at every meal for an entire lifetime. However, this approach over-emphasizes the average of the input distributions, eliminating the possibility that some individuals may in fact eat larger than average meals of fish and waterfowl cooked so as to minimize loss more often than would be expected by chance. To illustrate how much meal-to-meal and year-to-year dependencies between exposure events affect the risk results, Table 6-20 shows the coefficient of variation (CV) calculated for the one-dimensional and MEE Monte Carlo simulation risk and hazard distributions for each location for fish and waterfowl. The CV allows a comparison of the amount of variation across populations with different means. The rightmost third of the table shows the difference in CVs between the modeling approaches.

Table 6-20

Coefficient of Variation Calculated for the Risk Distributions and Hazard Distributions Resulting from the One-Dimensional and MEE Monte Carlo Simulations

	1-dimensional Monte Carlo risk distribution coefficient of variation			Microexposure Monte Carlo risk distribution coefficient of variation			Difference between CVs Model		
Site	cancer	noncancer adult	noncancer child	cancer	noncancer adult	noncancer child	cancer	noncancer adult	noncancer child
R56	195	203	202	59	179	177	136	24	25
RP	195	203	202	60	176	174	135	27	27
CB	195	203	202	60	181	178	134	22	23
CT	205	216	221	61	191	187	144	25	35
L	195	203	202	60	179	175	135	23	27
W	214	227	230	63	201	196	152	26	34

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout;
L = Lake Lillinonah/Zoar; W = waterfowl

The last third of the table shows the difference between the one-dimensional and the MEE CV (1-D – MEE).

For the both the cancer and noncancer models, the Monte Carlo MEE simulation results in a consistent reduction in variability compared to the one-dimensional model for both fish and waterfowl. Figure 6-113 shows the cancer exposure distributions calculated with the one-dimensional and MEE Monte Carlo models for the PSA. The MEE exposure distribution is more vertical and exhibits a shortened right-hand tail. The MEE model results in a significant reduction in cancer model variability over the 1-D treatment. Figure 6-114 shows the noncancer exposure distributions calculated with the one-dimensional and MEE Monte Carlo models for the PSA. Little difference exists between the distributions, except for the tail length beyond the 99th percentile. The extreme tail of the MEE noncancer exposure distribution is much shorter than the 1-D model tail; however, this results in only a modest reduction in variance for the noncancer models.

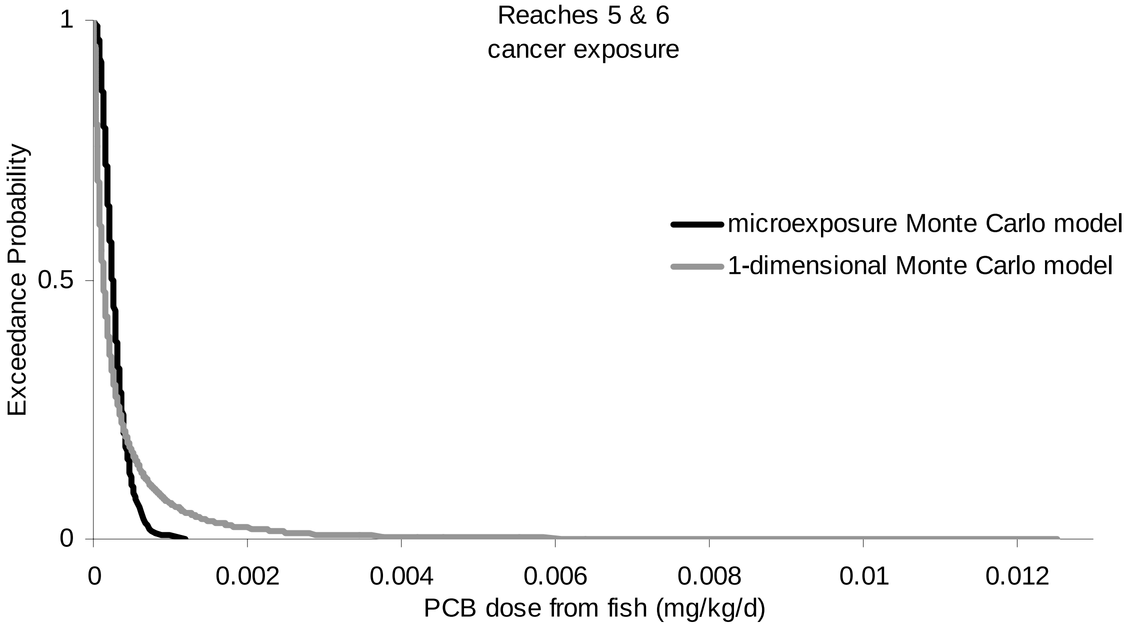
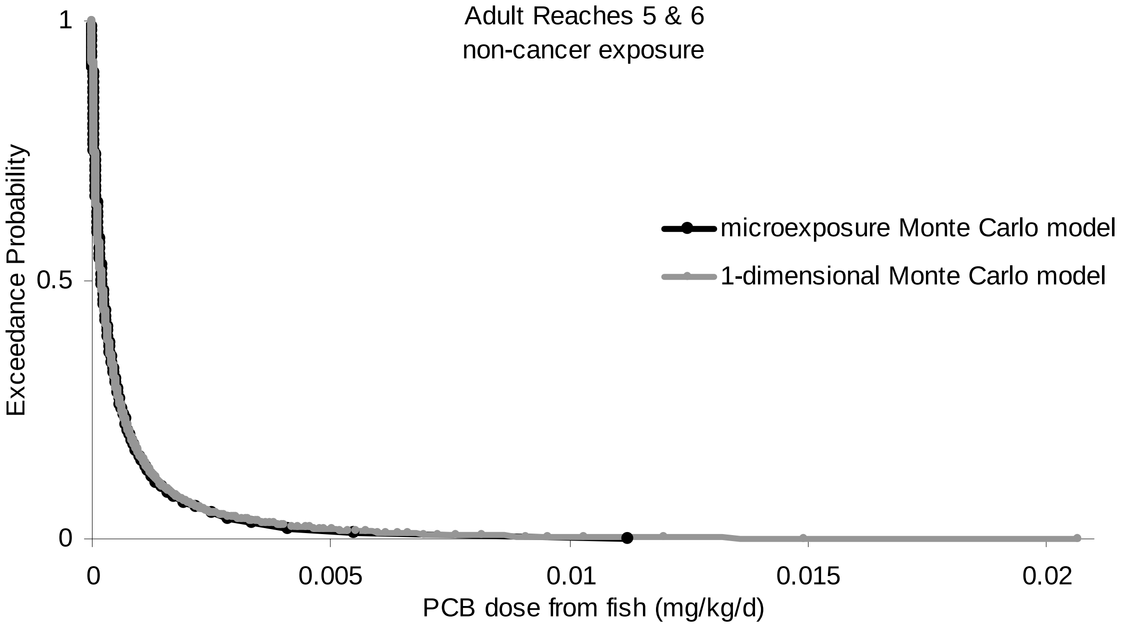


Figure 6-113 Comparison of Cancer Exposure Distributions Generated by the Monte Carlo Simulation of the One-Dimensional and MEE Risk Model



Note: The black dot on the x-axis shows the right-hand terminus of the MEE model exposure distribution.

Figure 6-114 Comparison of Noncancer Exposure Distributions Generated by the Monte Carlo Simulation of the One-Dimensional and MEE Risk Model

Table 6-21 shows the results of a sensitivity analysis of the p-boxes resulting from the one-dimensional probability bounds analysis and the MEE probability bounds analysis. The table shows the percent reduction in variability (measured by p-box breadth, see Attachment 5 of the HHRA) from the p-box generated with the one-dimensional model to the p-box generated with the MEE model. In every case, the MEE model results in a reduction in variability in the probability bounds around the risk or hazard.

Table 6-21

Reduction in Variability of the p-box Around the Cancer Risk and Noncancer Hazard Distributions Calculated with the One-Dimensional Probability Bounds Analysis and the MEE Probability Bounds Analysis

	Probability bounds Reduction in variability		
Site	cancer	non-cancer adult	non-cancer child
R56	39	23	20
RP	39	23	20
CB	39	23	20
CT	43	17	15
L	39	23	20
W	52	43	42

R56 = Reaches 5 & 6; RP = Rising Pond; CB = West Cornwall/Bulls Bridge bass; CT = West Cornwall trout; L = Lake Lillinonah/Zoar; W = waterfowl

"Reduction" refers to the percentage reduction in breadth of the one-dimensional p-box that results when the p-box is calculated with an MEE analysis.

Model uncertainty was explicitly assessed by analyzing two risk models – one-dimensional and MEE. These bracket a range of important assumptions regarding intra-individual variability in exposure over time. This treatment, however, represents only one dimension of model uncertainty. Other dimensions include dependency and alternate model exposure formulations. Model uncertainty due to dependencies was also quantitatively addressed with the dependency bounds analyses. These dependency bounds include all risk distributions that might result where the Monte Carlo simulation iterated through any and all possible dependency relationships between input variables. This approach quantifies the degree to which the risk results might vary were different assumptions regarding dependencies made.

Attachment 6 to Volume I (Section 4.4) discusses the issue of model uncertainty in probabilistic risk assessments in general detail. For the fish and waterfowl ingestion risks calculated in this risk assessment in particular, however, uncertainties regarding the mathematical models remain. The general quantitative treatment for model uncertainty is to specify additional competing models and compare their results, as was done with one-dimensional and MEE models in this assessment. Although the mathematical formulations used in this assessment are conventional and have a long track record of applications, other formulations may be reasonable. In this risk assessment, model structural assumptions regarding the temporal component of exposure were considered, as was the contribution of dependencies.

6.9.3 Truncation

Only one variable, adult exposure duration, is significantly truncated in the probabilistic analyses. This variable is truncated to 64 years in order to match the duration of the cancer model averaging time of 70 years. The Monte Carlo simulation truncates by replacing random draws larger than 64 years with 64 years (approximately 6% of all draws). The probability bounds analysis incorporated a pre-truncation mean and standard deviation that resulted in post-truncation statistics the same as the original (un-truncated) distribution, thus bounding all risk distributions that could result from any truncation choice that retains the observed mean and variance. Table 6-22 shows the effect of truncating adult exposure duration on the RME range. Removing truncation would increase the risk estimate by a small amount. Note, however, that the un-truncated model allows for exposure durations longer than 70 years, which means that the increased risks shown in the table are outer bounds on possible risk.

Two of the input distributions used to make the stochastic mixture for cooking loss were also truncated. These lognormal distributions were fitted to cooking loss data for broiling and deep fat frying, respectively. Because cooking loss is a proportion, the maximum loss must be no greater than one (i.e., 100% loss). These truncations were minor, however, both occurring well beyond the 99th percentile of the loss distribution for each cooking method (see Figure 6-3 and Figure 6-5).

Table 6-22

Increase in Cancer Risk Exposure Calculation (mg/kg bw-d) over the RME Range when Adult Exposure Duration is Allowed to Vary Beyond 64 Years

	Average increase without truncation	
RME range	1-dimensional model	Microexposure model
0.90	0.0000	0.0001
0.91	0.0000	0.0001
0.92	0.0000	0.0001
0.93	0.0001	0.0002
0.94	0.0001	0.0001
0.95	0.0001	0.0002
0.96	0.0002	0.0006
0.97	0.0005	0.0005
0.98	0.0008	0.0014
0.99	0.0670	0.0014

The increase reported is the average across all locations, bass and trout, and fish and waterfowl.

6.10 SOURCES OF UNCERTAINTY

Tables 6-23 through 6-26 summarize the major assumptions leading to uncertainty in the risk and hazard distribution results used by the Monte Carlo simulations and the probability bounds analyses for fish and waterfowl consumption. The assumptions marked with an "O" are expected to be optimistic or nonprotective assumptions. This means that such an assumption could lead to exposures and risk estimates that are likely to be no larger than the true exposures to the receptor populations, and may be lower. In the case of the bounding analyses, it means that the uncertainty is, if anything, understated. The assumptions in the table marked with a "C" are expected to be conservative or protective. Such an assumption could overestimate risks or the uncertainty about the risks. Those assumptions marked with a "?" have mixed or uncertain bias consequences for the analyses. In light of the sensitivity analyses presented in the previous section, assumptions related to exposure frequency (*EF*), exposure duration (*ED*) and fraction ingested (*FI*) are of particular interest.

Table 6-23

Monte Carlo Simulation Assumptions and Sources of Uncertainty for Fish Exposure Pathway Risk and Hazard Analysis

C	One-dimensional modeling
O	Microexposure event modeling
C	C_{fish}, EPC point estimate used rather than mean or distribution
O	C_{fish}, tissue concentrations for bullhead/bass and perch/sunfish evenly mixed (angler may have preference for bass/bullhead)
?	C_{fish}, trout modeled separately from other fish
+/-	$LOSS$, cooking methods mixed based on a study reported preferences Small$LOSS$, fish species from loss studies not exactly the same as fish in the Housatonic
?	BW, values constant for adults
?	BW, perfect correlation among body weights for growing children
?	BW, even mixture of males and females
?	BW, even mixture of boys and girls, averaged over 1 to 6 years of age
?	EF, $EF \times IR$, data from Maine angler population used as surrogate for MA and CT anglers
O	EF, $EF \times IR$, trout exposure modeled with streams and rivers data from Maine
?	EF, $EF \times IR$, fish (non-trout) exposure modeled with all waters data from Maine
C	EF, $EF \times IR$, Maine data not truncated
C	EF, $EF \times IR$, assumed anglers did not share their catch with other household
C	EF, $EF \times IR$, used same distribution for adult and child
?	ED, uniform distribution for children
O	ED, truncated to a value smaller than observed residence times
?	FI, EDF based on distances Maine anglers travel to fish
?	FI, weights of six fractions based on Maine angler behavior
?	IR, assumed triangular distribution with 8 oz. midpoint for fish meal size
?	IR, assumed meal sizes never smaller than 5 oz. and never larger than 12 oz.
?	IR, children taken to be 1/2 value for adult fish ingestion

Table 6-24

Probability Bounds Analysis Assumptions and Sources of Uncertainty for Fish Exposure Pathway Risk and Hazard Analysis

C	One-dimensional modeling
O	Microexposure event modeling
C	C_{fish}, distribution means are interval from sample mean to EPC
O	C_{fish}, tissue concentrations for bullhead/bass and perch/sunfish evenly mixed
?	C_{fish}, trout modeled separately from other fish
O	*LOSS*, mixture of few averages, no sampling uncertainty
?	*LOSS*, cooking methods mixed based on a study reported preferences
?	*LOSS*, fish species from loss studies not exactly the same as fish in the Housatonic
O	*BW*, precise distribution
?	*BW*, values constant for adults
?	*BW*, perfect correlation among body weights for growing children
?	*BW*, even mixture of males and females
?	*BW*, even mixture of boys and girls, averaged over 1 to 6 years of age
O	*EF*, *EF*×*IR*, trout exposure modeled with streams and rivers data from Maine
?	*EF*, *EF*×*IR*, six Maine EDFs enveloped to form p-box
C	*EF*, *EF*×*IR*, used same distribution for adult and child
O	*ED*, truncated to a value smaller than observed residence times
?	*FI*, p-box based on summary statistics regarding distances Maine anglers travel to fish
?	*FI*, weights of six fractions based on Maine angler behavior
O	*IR*, modest range ([5,12] ounces) for uncertainty about meal size
?	*IR*, *EF*×*IR*, children assumed to be 1/2 value of adults

Table 6-25

Monte Carlo Simulation Assumptions and Sources of Uncertainty for Waterfowl Exposure Pathway Risk and Hazard Analysis

C	One-dimensional modeling
O	Microexposure event modeling
C	C_{duck}, EPC point estimate used rather than mean or distribution
C	*LOSS*, assumed to be zero
?	*BW*, distribution tails truncated
?	*BW*, values constant for adults
?	*BW*, perfect correlation among body weights for growing children
?	*BW*, even mixture of males and females
?	*BW*, even mixture of boys and girls, averaged over 1 to 6 years of age
?	*EF*, data from study of MA hunters
C	*EF*, used same distribution for adult and child
?	*ED*, uniform distribution for children
O	*ED*, truncated to a value smaller than observed residence times
?	*IR*, distribution from literature
?	*IR*, children taken to be 1/2 value for adult waterfowl ingestion
C	IR, distribution for purchased chicken not hunted fowl

Table 6-26

Probability Bounds Analysis Assumptions and Sources of Uncertainty for Waterfowl Exposure Pathway Risk and Hazard Analysis

C	One-dimensional modeling
O	Microexposure event modeling
C	C_{duck}, distribution means are interval from sample mean to EPC
C	*LOSS*, assumed to be zero
O	*BW*, precise distribution
?	*BW*, distribution tails truncated
?	*BW*, values constant for adults
?	*BW*, perfect correlation among body weights for growing children
?	*BW*, even mixture of males and females
?	*BW*, even mixture of boys and girls, averaged over 1 to 6 years of age
?	*EF*, data from study of MA hunters
C	*EF*, used same distribution for adult and child
C	*EF*, maximum = 99.95th percentile of Monte Carlo distribution
O	*ED*, truncated to a value smaller than observed residence times
?	*IR*, distribution from literature
?	*IR*, children taken to be 1/2 value for adult waterfowl ingestion
C	*IR*, maximum = 99.95th percentile of Monte Carlo distribution
?	*IR*, converted to pre-cooked weight to match uncooked tissue concentration samples
C	IR, distribution for purchased chicken not hunted fowl

6.11 EXHIBITS

Exhibit 6-1 shows the Pascal code used to implement the Monte Carlo cancer and noncancer exposure simulation for fish ingestion. Waterfowl ingestion code was nearly identical except for parameter values and fewer locations.

Exhibit 6-2 shows Risk Calc code for dependency and probability bounds analysis of cancer and noncancer models of exposure from fish ingestion. Waterfowl code was nearly identical except for different parameter values and fewer locations.

6.12 REFERENCES

Berleant, D. 1993. Automatically verified reasoning with both intervals and probability density functions. *Interval Computations* 1993 (2): 48-70.

Berleant, D. 1996. Automatically verified arithmetic on probability distributions and intervals, in B. Kearfott and V. Kreinovich, eds., *Applications of Interval Computations,* Kluwer Academic Publishers, 227-244.

Berleant, D. and H. Cheng. 1998. A software tool for automatically verified operations on intervals and probability distributions. *Reliable Computing* 4: 71-82.

Berleant, D. and C. Goodman-Strauss. 1998. Bounding the results of arithmetic operations on random variables of unknown dependency using intervals. *Reliable Computing* 4: 147-165.

Boole, G. 1854. *An Investigation of the Laws of Thought, On Which Are Founded the Mathematical Theories of Logic and Probability*. Walton and Maberly, London.

Brainard J and Burmaster D.E. 1992. Bivariate distributions for height and weight of men and women in the United States. *Risk Analysis* 12: 267-275.

Burmaster, D.E. and E.A.C. Crouch 1997. Lognormal distributions for body weight as a function of age for males and females in the United States, 1976-1980. *Risk Analysis* 17(4):499-505.

Chebyshev [Tchebichef], P. 1874. Sur les valeurs limites des integrales. *Journal de Mathematiques Pures Appliques.* Ser 2, 19: 157-160.

ChemRisk. 1992. *Consumption of Freshwater Fish by Maine Anglers.* 24 July 1992.

Decisioneering, Inc. 1999. Crystal Ball 2000 Standard (v5.0). Denver, CO: Decisioneering, Inc. (Software).

Donald, S. and S. Ferson. 1997. Human health risks from the Visalia Pole Yard: a quality assurance study. Report to Southern California Edison, Rosemead, California, and the Electric Power Research Institute, Palo Alto, California.

Ebert, E.S., S.H. Su, T.J. Barry, M.N. Gray, and N.W. Harrington. 1996. Estimated rates of fish consumption by anglers participating in the Connecticut Housatonic River Creel Survey. *North American Journal of Fisheries Management* 16:81-89.

EPA (U.S. Environmental Protection Agency). 1989. *Exposure Factors Handbook.* August 1989 U.S. Environmental Protection Agency, National Center for Environmental Assessment, Washington, DC EPA/600/8-89/043.

EPA (U.S. Environmental Protection Agency). 1992. *Guidelines for Exposure Assessment. National Center for Environmental Assessment* EPA/600Z-92/001. May 1992.

EPA (U.S. Environmental Protection Agency). 1997. *Exposure Factors Handbook Volume 1 General Factors*, August 1997 U. S. Environmental Protection Agency, National Center for Environmental Assessment, Washington, DC EPA/600/P-95/002Fa.

EPA (U.S. Environmental Protection Agency). 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. http://www.epa.gov/ost/fishadvice/volume2/index.html.

EPA (U.S. Environmental Protection Agency). 2001. *Risk Assessment Guidance for Superfund (RAGS), Volume III - Part A: Process for Conducting Probabilistic Risk Assessment*. EPA 540-R-02-002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC. Available on-line at the EPA website http://www.epa.gov/superfund/programs/risk/rags3a/index.htm

Feller, W. 1968. *An Introduction to Probability Theory and Its Applications. Volume 1*. John Wiley & Sons, New York.

Feller, W. 1971. *An Introduction to Probability Theory and Its Applications. Volume 2*. John Wiley & Sons, New York.

Ferson, S. 1997. Probability bounds analysis. Computing in Environmental Resource Management. Proceedings of the Conference, A. Gertler (ed.), Air and Waste Management Association and the U.S. Environmental Protection Agency, Pittsburgh, Pennsylvania. pp. 669–678.

Ferson, S. and T.F. Long. 1995. Conservative uncertainty propagation in environmental risk assessments. *Environmental Toxicology and Risk Assessment*, Third Volume, ASTM STP 1218, J.S. Hughes, G.R. Biddinger and E. Mones (eds.), ASTM, Philadelphia, pp. 97–110.

Frank, M.J. R.B. Nelsen and B. Schweizer. 1987. Best-possible bounds for the distribution of a sum—a problem of Kolmogorov. *Probability Theory and Related Fields* 74: 199-211.

Fréchet, M., 1935. Généralisations du théorème des probabilités totales. *Fundamenta Mathematica* 25: 379–387.

MDPH (Massachusetts Department of Public Health). 2001. Letter from Suzanne K. Condon, Assistant Commissioner of the Bureau of Environmental Health Assessment to Bryan Olson, U.S. Environmental Protection Agency, Region I. Tables with *Hunting Information for Individual Family Members Who Reported Hunting Birds from the HRA, PCB Exposure Assessment Study, Volunteer Study,* and *Hotline Study* and *Calls from Individuals Concerned about Hunting after Hearing about the PCB Duck Advisory.* 21 August 2001.

Markov (Markoff), A. 1886. Sur une question de maximum et de minimum proposée par M. Tchebycheff. *Acta Mathematica* 9:57-70.

Moore, R.E. 1966. *Interval Analysis*. Prentice Hall, Englewood Cliffs, New Jersey.

Neumaier, A. 1990. *Interval Methods for Systems of Equations*. Cambridge University Press, Cambridge.

Pao, E.M., K.H. Fleming, P.M. Guenther, and S.J. Mickle. 1982. *Foods Commonly Eaten by Individuals: Amount Per Day and Per Eating Occasion*. Consumer Nutrition Center, Human Nutrition Information Service, U.S. Department of Agriculture. Hyattsville, Maryland. Home Economics Research Report Number 44.

Price, P.S., C.L. Curry, P.E. Goodrum, M.N. Gray, J.I. McCrodden, N.H. Harrington, H. Carlson-Lynch, and R.E. Keenan. 1996. Monte Carlo modeling of time-dependent exposures using a microexposure event approach. *Risk Analysis* 16: 339–348.

Regan, H.M., B.E. Sample and S. Ferson. 2002a. Comparison of deterministic and probabilistic calculation of ecological soil screening levels. *Environmental Toxicology and Chemistry* 21: 882-890.

Regan, H.M., B.K. Hope and S. Ferson. 2002b. An analysis of uncertainty in a food web exposure model. *Human and Ecological Risk Assessment* [in press].

Sokal, R.R. and F.J. Rohlf. 1981. *Biometry*. 2nd edition; p-23. Freeman, NY.

Spencer, M. Fisher, N.S., and W.-X. Wang. 1999. Exploring the effects of consumer-resource dynamics on contaminant bioaccumulation by aquatic herbivores. *Environmental Toxicology and Chemistry* 18: 1582-1590.

Spencer, M., N.S. Fisher, W.-X. Wang, S. Ferson. 2001. Temporal variability and ignorance in Monte Carlo contaminant bioaccumulation models: a case study with selenium in Mytilus edulis. *Risk Analysis* 21: 383-394.

West, P.C., J.M. Fly, R. Marans, F. Larkin, and D. Rosenblatt. 1993. 1991-92 Michigan Sport Anglers Fish Consumption Study. Prepared by the University of Michigan, School of Natural Resources for the Michigan Department of Natural Resources, Ann Arbor, MI. Technical Report No. 6. May.

Williamson, R.C. and T. Downs 1990. Probabilistic arithmetic I: Numerical methods for calculating convolutions and dependency bounds. *International Journal of Approximate Reasoning* 4: 89-158.

Yager, R.R. 1986. Arithmetic and other operations on Dempster-Shafer structures. *International Journal of Man-machine Studies* 25: 357-366.

EXHIBIT 6-1

EXAMPLE OF MONTE CARLO PASCAL CODE

EXHIBIT 6-1

EXAMPLE OF MONTE CARLO PASCAL CODE

```
program angler_exposure;
uses dos;
type
  float    = real;

function rnorm : float;
  const
  a=0.919544405706926; b=2.40375765693742;  c=0.825339282536923; d=2.11402808333742;
  e=0.965487131213858; f=4.46911473713927;  g=0.398942280401433; h=0.949990708733028;
  i=1.84039874739771;  j=0.273629335939706; k=0.44329912582022;  l=0.209694057195486;
  m=0.042702581590795; n=0.925852333707704; o=0.2897295736;      p=1.55066917379771;
  q=0.015974522655238; r=0.382544556042518; s=0.016397724358915;
  var u,u0,u1,u2,us,y,cons,test : float;
  begin
  u := random;  u0 := random;
  if u < a
     then rnorm := b * (u0 + u * c) - d
     else if u >= e
        then begin
             repeat
               u1 := random; u2 := random;
               y := sqrt(f - 2 * ln(u1));  {not sqrt?}
               until (y * u2 - d) <= 0.0;
             if (u0 >= 0.5) then rnorm := -y else rnorm := y
             end
        else begin
             cons := g;
             if u >= h
                then begin
                     repeat
                       u1 := random; u2 := random;
                       y := i + u1 * j;
                       test := cons * exp(-(y * y) / 2.0) - k + y * l;
                       until (test - u2 * m) >= 0.0;
                     if u0 >= 0.5 then rnorm := -y else rnorm := y
                     end
                else if u >= n
                     then begin
                          repeat
                            u1 := random; u2 := random;
                            y := o + u1 * p;
                            test := cons * exp(-(y*y)/2.0) - k + y * l;
                            until (test - u2 * q) >= 0.0;
                          if u0 >= 0.5 then rnorm := -y else rnorm := y
                          end
                     else begin
                          repeat
                            u1 := random; u2 := random;
                            y := u1 * o;
                            test := cons * exp(-(y*y)/2.0) - r;
                            until (test - u2 * s) >= 0.0;
                          if u0 >= 0.5 then rnorm := -y else rnorm := y
                          end
             end
    end;

function norm(m, s : float) : float;
  begin
  norm := m + s * rnorm;
  end;

function lognorm(mean, stdev : float) : float;
```

```
  var aa,bb : float;
  begin
  aa := sqr(mean);
  bb := sqr(stdev);
  lognorm := exp(norm((ln(aa/sqrt(aa+bb))), sqrt(ln((aa+bb)/aa))));
  end;

function triang(min,mid,max : float) : float;
  var p,pm,r : float;
  begin
  p := random;
  pm := (mid-min)/(max-min);
  r := mid;
  if p<pm then r:= min + sqrt(p*(max-min)*(mid-min));
  if p>pm then r:= max - sqrt((1.0-p)*(max-min)*(max-mid));
  triang := r;
  end;

type
  shape_type = (constant, normal, lognormal, uniform,
               triangular, binomial, beta, edf1, edf2, edf3);
  distribution_type = record shape : shape_type; mean, stdev, min, max : float; end;
const
  shapename : array[shape_type] of string[10] =
       ('constant','normal','lognormal','uniform','triangular',
       'binomial','beta','edf1','edf2','edf3');
  edf_x : array [edf1..edf3, 0..99] of float = (
       (0.085377049,0.091052503,0.115480174,0.115480174,0.129725361,0.129725361,0.141666909,
       0.141666909,0.151274278,0.151274278,0.161686227,0.161686227,0.17139718,0.17139718,
       0.18321393,0.183271393,0.195885641,0.195885641,0.214456702,0.214456702,0.247807705,
       0.247807705,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,
       0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,
       0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,
       0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,
       0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26,0.26),
       (0.25,0.35,0.38,0.41,0.43,0.46,0.49,0.52,0.56,0.62,0.68,0.75,0.80,0.85,0.90,0.94,0.99,
       1.03,1.07,1.12,1.17,1.23,1.29,1.36,1.44,1.53,1.62,1.72,1.82,1.94,2.07,2.21,2.36,2.52,
       2.68,2.83,2.97,3.10,3.23,3.37,3.50,3.63,3.77,3.91,4.07,4.25,4.45,4.69,4.99,5.35,5.77,
       6.21,6.63,7.01,7.35,7.66,7.97,8.26,8.55,8.84,9.12,9.41,9.69,9.99,10.28,10.58,10.90,11.21,
       11.57,11.93,12.30,12.69,13.09,13.51,13.95,14.41,14.92,15.46,16.04,16.68,17.35,18.07,
       18.86,19.74,20.77,21.96,23.31,24.90,26.76,29.02,31.70,34.88,38.65,43.34,49.66,58.73,
       71.74,88.71,108.38,145.00),
       (0.27,0.34,0.37,0.39,0.40,0.42,0.43,0.45,0.46,0.48,0.50,0.51,0.53,0.55,0.57,0.60,0.62,
       0.65,0.67,0.70,0.73,0.77,0.80,0.83,0.86,0.89,0.93,0.96,1.00,1.04,1.08,1.12,1.17,1.22,
       1.29,1.35,1.43,1.51,1.60,1.68,1.77,1.86,1.94,2.02,2.11,2.19,2.28,2.37,2.47,2.57,2.68,
       2.78,2.90,3.01,3.13,3.25,3.38,3.51,3.64,3.77,3.91,4.06,4.20,4.36,4.52,4.69,4.87,5.05,
       5.26,5.46,5.68,5.89,6.12,6.37,6.63,6.92,7.23,7.55,7.90,8.28,8.70,9.15,9.63,10.15,10.69,
       11.27,11.90,12.57,13.28,14.04,14.92,15.94,17.18,18.75,21.18,25.54,33.79,46.88,61.60,
       75.00)  );

function deviate(d : distribution_type) : float;
  var t,r : float; j : integer;
  begin
  case d.shape of
    constant     : t := d.mean;
    normal       : t := norm(d.mean, d.stdev);
    lognormal    : t := lognorm(d.mean, d.stdev);
    triangular   : t := triang(d.min,d.mean,d.max);
    {uniform      : t := random * (d.max - d.min) + d.min;}
    {uniform1(a, b) ~ uniform(a-sqrt(3)*b, a+sqrt(3)*b) }
    uniform      : begin
                   t := (random * 2 * sqrt(3) * d.stdev) + (d.mean - (sqrt(3) * d.stdev));
                   if t < d.min then t := d.min;
                   if d.max < t then t := d.max;
                   end;
    edf1..edf3   : begin
                   j := 0;
                   r := random;
                   while j/99 < r do inc(j);
                   t := edf_x[d.shape,j];
                   end;
```

```
    else           t := 0;
    end;
  if t < d.min then t := d.min;
  if d.max < t then t := d.max;
  deviate := t;
  end;

const
  anglers = 10000;
  dumb = -99999;
  bl = ' ';

type
  answers  = array[0..anglers] of float;
  inputs   = record
             thence: string[8];
             who   : string;
             conc  : float;
{             loss  : distribution_type;     }
             amass : distribution_type;
             cmass : distribution_type;
             ingest: distribution_type;
             cingest: distribution_type;
             aedur : distribution_type;
             cedur : distribution_type;
             efreq : distribution_type;
             cefreq : distribution_type;
             avert : float;
             convf : float;
             end;

const
  daysperyear  = 365.25;
  doit : array[1..17] of inputs =
  (

  {Reaches 5 & 6}
  (thence: 'dose01';
   who   : ' Total, Fish, Cancer , Microexposure, Reaches5&6, Adults and Children';
   conc  : 13.9;
   amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
   cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
   ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
   cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
   aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
   cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
   efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   avert : 70.0 * daysperyear;
   convf : 0.001),


  (thence: 'intak01';
   who   : ' Total, Fish, Hazard, Microexposure, Reaches5&6, Adults';
   conc  : 13.9;
   amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
   cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
   ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
   cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
   aedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
   cedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
   efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   avert : daysperyear;
   convf : 0.001),


  (thence: 'cinta01';
   who   : ' Total Fish, Hazard Microexposure Reaches5&6, Children';
   conc  : 13.9;
   amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
```

```
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
 cedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : daysperyear;
 convf : 0.001),


(thence: 'qdosef01';
 who   : ' TEQ Fish, Cancer Microexposure Reaches5&6, Adults and Children';
 conc  : 0.276;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
 cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : 70.0 * daysperyear;
 convf : 0.001),




{Rising Pond}
(thence: 'dose11';
 who   : ' Total, Fish, Cancer , Microexposure, Rising Pond, Adults and Children';
 conc  : 9.48;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
 cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : 70.0 * daysperyear;
 convf : 0.001),




(thence: 'intak11';
 who   : ' Total, Fish, Hazard, Microexposure, Rising Pond, Adults';
 conc  : 9.48;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 cedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : daysperyear;
 convf : 0.001),




(thence: 'cinta11';
 who   : ' Total Fish, Hazard Microexposure Rising Pond, Children';
 conc  : 9.48;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
```

```
 cedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : daysperyear;
 convf : 0.001),



(thence: 'qdosef11';
 who   : ' TEQ Fish, Cancer Microexposure Rising Pond, Adults and Children';
 conc  : 0.134;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
 cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : 70.0 * daysperyear;
 convf : 0.001),




{Cornwall/Bulls Bridge Bass}
(thence: 'dose21';
 who   : ' Total, Fish, Cancer , Microexposure,
      Cornwall/Bulls Bridge Bass, Adults and Children';
 conc  : 1.14;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
 cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : 70.0 * daysperyear;
 convf : 0.001),



(thence: 'intak21';
 who   : ' Total, Fish, Hazard, Microexposure, Cornwall/Bulls Bridge Bass, Adults';
 conc  : 1.14;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 cedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : daysperyear;
 convf : 0.001),




(thence: 'cinta21';
 who   : ' Total Fish, Hazard Microexposure Cornwall/Bulls Bridge Bass, Children';
 conc  : 1.14;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
 cedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
```

```
 avert : daysperyear;
 convf : 0.001),




{Cornwall/Bulls Bridge Trout}
(thence: 'dose31';
 who   : ' Total, Fish, Cancer , Microexposure, Cornwall/Bulls Bridge Trout,
      Adults and Children';
 conc  : 2.27;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
 cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
 efreq : (shape: edf3; mean: dumb; stdev: dumb; min: 0.27; max: 46.62);
 cefreq : (shape: edf3; mean: dumb; stdev: dumb; min: 0.27; max: 46.62);
 avert : 70.0 * daysperyear;
 convf : 0.001),



(thence: 'intak31';
 who   : ' Total, Fish, Hazard, Microexposure, Cornwall/Bulls Bridge Trout, Adults';
 conc  : 2.27;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 cedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
 efreq : (shape: edf3; mean: dumb; stdev: dumb; min: 0.27; max: 46.62);
 cefreq : (shape: edf3; mean: dumb; stdev: dumb; min: 0.27; max: 46.62);
 avert : daysperyear;
 convf : 0.001),


(thence: 'cinta31';
 who   : ' Total Fish, Hazard Microexposure Cornwall/Bulls Bridge Trout, Children';
 conc  : 2.27;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
 cedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
 efreq : (shape: edf3; mean: dumb; stdev: dumb; min: 0.27; max: 46.62);
 cefreq : (shape: edf3; mean: dumb; stdev: dumb; min: 0.27; max: 46.62);
 avert : daysperyear;
 convf : 0.001),




{Lake Lillinonah/Zoar Bass}
(thence: 'dose41';
 who   : ' Total, Fish, Cancer , Microexposure, Lake Lillinonah/Zoar Bass,
      Adults and Children';
 conc  : 0.799;
 amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.63; max: 118.79);
 cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
 ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
 cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
 aedur : (shape: lognormal; mean: 28.63; stdev: 20.34; min: 1.0; max: 64.0);
 cedur : (shape: uniform; mean: 3.5; stdev: 1.443376; min: 1.0; max: 6.0);
 efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
 avert : 70.0 * daysperyear;
 convf : 0.001),
```

```
  (thence: 'intak41';
   who   : ' Total, Fish, Hazard, Microexposure, Lake Lillinonah/Zoar Bass, Adults';
   conc  : 0.799;
   amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
   cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
   ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
   cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
   aedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
   cedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
   efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   avert : daysperyear;
   convf : 0.001),



  (thence: 'cinta41';
   who   : ' Total Fish, Hazard Microexposure Lake Lillinonah/Zoar Bass, Children';
   conc  : 0.799;
   amass : (shape: lognormal; mean: 71.56; stdev: 14.78; min: 38.64; max: 118.79);
   cmass : (shape: lognormal; mean: 16.5; stdev: 2.27; min: 11.48; max: 23.26);
   ingest: (shape: triangular; mean: 227; stdev: dumb; min: 141.75; max: 340.19);
   cingest: (shape: triangular; mean: 118.12; stdev: dumb; min: 70.87; max: 170.10);
   aedur : (shape: constant; mean: 0; stdev: dumb; min: 0.0; max: 0.0);
   cedur : (shape: constant; mean: 1; stdev: dumb; min: 1.0; max: 1.0);
   efreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   cefreq : (shape: edf2; mean: dumb; stdev: dumb; min: 0.27; max: 80.22);
   avert : daysperyear;
   convf : 0.001)


);

procedure heapsort(n : integer; var arr : answers);
  {zero based; n should be count, i.e., max index + 1}
  var l,j,ir,i,nn : integer; rra : float;
  begin
  if n=1 then exit;
  l := (n div 2) + 1;
  ir := n;
  while true do
    begin
    if (l>1) then begin
                  l := l - 1;
                  rra := arr[l-1]
                  end
             else begin
                  rra := arr[ir-1];
                  arr[ir-1] := arr[0{1-1}];
                  ir := ir - 1;
                  if (ir=1) then begin
                                 arr[0{1-1}] := rra;
                                 exit;
                                 end
                  end;
    i := l;
    j := l + l;
    while j<=ir do
      begin
      if j<ir then if arr[j-1]<arr[j{+1-1}] then j := j + 1;
      if rra<arr[j-1]
        then begin
             arr[i-1] := arr[j-1];
             i := j;
             j := j + j;
             end
        else j := ir + 1
      end;
```

```
    arr[i-1] := rra
    end;
  end;

{ test heapsort
var i : integer; a : answers;
begin
randomize;
for i := 0 to 10 do a[i] := random;
heapsort(10+1,a);
end.
}

procedure writedistrib(name : string; var f : text; d : distribution_type);
  begin
  with d do writeln(f,name,'=',shapename[shape],'(','mean=',mean,',
                       stdev=',stdev,', min=',min,', max=',max ,')');
  end;

function datetimestamp : string;
  var h,m,sec,hsec,y,mn,d,w : word; s,ss : string;
  begin
  getdate(y,m,d,w);
  gettime(h,mn,sec,hsec);
  str(y,s); ss := s + ' ';
  str(m,s); ss := ss + s + '/';
  str(d,s); ss := ss + s + ' ';
  str(h,s); ss := ss + s + ':';
  str(mn,s); ss := ss + s + ':';
  str(sec,s); ss := ss + s;
  datetimestamp := ss;
  end;

function loss : float;
  var r,t : float;

  begin

  r := random;
  if r <= 0.2 then t := lognorm(0.215,0.112)          {bake}
    else if r <= 0.4 then t := lognorm(0.199,0.2025)  {broil}
       else if r <= 0.8 then t := lognorm(0.236,0.151) {panfry}
         else t := lognorm(0.438,0.18);                {deepfatfry}
    if t > 1 then loss := 1
    else loss := t
  end; {loss}

function Fring : float;
  var r,t : float;

  begin

  r := random;
  if r <= 0.05 then t := 0.1
    else if r <= 0.15 then t := 0.2
       else if r <= 0.45 then t := 0.3
         else if r <= 0.8 then t := 0.5
          else if r <= 0.98 then t := 0.97
           else t := 1;
    if t > 1 then Fring := 1
    else Fring := t
  end; {Fring}


var
  a : ^answers;  f : text;
  answer, bm, ir, c, cl, slug, totalPCB, at, cf, sum, fi: float;
  year, years, meal, meals, angler, run : integer;

{corr} ff : text; cbm,cyears,cmeals,cir,ccl,cfi, abm,ayears,ameals,air,acl,afi : float;
```

```
begin
new(a);
randomize;  {omit to make results reproducible}
for run := 1 to sizeof(doit) div sizeof(doit[1]) do
  with doit[run] do
  begin
  writeln('Run ', run, ' ', datetimestamp);
  writeln(who);
  writeln('Writing to ',thence);
  assign(f,thence+'.prn');
  rewrite(f);
  writeln(f, 'Run ', run, ' ', datetimestamp);
  writeln(f, who);

{corr}
  assign(ff,thence+'.cor');
  rewrite(ff);
  writeln(ff, 'Run ', run, ' ', datetimestamp);
  writeln(ff, who);
{corr}

  at := avert;                                                          {days}
  cf := convf;                                                          {kg/g}
  c := conc;                                                            {mg/kg}

  for angler := 0 to anglers do
    begin
    totalPCB := 0.0;

    {childhood}
    ir := -0.99;
    cl := -0.99;
    bm := deviate(cmass);                                                {kg}
    years := -1;
    years := round(deviate(cedur));                                      {years}
    for year := 1 to years do
      begin
      meals := -1;
      meals := round(deviate(cefreq));                                    {meals}
      fi := Fring;

      for meal := 1 to meals do
        begin
        c := conc;                                                      {mg/kg}
        ir := deviate(cingest); {half adult value}                 {g}
        cl := loss;                                                 {unitless proportion}
        slug := fi * ((c * (1 - cl) * ir * cf) / bm);                          {mg}
        totalPCB := totalPCB + (slug);                                  {mg}
        end; {meal}
      end; {year}

{corr}
{just use the last set of meals, ir, cl}
if years > 0 then begin
  if meals > 0 then begin
  cbm := bm;
  cyears := years;
  cmeals := meals;
  cir := ir;
  ccl := cl;
  cfi := fi;
  end; {if}
end; {if}
{corr}

    {adulthood}
    ir := -0.99;
    cl := -0.99;
    bm := deviate(amass);                                                {kg}
    years := -1;
    years := round(deviate(aedur));                                      {years}
```

```
    for year := 1 to years do
      begin
      meals := -1;
      meals := round(deviate(efreq));                                    {meals}
      fi := Fring;

      for meal := 1 to meals do
        begin
        ir := deviate(ingest);                                          {g}
        cl := loss;                                            {unitless proportion}
        slug := fi * ((c * (1 - cl) * ir * cf) / bm);                          {mg}
        totalPCB := totalPCB + (slug);                                  {mg}
        end; {meal}
      end; {year}

{corr}
{just use the last set of meals, ir, cl}
if years > 0 then begin
  if meals > 0 then begin
  abm := bm;
  ayears := years;
  ameals := meals;
  air := ir;
  acl := cl;
  afi := fi;
  end; {if}
end; {if}
{corr}

    answer := totalPCB / at;                                            {mg/kd/day}
    {if (angler mod 100) = 0 then writeln(angler, ' ', answer:0:10);}
    a^[angler] := answer;

{corr}
if (angler<1000) then writeln(ff, angler, bl, answer, bl, c, bl, cbm,
                             bl, cyears, bl, cmeals, bl, cir, bl, ccl,
                             bl, cfi, bl, abm, bl, ayears, bl, ameals,
                             bl, air, bl, acl, bl, afi, bl, at, bl, cf);
{corr}

    end; {angler}

writeln(f,'/////////////////////////');
for angler := 0 to anglers do writeln(f,a^[angler]);
writeln(f,'/////////////////////////');

  write('Sorting...');  heapsort(anglers+1,a^);  writeln('done');
  sum := 0.0; for angler := 0 to anglers do sum := sum + a^[angler];
  writeln(f,'Average exposure ', sum / anglers);
  writeln(f,'Median exposure ', a^[anglers div 2]);
  for angler := 100 downto 0 do writeln(f, angler, ' ', a^[angler * (anglers div 100)]);

  {echo inputs for this run}
  writeln(f,^m^j^m^j^m^j,'file:', thence);
  writeln(f, who);
  writeln(f, 'conc=',conc,', at=',avert,', cf=',convf);
{  writedistrib('loss',f,loss);                            }
  writedistrib('adult body mass',f,amass);
  writedistrib('child body mass',f,cmass);
  writedistrib('ingestion',f,ingest);
  writedistrib('c ingestion',f,cingest);
  writedistrib('adult exposure duration',f,aedur);
  writedistrib('child exposure duration',f,cedur);
  writedistrib('exposure frequency',f,efreq);
  writedistrib('c exposure frequency',f,cefreq);
{corr}  close(ff);
  close(f);
  end; {run}
dispose(a);
end.
```

EXHIBIT 6-2

EXAMPLE OF RISK CALC CODE FOR DEPENDENCY AND PROBABILITY BOUNDS

EXHIBIT 6-2

EXAMPLE OF RISK CALC CODE FOR DEPENDENCY AND PROBABILITY BOUNDS

In the following code, annotations explaining various program elements are shown bold after two forward slashes, e.g. **`// annotation`**.

```
// fish33.uc
// 06/14/04  wtt

// needs 26 input files:

// EFadult-0-1.prn : (meal/year), non-sharing all waters all data edf from Maine angler
//                   pre-divided by 227 gram per meal and multiplied by 365 days per year.
// EFadult-3-1.prn : (meal/year), non-sharing rivers all data edf from Maine angler
//                   pre-divided by 227 gram per meal and multiplied by 365 days per year.
//
// allwat_01.prn : (gram/day), all waters, no other, no sharing, original n=87
// allwat_a1.prn : (gram/day), all waters, includes other, no sharing, original n=138
// allwat_a2.prn : (gram/day), all waters, no other, includes sharing, original n=393
// allwat_a3.prn : (gram/day), all waters, no other, no sharing, original n=393
// allwat_a4.prn : (gram/day), all waters, includes other, includes sharing, original n=1002
// allwat_a5.prn : (gram/day), all waters, includes other, no sharing, original n=1002
// river_31.prn : (gram/day), rivers, no other, no sharing, original n=47
// river_b1.prn : (gram/day), rivers, includes other, no sharing, original n=63
// river_b2.prn : (gram/day), rivers, no other, includes sharing, original n=217
// river_b3.prn : (gram/day), rivers, no other, no sharing, original n=217
// river_b4.prn : (gram/day), rivers, includes other, includes sharing, original n=446
// river_b5.prn : (gram/day), rivers, includes other, no sharing, original n=446

// EDFs used for deconvolutions
// ef01a.prn : (meal/day), allwat_01.prn / IR.1 (triangular gram/meal) * 365 day per year
// efa1.prn : (meal/day), allwat_a1.prn / IR.1 (triangular gram/meal) * 365 day per year
// efa2.prn : (meal/day), allwat_a2.prn / IR.1 (triangular gram/meal) * 365 day per year
// efa3.prn : (meal/day), allwat_a3.prn / IR.1 (triangular gram/meal) * 365 day per year
// efa4.prn : (meal/day), allwat_a4.prn / IR.1 (triangular gram/meal) * 365 day per year
// efa5.prn : (meal/day), allwat_a5.prn / IR.1 (triangular gram/meal) * 365 day per year

// ef31a.prn : (meal/day), river_31.prn / IR.1 (triangular gram/meal) * 365 day per year
// efb1.prn : (meal/day), river_b1.prn / IR.1 (triangular gram/meal) * 365 day per year
// efb2.prn : (meal/day), river_b2.prn / IR.1 (triangular gram/meal) * 365 day per year
// efb3.prn : (meal/day), river_b3.prn / IR.1 (triangular gram/meal) * 365 day per year
// efb4.prn : (meal/day), river_b4.prn / IR.1 (triangular gram/meal) * 365 day per year
// efb5.prn : (meal/day), river_b5.prn / IR.1 (triangular gram/meal) * 365 day per year


// variables and parameters
// compound variable names are '.site.model' where "
// site is 0 (Reaches 5&6), 1 (Rising Pond), 2 (CT bass), 3 (CT trout) and 4 (CT lakes Bass)"
// model is 0 (pba) or 1 (dba and mca)"


// concentrations
// Total PCBs (tPCB)
// pba is interval from mean to EPC.  EPCs provided by Avatar.  mca is point estimate EPC

// Concentration of tPCB in fish for Reaches 5&6       -No change
Cfish.0.0 = [10.84 mg per kg,13.9 mg per kg]
Cfish.0.1 = 13.9 mg per kg

clear; show Cfish.0.0; show Cfish.0.1 in red
```

```
// Concentration of tPCB in fish for Rising Pond       -No change
Cfish.1.0 = [6.02 mg per kg,9.48 mg per kg]
Cfish.1.1 = 9.48 mg per kg

clear; show Cfish.1.0; show Cfish.1.1 in red

// Concentration of tPCB in fish for CT Bass Cornwall/Bull's Bridge       -No change
Cfish.2.0 = [0.97 mg per kg,1.14 mg per kg]
Cfish.2.1 = 1.14 mg per kg

clear; show Cfish.2.0; show Cfish.2.1 in red

// Concentration of tPCB in fish for CT Trout Cornwall
Cfish.3.0 = [1.86 mg per kg,2.27 mg per kg]                  // changed 2.45 to 2.27 (Table 4-7)
Cfish.3.1 = 2.27 mg per kg                                   // changed 2.45 to 2.27 (Table 4-7)

clear; show Cfish.3.0; show Cfish.3.1 in red

// Concentration of tPCB in fish for CT Bass Lake Lillinonah/Zoar       -No change
Cfish.4.0 = [0.64 mg per kg,0.799 mg per kg]
Cfish.4.1 = 0.799 mg per kg

clear; show Cfish.4.0; show Cfish.4.1 in red

// concentrations
//TEQ
// pba is interval from mean to EPC.  EPCs provided by Avatar.  mca is point estimate EPC

// Concentration of excess dioxin-like PCB TEQ in fish for Reaches 5&6
qCfish.0.0 = [0.152 ug per kg,2.76e-1 ug per kg]        // changed 2.12e-1 to 2.76e-1 (table 4-5)
qCfish.0.1 = 2.76e-1 ug per kg            // changed 2.12e-1 to 2.76e-1 (table 4-5)
clear; show qCfish.0.0; show qCfish.0.1 in red

// Concentration of excess dioxin-like PCB TEQ in fish for Rising Pond
qCfish.1.0 = [0.0303403 ug per kg,1.34e-1 ug per        // changed 7.44e-2 to 1.34e-1 (table 4-6)
qCfish.1.1 = 1.34e-1 ug per kg            // changed 7.44e-2 to 1.34e-1 (table 4-6)
clear; show qCfish.1.0; show qCfish.1.1 in red


// Cooking loss
// Data from "PCB loss cooking.v3.whb.doc" Tables 1 and 3

setdefault(confidence,0)
histbake = hist(0,100,5,16,34,7.5,27,20,35,22,13,39,18) / 100
xbarbake = 21.5/100
sbake = 11.2/100
ppbake = min(L(xbarbake,sbake),1)
histbakea = mmms(0,1,xbarbake,sbake)
clear; show histbake; show ppbake in red; show histbakea in blue

histbroil = hist(0,100,0,53,7.5,24,12,16,47,0) / 100
xbarbroil = 19.9/100
sbroil = 20.25/100
ppbroil = min(L(xbarbroil, sbroil),1)
histbroila = mmms(0,1,xbarbroil,sbroil)
clear; show histbroil; show ppbroil in red; show histbroila in blue

histpanfry = hist(0,100,46,7.5,35,31,15,27,0,27) / 100
xbarpanfry = 23.6/100
spanfry = 15.1/100
pppanfry = min(L(xbarpanfry,spanfry),1)
histpanfrya = mmms(0,1,xbarpanfry,spanfry)
clear; show histpanfry; show pppanfry in red; show histpanfrya in blue

histdeepfatfry = hist(0,100,74,31,35,32,47) / 100
xbardeepfatfry = 43.8/100
sdeepfatfry = 18/100
ppdeepfatfry = min(L(xbardeepfatfry,sdeepfatfry),1)
histdeepfatfrya = mmms(0,1,xbardeepfatfry,sdeepfatfry)
clear; show histdeepfatfry; show ppdeepfatfry in red; show histdeepfatfrya in blue
```

```
LOSS.0.0 = mixture(0.2,histbakea, 0.2,histbroila, 0.4,histpanfrya, 0.2,histdeepfatfrya)
LOSS.0.1 = spanning(mixture(0.2,ppbake, 0.2,ppbroil, 0.4,pppanfry, 0.2,ppdeepfatfry))
setdefault(confidence,3)

clear; show LOSS.0.0; show LOSS.0.1 in red

LOSS.1.0 = LOSS.0.0
LOSS.1.1 = LOSS.0.1
LOSS.2.0 = LOSS.0.0
LOSS.2.1 = LOSS.0.1
LOSS.3.0 = LOSS.0.0
LOSS.3.1 = LOSS.0.1
LOSS.4.0 = LOSS.0.0
LOSS.4.1 = LOSS.0.1


// Body weight for adult (ages 18-74), Brainard and Burmaster 1992, from 1976-80 data
maleBW = ssi(lognormal2(5.13 pounds, 0.17 pounds))  // adult male n=9983
femaleBW = ssi(lognormal2(4.96 pounds, 0.20 pounds)) // adult female n=10,339
adultBW.0 = spanning(mixture(femaleBW,maleBW))
adultBW.1 = spanning(mixture(femaleBW,maleBW))

clear; show maleBW in blue; show femaleBW in darkgreen; show adultBW.1 in red

// Body weight for kids from Burmaster and Crouch 1997, NHANES II data collected 1976-1980

// lognormal dists for each age, males 1 - 6 from Burmaster and Crouch Table 2, MLE estimates
w.1 = lognormal2(2.45778 kilograms,0.12001 kilograms)       // n = 370
w.2 = lognormal2(2.60259 kilograms,0.11843 kilograms)       // n = 375
w.3 = lognormal2(2.74274 kilograms,0.11483 kilograms)       // n = 418
w.4 = lognormal2(2.86471 kilograms,0.13278 kilograms)       // n = 404
w.5 = lognormal2(2.97656 kilograms,0.13951 kilograms)       // n = 397
w.6 = lognormal2(3.11429 kilograms,0.14589 kilograms)       // n = 133
                      // males total n = 2097
// lognormal dists for each age, females 1 - 6 from Burmaster and Crouch Table 2, MLE estimates
wf.1 = lognormal2(2.37602 kilograms,0.12877 kilograms)      // n = 336
wf.2 = lognormal2(2.55520 kilograms,0.11287 kilograms)      // n = 336
wf.3 = lognormal2(2.68791 kilograms,0.13614 kilograms)      // n = 366
wf.4 = lognormal2(2.82040 kilograms,0.13495 kilograms)      // n = 396
wf.5 = lognormal2(2.93160 kilograms,0.16435 kilograms)      // n = 364
wf.6 = lognormal2(3.08062 kilograms,0.17318 kilograms)      // n = 135
                      // females total n = 1933
                      // children total n = 4030

w = average(w.1,w.2,w.3,w.4,w.5,w.6)         // average the dists for each age: male
wf = average(wf.1,wf.2,wf.3,wf.4,wf.5,wf.6)         // average the dists for each age: female
childbw = mixture(w,wf)                      // mix males and females
cbwx = mean(childbw)                 // child body weight mean
cbws = (left(stddev(childbw)) + right(stddev(childbw)))/2
childBW.0 = L(cbwx,cbws)             // lognormal corresponding to the mix - USE THIS mc&pba
childBW.1 = L(cbwx,cbws)             // lognormal corresponding to the mix - USE THIS mc&pba


clear;show childbw; show childBW.1 in red           // shows lognormal is the same as the mix

// Ingestion rate of fish by adults
IRla = [5,12] ounces per meal                                // max meal increased to 12 oz
IRlb = T(5,8,12) * 1 oz per meal                   // this is new.  meal max up to 12, triangular
IR.0 = ssi(IRla) * 1000 gram per kilogram
IR.1 = ssi(IRlb) * 1000 gram per kilogram
clear; show IR.0;show IR.1 in red

// Ingestion rate of fish by children
// 1/2 adult rate, from CIP - Fish Ingestion Rates
cIR.0 = (1/2) * IR.0
cIR.1 = (1/2) * IR.1
clear; show cIR.0;show cIR.1 in red
// Exposure Duration for adults
oldEDadult.1 = min(lognormal(28.63 year, 20.34 year), 64 year)     // truncated at 64 years

// adjust to get original mean
```

```
EDadulta.1 = lognormal(28.63 year, 20.34 year)              // not truncated at 64 years
EDadult.1 = min(lognormal(29.99 year, 20.34 year), 64 year)         // truncated at 64 years
clear; show EDadult.1 in red; show oldEDadult.1 in blue

// calculate confidence intervals around mean and sd for p-box
// sokal and rohlf p. 156 for var
// CLT 95% CI around mean
xbar = 28.63
z95 = 1.645
ss = 20.34
s2 = (20.34)*(20.34)
n = 84
xlcl = xbar - (z95 * ss/sqrt(n))
xucl = xbar + (z95 * ss/sqrt(n))
// CI around variance: method of shortest unbiassed CIs

// linear interp values for table 22
f1 = ((3/7)*0.7564)+((1-(3/7))*0.7443)
f2 = ((3/7)*1.360)+((1-(3/7))*1.387)

slcl = sqrt(f1*s2)
sucl = sqrt(f2*s2)

clear; show xlcl,xucl; show slcl,sucl in red

EDadult.0 = mmms(1 year, 64 year, [xlcl,xucl] year, [slcl,sucl] year)
clear; show EDadult.0; show EDadult.1 in red

// Exposure Duration for Children
EDchild.0 = [1,6] year
EDchild.1 = U(1,6) * 1 year
clear; show EDchild.0; show EDchild.1 in red


// Exposure frequency for adults

// need 1 set of EFs for the simple model, and one set for the microexposure model
// simple model EFs include IR and are called sEFIRadult.0.0, etc.
// microexposure model EFs don't include IR and are called EFadult.0.0, etc.

// Precise distributions:
// These were used in the previous revision of the risk assessment
import EFadult.0.1
// Importing variable from EFadult-0-1.prn
import EFadult.3.1
// Importing variable from EFadult-3-1.prn
oldEFadult.0.1 = EFadult.0.1
oldEFadult.3.1 = EFadult.3.1

import allwat_01  // all waters, no other, no sharing, original n=87 – precise dist viz Harlee
// Importing variable from allwat_01.prn
import allwat_a1  // all waters, includes other, no sharing, original n=138
// Importing variable from allwat_a1.prn
import allwat_a2  // all waters, no other, includes sharing, original n=393
// Importing variable from allwat_a2.prn
import allwat_a3  // all waters, no other, no sharing, original n=393
// Importing variable from allwat_a3.prn
import allwat_a4  // all waters, includes other, includes sharing, original n=1002
// Importing variable from allwat_a4.prn
import allwat_a5  // all waters, includes other, no share, orig n=1002 - EDF from last revision
// Importing variable from allwat_a5.prn
import river_31  // rivers, no other, no sharing, original n=47 - Harlee's choice- precise dist
// Importing variable from river_31.prn
import river_b1  // rivers, includes other, no sharing, original n=63
// Importing variable from river_b1.prn
import river_b2  // rivers, no other, includes sharing, original n=217
// Importing variable from river_b2.prn
import river_b3  // rivers, no other, no sharing, original n=217
// Importing variable from river_b3.prn
import river_b4  // rivers, includes other, includes sharing, original n=446
// Importing variable from river_b4.prn
```

```
import river_b5  // rivers, includes other, no sharing, original n=446 - EDF from last revision
// Importing variable from river_b5.prn

// simple model EF X IR
sEFIRadult.0.1 = allwat_01 -0 gram per year

sEFIRadult.3.1 = river_31 -0 gram per year

// efir pboxes
// all waters
// adult

sEFIRa1 = allwat_a1
sEFIRa2 = allwat_a2
sEFIRa3 = allwat_a3
sEFIRa4 = allwat_a4
sEFIRa5 = allwat_a5
clear; show sEFIRa1;show sEFIRa2;show sEFIRa3;show sEFIRa4;show sEFIRa5

sEFIRadult.0.0 = env(sEFIRadult.0.1,sEFIRa1,sEFIRa2,sEFIRa3,sEFIRa4,sEFIRa5) -0 gram per year

clear; show sEFIRadult.0.0; show sEFIRadult.0.1 in red

// child
sEFIRchild.0.0 = sEFIRadult.0.0 * 0.5
sEFIRchild.0.1 = sEFIRadult.0.1 * 0.5
clear; show sEFIRadult.0.1; show sEFIRchild.0.1 in blue
clear; show sEFIRadult.0.0; show sEFIRchild.0.0 in blue
clear; show sEFIRchild.0.0; show sEFIRchild.0.1 in red

// rivers and streams
// adult

sEFIRb1 = river_b1
sEFIRb2 = river_b2
sEFIRb3 = river_b3
sEFIRb4 = river_b4
sEFIRb5 = river_b5
clear; show sEFIRb1;show sEFIRb2;show sEFIRb3;show sEFIRb4;show sEFIRb5

sEFIRadult.3.0 = env(sEFIRadult.3.1, sEFIRb1,sEFIRb2,sEFIRb3,sEFIRb4,sEFIRb5) -0 gram per year

clear; show sEFIRadult.3.0; show sEFIRadult.3.1 in red

// child
sEFIRchild.3.0 = sEFIRadult.3.0 * 0.5
sEFIRchild.3.1 = sEFIRadult.3.1 * 0.5
clear; show sEFIRadult.3.1; show sEFIRchild.3.1 in blue
clear; show sEFIRadult.3.0; show sEFIRchild.3.0 in blue
clear; show sEFIRchild.3.0; show sEFIRchild.3.1 in red

sEFIRadult.1.1 = sEFIRadult.0.1
sEFIRadult.2.1 = sEFIRadult.0.1
sEFIRadult.4.1 = sEFIRadult.0.1

sEFIRadult.1.0 = sEFIRadult.0.0
sEFIRadult.2.0 = sEFIRadult.0.0
sEFIRadult.4.0 = sEFIRadult.0.0

sEFIRchild.1.0 = sEFIRchild.0.0
sEFIRchild.2.0 = sEFIRchild.0.0
sEFIRchild.4.0 = sEFIRchild.0.0
sEFIRchild.1.1 = sEFIRchild.0.1
sEFIRchild.2.1 = sEFIRchild.0.1
sEFIRchild.4.1 = sEFIRchild.0.1


// manual deconvolution
// EFadult.0.1
// max in data, sharing, no other = 145 meals per year
// allwat_a2 * 365 day per year |/| 227 gram per meal
```

```
//    ~(range=[0.0482379,144.907],  mean=8.48131,  var=252.587) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRadult.0.1|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import ef01a
// Importing variable from ef01a.prn
clear; show ef01a in blue
show EFIRoverIR in green
EFIRoverIR = ef01a

pwr1 = 1.02
maxmpr = 145 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFadult.0.1 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year,
maxmpr)

// forward calculation
mexp = (EFadult.0.1 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRadult.0.1 - 0 grams per day

clear; show sEFIR in red; show mexp in blue

clear; show EFadult.0.1; show oldEFadult.0.1 in blue

// EFadult.3.1
// max in data, sharing, no other = 75 meals per year
// river_b2 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.041565,74.9617],  mean=3.13435,  var=44.5911) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRadult.3.1|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import ef31a
// Importing variable from ef31a.prn
clear; show EFIRoverIR; show ef31a in red
hide EFIRoverIR
EFIRoverIR = ef31a

pwr1 = 1.012
maxmpr = 75 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFadult.3.1 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year,
maxmpr)

// forward calculation
mexp = (EFadult.3.1 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRadult.3.1 - 0 grams per day

clear; show sEFIR in red; show mexp in blue

clear; show EFadult.3.1; show oldEFadult.3.1 in blue

EFadult.1.1 = EFadult.0.1
EFadult.2.1 = EFadult.0.1
EFadult.4.1 = EFadult.0.1

// EF pboxes
// EFadult.0.0 : all waters
// deconvolve sEFIRa1 - a5, then envelope them

// EFa1
// max in data, sharing, no other = 145 meals per year
// allwat_a2 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.0482379,144.907],  mean=8.48131,  var=252.587) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

```

```
// shell
EFIRoverIR = sEFIRa1|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efa1
// Importing variable from efa1.prn
clear; show EFIRoverIR; show efa1 in red
hide EFIRoverIR
EFIRoverIR = efa1

pwr1 = 0.995
maxmpr = 145 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFa1 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFa1 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRa1 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFa2
// max in data, sharing, no other = 145 meals per year
// allwat_a2 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.0482379,144.907],  mean=8.48131,  var=252.587) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRa2|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efa2
// Importing variable from efa2.prn
clear; show EFIRoverIR; show efa2 in red
hide EFIRoverIR
EFIRoverIR = efa2

pwr1 = 1
maxmpr = 97 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFa2 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFa2 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRa2 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFa3
// max in data, sharing, no other = 290 meals per year
// allwat_a3 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.144714,289.797],  mean=17.6786,  var=1059.86) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRa3|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efa3
// Importing variable from efa3.prn
clear; show EFIRoverIR; show efa3 in red
hide EFIRoverIR
EFIRoverIR = efa3

pwr1 = 1.01
maxmpr = 200 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFa3 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)
```

```
// forward calculation
mexp = (EFa3 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRa3 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFa4
// max in data, sharing, no other = 290 meals per year
// allwat_a4 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.0482379,293.431],  mean=10.2838,  var=571.103) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRa4|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efa4
// Importing variable from efa4.prn
clear; show EFIRoverIR; show efa4 in red
hide EFIRoverIR
EFIRoverIR = efa4

pwr1 = 1.015
maxmpr = 196 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFa4 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFa4 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRa4 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFa5
// max in data, sharing, no other = 1041 meals per year
// allwat_a5 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.144714,1041.1],  mean=25.2117,  var=3681.84) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRa5|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efa5
//Importing variable from efa5.prn
clear; show EFIRoverIR; show efa5 in red
hide EFIRoverIR
EFIRoverIR = efa5

pwr1 = 1.025
maxmpr = 490 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFa5 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFa5 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRa5 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


EFadult.0.0 = env(EFadult.0.1, EFa1,EFa2,EFa3,EFa4,EFa5)
EFadult.1.0 = EFadult.0.0
EFadult.2.0 = EFadult.0.0
EFadult.4.0 = EFadult.0.0

clear; show EFadult.0.0; show EFadult.0.1 in red

// rivers and streams
```

```
// EFb1
// max in data, sharing, no other = 180 meals per year
// river_b1 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.257269,179.976],  mean=9.78412,  var=608.113) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRb1|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efb1
// Importing variable from efb1.prn
clear; show EFIRoverIR; show efb1 in red
hide EFIRoverIR
EFIRoverIR = efb1

pwr1 = 1
maxmpr = 150 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFb1 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFb1 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRb1 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFb2
// max in data, sharing, no other = 75 meals per year
// river_b2 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.041565,74.9617],  mean=3.13435,  var=44.5911) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRb2|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efb2
// Importing variable from efb2.prn
clear; show EFIRoverIR; show efb2 in red
hide EFIRoverIR
EFIRoverIR = efb2

pwr1 = 1.01
maxmpr = 50 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFb2 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFb2 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRb2 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFb3
// max in data, sharing, no other = 129 meals per year
// river_b3 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.22511,128.731],  mean=6.25596,  var=148.854) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRb3|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efb3
// Importing variable from efb3.prn
clear; show EFIRoverIR; show efb3 in red
hide EFIRoverIR
EFIRoverIR = efb3
```

```
pwr1 = 1.03
maxmpr = 121 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFb3 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFb3 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRb3 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFb4
// max in data, sharing, no other = 190 meals per year
// river_b4 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.0438965,190.089],  mean=5.8789,  var=345.766) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRb4|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efb4
// Importing variable from efb4.prn
clear; show EFIRoverIR; show efb4 in red
hide EFIRoverIR
EFIRoverIR = efb4

pwr1 = 1.01
maxmpr = 165 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFb4 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFb4 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRb4 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


// EFb5
// max in data, sharing, no other = 760 meals per year
// river_b5 * 365 day per year |/| 227 gram per meal
//    ~(range=[0.22511,760.358],  mean=14.7275,  var=2736.35) year^-1 meal
// SO THIS IS DEFENSIBLE TOTAL MAX MEALS PER YEAR FOR ALL WATERS

// shell
EFIRoverIR = sEFIRb5|/|IR.1 -0 meal per day
// export excel EFIRoverIR
// Exporting variable to EFIRoverIR.xls
import efb5
// Importing variable from efb5.prn
clear; show EFIRoverIR; show efb5 in red
hide EFIRoverIR
EFIRoverIR = efb5

pwr1 = 1.038
maxmpr = 508 meals per year
sdize = right(EFIRoverIR) // to standardize to 1
EFb5 = min(((mag(EFIRoverIR) |/| mag(sdize)) ^ pwr1) |*| sdize   - 0 meals per year, maxmpr)

// forward calculation
mexp = (EFb5 |*| IR.1 - 0 gram per day)
sEFIR = sEFIRb5 - 0 grams per day

clear; show sEFIR in red; show mexp in blue


EFadult.3.0 = env(EFadult.3.1,EFb1,EFb2,EFb3,EFb4,EFb5)
clear; show EFadult.3.0; show EFadult.3.1 in red
```

```
EFchild.0.1 = EFadult.0.1
EFchild.0.0 = EFadult.0.0
clear; show EFchild.0.0; show EFchild.0.1 in red

EFchild.1.0 = EFchild.0.0
EFchild.2.0 = EFchild.0.0
EFchild.4.0 = EFchild.0.0
EFchild.1.1 = EFchild.0.1
EFchild.2.1 = EFchild.0.1
EFchild.4.1 = EFchild.0.1

EFchild.3.1 = EFadult.3.1
EFchild.3.0 = EFadult.3.0
clear; show EFchild.3.0; show EFchild.3.1 in red


// FI  data from FractionIngestedEDF.xls from Harlee
// FI.0 = hist(0,1,.1,.2,.3,.5,.97,1) no
FI.1 = mixture(.05,.1,.1,.2,.3,.3,.35,.5,.18,.97,.02,1)     // unitless
FI.0 = mmms(.1,1,mean(FI.1),stddev(FI.1))
clear; show FI.0; show FI.1 in red


// Averaging Time
AT = 70 year * 365.25 day per year                  // to match range of ED
AT1 =  365.25 day per year              // conversion factor, years to days for non-cancer models


// Conversion Factor
CF = 0.001 kg per gram


// Cancer models
// probabilistic exposure models for humans ingesting fish from the Housatonic River
// simple model and microexposure model, tPCB and TEQ


// since ED for kids is only 1-6 yrs, mean function removes much more uncert than MC
// calculate the arithmetic average instead - this mirrors MC almost exactly
// don't assume independence between EF from year to year
meanEFchild.0.0 = (EFchild.0.0 + EFchild.0.0 + EFchild.0.0 + EFchild.0.0 + EFchild.0.0 +
EFchild.0.0) / 6
meanEFchild.0.1 = (EFchild.0.1 + EFchild.0.1 + EFchild.0.1 + EFchild.0.1 + EFchild.0.1 +
EFchild.0.1) / 6
meanEFchild.1.0 = (EFchild.1.0 + EFchild.1.0 + EFchild.1.0 + EFchild.1.0 + EFchild.1.0 +
EFchild.1.0) / 6
meanEFchild.1.1 = (EFchild.1.1 + EFchild.1.1 + EFchild.1.1 + EFchild.1.1 + EFchild.1.1 +
EFchild.1.1) / 6
meanEFchild.2.0 = (EFchild.2.0 + EFchild.2.0 + EFchild.2.0 + EFchild.2.0 + EFchild.2.0 +
EFchild.2.0) / 6
meanEFchild.2.1 = (EFchild.2.1 + EFchild.2.1 + EFchild.2.1 + EFchild.2.1 + EFchild.2.1 +
EFchild.2.1) / 6
meanEFchild.3.0 = (EFchild.3.0 + EFchild.3.0 + EFchild.3.0 + EFchild.3.0 + EFchild.3.0 +
EFchild.3.0) / 6
meanEFchild.3.1 = (EFchild.3.1 + EFchild.3.1 + EFchild.3.1 + EFchild.3.1 + EFchild.3.1 +
EFchild.3.1) / 6
meanEFchild.4.0 = (EFchild.4.0 + EFchild.4.0 + EFchild.4.0 + EFchild.4.0 + EFchild.4.0 +
EFchild.4.0) / 6
meanEFchild.4.1 = (EFchild.4.1 + EFchild.4.1 + EFchild.4.1 + EFchild.4.1 + EFchild.4.1 +
EFchild.4.1) / 6


// microexposure model tPCB
dosef.0.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.0.0 * mean(FI.0) * mean(Cfish.0.0
|*| (1-LOSS.0.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.0.0) * mean(FI.0) *
mean(Cfish.0.0 |*| (1-LOSS.0.0) |*| IR.0))) -0 mg per kilogram per day
dosef.1.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.1.0 * mean(FI.0) * mean(Cfish.1.0
|*| (1-LOSS.1.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.1.0) * mean(FI.0) *
mean(Cfish.1.0 |*| (1-LOSS.1.0) |*| IR.0))) -0 mg per kilogram per day
```

```
dosef.2.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.2.0 * mean(FI.0) * mean(Cfish.2.0
|*| (1-LOSS.2.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.2.0) * mean(FI.0) *
mean(Cfish.2.0 |*| (1-LOSS.2.0) |*| IR.0))) -0 mg per kilogram per day
dosef.3.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.3.0 * mean(FI.0) * mean(Cfish.3.0
|*| (1-LOSS.3.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.3.0) * mean(FI.0) *
mean(Cfish.3.0 |*| (1-LOSS.3.0) |*| IR.0))) -0 mg per kilogram per day
dosef.4.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.4.0 * mean(FI.0) * mean(Cfish.4.0
|*| (1-LOSS.4.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.4.0) * mean(FI.0) *
mean(Cfish.4.0 |*| (1-LOSS.4.0) |*| IR.0))) -0 mg per kilogram per day
dosef.0.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.0.1 * mean(FI.1) * mean(Cfish.0.1
|*| (1-LOSS.0.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.0.1) * mean(FI.1) *
mean(Cfish.0.1 |*| (1-LOSS.0.1) |*| IR.1))) -0 mg per kilogram per day
dosef.1.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.1.1 * mean(FI.1) * mean(Cfish.1.1
|*| (1-LOSS.1.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.1.1) * mean(FI.1) *
mean(Cfish.1.1 |*| (1-LOSS.1.1) |*| IR.1))) -0 mg per kilogram per day
dosef.2.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.2.1 * mean(FI.1) * mean(Cfish.2.1
|*| (1-LOSS.2.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.2.1) * mean(FI.1) *
mean(Cfish.2.1 |*| (1-LOSS.2.1) |*| IR.1))) -0 mg per kilogram per day
dosef.3.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.3.1 * mean(FI.1) * mean(Cfish.3.1
|*| (1-LOSS.3.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.3.1) * mean(FI.1) *
mean(Cfish.3.1 |*| (1-LOSS.3.1) |*| IR.1))) -0 mg per kilogram per day
dosef.4.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.4.1 * mean(FI.1) * mean(Cfish.4.1
|*| (1-LOSS.4.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.4.1) * mean(FI.1) *
mean(Cfish.4.1 |*| (1-LOSS.4.1) |*| IR.1))) -0 mg per kilogram per day

clear; show dosef.0.0; show dosef.0.1 in blue


// microexposure model TEQ
qdosef.0.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.0.0 * mean(FI.0) *
mean(qCfish.0.0 |*| (1-LOSS.0.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.0.0) *
mean(FI.0) * mean(qCfish.0.0 |*| (1-LOSS.0.0) |*| IR.0))) -0 ug per kilogram per day
qdosef.1.0 = (CF / AT) * (((EDchild.0 / childBW.0) * meanEFchild.1.0 * mean(FI.0) *
mean(qCfish.1.0 |*| (1-LOSS.1.0) |*| cIR.0)) |+| ((EDadult.0 / adultBW.0) * mean(EFadult.1.0) *
mean(FI.0) * mean(qCfish.1.0 |*| (1-LOSS.1.0) |*| IR.0))) -0 ug per kilogram per day
qdosef.0.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.0.1 * mean(FI.1) *
mean(qCfish.0.1 |*| (1-LOSS.0.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.0.1) *
mean(FI.1) * mean(qCfish.0.1 |*| (1-LOSS.0.1) |*| IR.1))) -0 ug per kilogram per day
qdosef.1.1 = (CF / AT) * (((EDchild.1 / childBW.1) * meanEFchild.1.1 * mean(FI.1) *
mean(qCfish.1.1 |*| (1-LOSS.1.1) |*| cIR.1)) |+| ((EDadult.1 / adultBW.1) * mean(EFadult.1.1) *
mean(FI.1) * mean(qCfish.1.1 |*| (1-LOSS.1.1) |*| IR.1))) -0 ug per kilogram per day

clear; show qdosef.0.0; show qdosef.0.1 in blue


// non-cancer models
// adult tPCB

intake.0.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((EFadult.0.0)) * mean (IR.0 |*| Cfish.0.0
|*| (1-LOSS.0.0))) -0 mg per kilogram per day
intake.1.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((EFadult.1.0)) * mean (IR.0 |*| Cfish.1.0
|*| (1-LOSS.1.0))) -0 mg per kilogram per day
intake.2.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((EFadult.2.0)) * mean (IR.0 |*| Cfish.2.0
|*| (1-LOSS.2.0))) -0 mg per kilogram per day
intake.3.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((EFadult.3.0)) * mean (IR.0 |*| Cfish.3.0
|*| (1-LOSS.3.0))) -0 mg per kilogram per day
intake.4.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((EFadult.4.0)) * mean (IR.0 |*| Cfish.4.0
|*| (1-LOSS.4.0))) -0 mg per kilogram per day
intake.0.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((EFadult.0.1)) * mean (IR.1 |*| Cfish.0.1
|*| (1-LOSS.0.1))) -0 mg per kilogram per day
intake.1.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((EFadult.1.1)) * mean (IR.1 |*| Cfish.1.1
|*| (1-LOSS.1.1))) -0 mg per kilogram per day
intake.2.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((EFadult.2.1)) * mean (IR.1 |*| Cfish.2.1
|*| (1-LOSS.2.1))) -0 mg per kilogram per day
intake.3.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((EFadult.3.1)) * mean (IR.1 |*| Cfish.3.1
|*| (1-LOSS.3.1))) -0 mg per kilogram per day
intake.4.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((EFadult.4.1)) * mean (IR.1 |*| Cfish.4.1
|*| (1-LOSS.4.1))) -0 mg per kilogram per day

clear; show intake.0.0; show intake.0.1 in blue
```

```
// non-cancer models
// child tPCB

cintake.0.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((EFchild.0.0) * mean (cIR.0 |*| Cfish.0.0
|*| (1-LOSS.0.0))) -0 mg per kilogram per day
cintake.1.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((EFchild.1.0) * mean (cIR.0 |*| Cfish.1.0
|*| (1-LOSS.1.0))) -0 mg per kilogram per day
cintake.2.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((EFchild.2.0) * mean (cIR.0 |*| Cfish.2.0
|*| (1-LOSS.2.0))) -0 mg per kilogram per day
cintake.3.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((EFchild.3.0) * mean (cIR.0 |*| Cfish.3.0
|*| (1-LOSS.3.0))) -0 mg per kilogram per day
cintake.4.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((EFchild.4.0) * mean (cIR.0 |*| Cfish.4.0
|*| (1-LOSS.4.0))) -0 mg per kilogram per day
cintake.0.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((EFchild.0.1) * mean (cIR.1 |*| Cfish.0.1
|*| (1-LOSS.0.1))) -0 mg per kilogram per day
cintake.1.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((EFchild.1.1) * mean (cIR.1 |*| Cfish.1.1
|*| (1-LOSS.1.1))) -0 mg per kilogram per day
cintake.2.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((EFchild.2.1) * mean (cIR.1 |*| Cfish.2.1
|*| (1-LOSS.2.1))) -0 mg per kilogram per day
cintake.3.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((EFchild.3.1) * mean (cIR.1 |*| Cfish.3.1
|*| (1-LOSS.3.1))) -0 mg per kilogram per day
cintake.4.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((EFchild.4.1) * mean (cIR.1 |*| Cfish.4.1
|*| (1-LOSS.4.1))) -0 mg per kilogram per day

clear; show cintake.0.0; show cintake.0.1 in blue


// simple 1-d MCA and pba models
// cancer model tPCB
sdosef.0.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.0.0 |*| (Cfish.0.0
|*| (1-LOSS.0.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.0.0) |*| (Cfish.0.0 |*| (1-
LOSS.0.0))))
sdosef.1.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.1.0 |*| (Cfish.1.0
|*| (1-LOSS.1.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.1.0) |*| (Cfish.1.0 |*| (1-
LOSS.1.0))))
sdosef.2.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.2.0 |*| (Cfish.2.0
|*| (1-LOSS.2.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.2.0) |*| (Cfish.2.0 |*| (1-
LOSS.2.0))))
sdosef.3.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.3.0 |*| (Cfish.3.0
|*| (1-LOSS.3.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.3.0) |*| (Cfish.3.0 |*| (1-
LOSS.3.0))))
sdosef.4.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.4.0 |*| (Cfish.4.0
|*| (1-LOSS.4.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.4.0) |*| (Cfish.4.0 |*| (1-
LOSS.4.0))))
sdosef.0.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.0.1 |*| (Cfish.0.1
|*| (1-LOSS.0.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.0.1) |*| (Cfish.0.1 |*| (1-
LOSS.0.1))))
sdosef.1.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.1.1 |*| (Cfish.1.1
|*| (1-LOSS.1.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.1.1) |*| (Cfish.1.1 |*| (1-
LOSS.1.1))))
sdosef.2.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.2.1 |*| (Cfish.2.1
|*| (1-LOSS.2.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.2.1) |*| (Cfish.2.1 |*| (1-
LOSS.2.1))))
sdosef.3.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.3.1 |*| (Cfish.3.1
|*| (1-LOSS.3.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.3.1) |*| (Cfish.3.1 |*| (1-
LOSS.3.1))))
sdosef.4.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.4.1 |*| (Cfish.4.1
|*| (1-LOSS.4.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.4.1) |*| (Cfish.4.0 |*| (1-
LOSS.4.1))))

clear; show sdosef.0.0; show sdosef.0.1 in blue


// cancer model TEQ
sqdosef.0.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.0.0 |*| (qCfish.0.0
|*| (1-LOSS.0.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.0.0) |*| (qCfish.0.0 |*| (1-
LOSS.0.0))))
sqdosef.1.0 = FI.0 |*| (CF / AT) |*| (((EDchild.0 / childBW.0) |*| sEFIRchild.1.0 |*| (qCfish.1.0
|*| (1-LOSS.1.0))) |+| ((EDadult.0 / adultBW.0) |*| (sEFIRadult.1.0) |*| (qCfish.1.0 |*| (1-
LOSS.1.0))))
```

```
sqdosef.0.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.0.1 |*| (qCfish.0.1
|*| (1-LOSS.0.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.0.1) |*| (qCfish.0.1 |*| (1-
LOSS.0.1))))
sqdosef.1.1 = FI.1 |*| (CF / AT) |*| (((EDchild.1 / childBW.1) |*| sEFIRchild.1.1 |*| (qCfish.1.1
|*| (1-LOSS.1.1))) |+| ((EDadult.1 / adultBW.1) |*| (sEFIRadult.1.1) |*| (qCfish.1.1 |*| (1-
LOSS.1.1))))


// simple non-cancer models
// adult tPCB

sintake.0.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((sEFIRadult.0.0)) |*| (Cfish.0.0 |*| (1-
LOSS.0.0)))
sintake.1.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((sEFIRadult.1.0)) |*| (Cfish.1.0 |*| (1-
LOSS.1.0)))
sintake.2.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((sEFIRadult.2.0)) |*| (Cfish.2.0 |*| (1-
LOSS.2.0)))
sintake.3.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((sEFIRadult.3.0)) |*| (Cfish.3.0 |*| (1-
LOSS.3.0)))
sintake.4.0 = FI.0 |*| (CF / (AT1 * adultBW.0)) |*| (((sEFIRadult.4.0)) |*| (Cfish.4.0 |*| (1-
LOSS.4.0)))
sintake.0.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((sEFIRadult.0.1)) |*| (Cfish.0.1 |*| (1-
LOSS.0.1)))
sintake.1.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((sEFIRadult.1.1)) |*| (Cfish.1.1 |*| (1-
LOSS.1.1)))
sintake.2.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((sEFIRadult.2.1)) |*| (Cfish.2.1 |*| (1-
LOSS.2.1)))
sintake.3.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((sEFIRadult.3.1)) |*| (Cfish.3.1 |*| (1-
LOSS.3.1)))
sintake.4.1 = FI.1 |*| (CF / (AT1 * adultBW.1)) |*| (((sEFIRadult.4.1)) |*| (Cfish.4.1 |*| (1-
LOSS.4.1)))


// child tPCB

scintake.0.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((sEFIRchild.0.0) |*| (Cfish.0.0 |*| (1-
LOSS.0.0)))
scintake.1.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((sEFIRchild.1.0) |*| (Cfish.1.0 |*| (1-
LOSS.1.0)))
scintake.2.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((sEFIRchild.2.0) |*| (Cfish.2.0 |*| (1-
LOSS.2.0)))
scintake.3.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((sEFIRchild.3.0) |*| (Cfish.3.0 |*| (1-
LOSS.3.0)))
scintake.4.0 = FI.0 |*| (CF / (AT1 * childBW.0)) |*| ((sEFIRchild.4.0) |*| (Cfish.4.0 |*| (1-
LOSS.4.0)))
scintake.0.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((sEFIRchild.0.1) |*| (Cfish.0.1 |*| (1-
LOSS.0.1)))
scintake.1.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((sEFIRchild.1.1) |*| (Cfish.1.1 |*| (1-
LOSS.1.1)))
scintake.2.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((sEFIRchild.2.1) |*| (Cfish.2.1 |*| (1-
LOSS.2.1)))
scintake.3.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((sEFIRchild.3.1) |*| (Cfish.3.1 |*| (1-
LOSS.3.1)))
scintake.4.1 = FI.1 |*| (CF / (AT1 * childBW.1)) |*| ((sEFIRchild.4.1) |*| (Cfish.4.1 |*| (1-
LOSS.4.1)))

clear; show scintake.0.0; show scintake.0.1 in blue
```

7. UNCERTAINTY ANALYSIS

7.1 INTRODUCTION

EPA guidance and policy (EPA, 1995) require a thorough discussion of the variability and uncertainty surrounding the calculation of risk to inform decisionmakers when considering risk management alternatives. This risk assessment used multiple approaches to characterize the variability and uncertainty:

- Point estimate calculations of both reasonable maximum exposure (RME) and central tendency exposure (CTE) to provide a range of risk estimates.
- Monte Carlo analyses to characterize variability in risks, providing estimates of both a CTE and an RME range (i.e., 90th to 99.9th percentiles).
- Probability bounds analysis to quantify uncertainty in the risk assessment modeling assumptions and exposure parameters.
- Sensitivity analyses to identify the contribution of individual exposure parameters to variability and uncertainty.
- Qualitative discussion of the sources of uncertainty in the underlying data, the selection of parameter values, and modeling assumptions.
- Bounding analyses based on the point estimate approach to characterize higher risk behaviors that are not occurring at this time.

RME risk generally should be the principal basis for evaluating potential risks at Superfund sites (EPA, 1990, NCP Preamble, 55 FR 8711). The RME is defined as the highest exposure that is reasonably expected to occur at a site. As described in RAGS, “The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures.” In addition to the RME, EPA guidance suggests that the CTE be estimated as a semiquantitative predictor of uncertainty and variability. The CTE is designed to represent exposure to an average member of the exposed population. For the point estimate risk assessment, these two risk descriptors describe an upper- and mid-level estimate of risk.

EPA’s *Risk Assessment Guidance for Superfund – Process for Conducting Probabilistic Risk Assessment* (2001a) provides a tiered approach for conducting risk assessments, with three levels of complexity of analysis for quantifying the variability and uncertainty associated with the risk estimates. The decision to proceed beyond each tier is based on whether there is sufficient information for risk management decisions. The point estimate approach described in Section 5 represents Tier 1. The probabilistic risk assessment (PRA) described in Section 6 includes both Tier 2 and Tier 3. Tier 2 consists of a one-dimensional Monte Carlo analysis to characterize variability with uncertainty further characterized using probability bounds. The Tier 3 analysis consists of a microexposure event (MEE) analysis, also with uncertainty further characterized using probability bounds. The PRA also contains a formal sensitivity analysis to determine which parameters are most significant to the risk estimates.

The inclusion of all three tiers of analyses maximizes the quantitative information available to decisionmakers regarding the variability and uncertainty associated with the risks of consuming fish and waterfowl from the Housatonic River. Attachment C.7 evaluates variability and uncertainty associated with the risk of fish consumption in the Primary Study Area (PSA, Reaches 5 and 6) with a two-dimensional Monte Carlo simulation, and compares the results with the one-dimensional Monte Carlo simulation, with uncertainty characterized using probability bounds.

The following sections provide additional perspectives on the uncertainties associated with both the point estimate and probabilistic risk estimates. Section 7.2 provides a discussion of the uncertainties associated with the data underlying the parameters incorporated into the fish and waterfowl risk assessments. These uncertainties apply to both the point estimate and probabilistic risk assessment approaches because they are based on the same data sets. Section 7.2.4 provides bounding estimates of risk based on fishing and consumption behaviors that would result in higher exposures than currently exist in the Housatonic River area population. Section 7.3 describes the treatment of uncertainties associated with the modeling and parameterization used in the probabilistic analyses.

7.2 UNCERTAINTIES ASSOCIATED WITH SUPPORTING DATA

This section provides a qualitative, and in some cases semiquantitative, discussion of uncertainties associated with the data and assumptions that underlie hazard identification, and the basis for the exposure point concentrations (EPCs), exposure assessment, dose-response assessment, and risk characterization. These uncertainties apply to either the fish or the waterfowl evaluation, or to both the fish and waterfowl evaluations, and are identified as such in each section. The uncertainty associated with the propagation of variability in the risk characterization step is discussed in Section 7.3.

7.2.1 Uncertainties Associated with the Hazard Identification and the Basis for EPCs

7.2.1.1 Chemical Analyses for Fish and Waterfowl

7.2.1.1.1 Analytical Methods for PCBs

PCBs were unambiguously identified as a contaminant in fish in all reaches of the Rest of River and in resident waterfowl in the PSA. Total PCBs were quantified as the sum of individual congeners for all fish and waterfowl samples included in the EPC calculations in this risk assessment. The analytical method identified approximately 120 individual PCB congeners, some of which co-eluted as doublets or triplets. The analytical protocols and data quality objectives (DQO) are described in Attachment 7 of HHRA Volume I. The data included in the EPC calculations met all DQOs.

The uncertainty associated with measurements of tPCB concentrations in Housatonic River fish tissues can be quantified as the relative percent difference (RPD) of duplicate samples. The RPD is approximately 29%, based on the mean RPD of 38 duplicate biota tissue samples. The duplicate sample is a second fillet from a single specimen removed and analyzed by the same laboratory (see Attachment 9 of HHRA Volume I).

For analyses based on individual congener data, such as those based on TEQ from dioxin-like PCB congeners, several of the peaks consisting of co-eluting congeners had to be resolved. Specifically, in fish tissue samples from the EPA sampling programs, PCB-149/123 eluted as a doublet and PCB-201/157/173 eluted as a triplet. In a study conducted by the United States Geological Survey (USGS) for EPA (Tillitt 2003a, b), largemouth bass (*Micropterus salmoides*) samples were collected from different locations along the Housatonic River in 1999, and analyzed by the USGS Columbia Environmental Research Center (CERC). CERC determined

PCB congeners using an analytical protocol that resolved PCB-157 and PCB-123 into separate peaks, allowing them to be quantified separately. From these data, the relative proportion of each of the congeners in the doublet (PCB-149/123) and triplet (PCB-201/157/173) in fish tissue was estimated and applied to the fish data set.

In the doublet peak (PCB-149/123), the range of relative proportion of PCB-123 was from 0.21% to 0.81%, with a mean of 0.3%. In the triplet peak (PCB-201/157/173), the range of relative proportion of PCB-157 was from 10.8% to 34.8%, with a mean of 19.5%. The concentrations of PCB-123 and PCB-157 used in the HHRA were the concentration of the double peak multiplied by 0.003 and the concentration of the triplet peak multiplied by 0.195, respectively. These are anticipated to be central tendency, or best estimates of the congener concentrations. However, the contribution of PCB-123 and PCB-157 to total TEQ is small, and the choice of the correction value has negligible impact on the risk estimate.

Congener co-elution was also observed in waterfowl tissues. In the absence of waterfowl tissue data to resolve the peaks, the entire peak concentration was attributed to the congener contributing to the TEQ. A sensitivity analysis was conducted in which the impact on the EPC of assuming all or none of the peak was due to TEQ congener was assessed. There was no impact on the EPC with either assumption; the contribution of PCB-123 and PCB-157 to total TEQ was negligible regardless of how the co-elution was treated. Thus, the assumption that the entire doublet or triplet peak is due to the congener with the TEF has no impact on the risk estimates.

7.2.1.1.2 Treatment of Censored Data (Below the Limit of Detection)

EPCs were calculated by substituting one-half of the sample quantitation limit (SQL) as the concentration in samples in which there were non-detects for individual congeners. To examine the impact of this substitution value, EPCs were also calculated substituting “0” and the SQL, respectively. Table 7-1 presents the impact on the EPC of the use of zero, ½ SQL, and the SQL in place of non-detects.

Table 7-1

Changes in EPC Based on Alternative Non-Detect Concentration Substitution Values

Tissue/Location/COPC Class	EPC Used in the HHRA (mg/kg) (based on non-detects at 1/2 the SQL)	EPC Change (using "0" or the SQL)
Fish		
Reaches 5 and 6		
Dioxin congener-based TEQ	0.0000027	-90% to +95%
Furan congener-based TEQ	0.0000096	-12% to +13%
Dioxin-like PCB congener-based TEQ	0.00028	No change
Rising Pond		
Dioxin congener-based TEQ	0.00000028	-4% to +89%
Furan congener-based TEQ	0.000013	-11% to +7%
Dioxin-like PCB congener-based TEQ	0.00013	No change
Waterfowl		
Reaches 5 and 6		
Dioxin congener-based TEQ	0.0000046	+85% to +97%
Furan congener-based TEQ	0.000017	-18% to +35%
Dioxin-like PCB congener-based TEQ	0.0019	No change

Total PCBs and dioxin-like PCB congeners were detected in every fish and waterfowl sample, thus there was no uncertainty associated with the treatment of censored data for these COPCs. Furan-based TEQ EPCs could be over- or under-estimated by approximately 13% for fish and 18 to 35% in waterfowl. The percent change based on the treatment of non-detects for dioxin-based TEQ is larger. However, these changes had no impact on risk calculated from total TEQ because PCB congener TEQ concentrations were at least 10 times high than dioxin/furan TEQ combined.

7.2.1.1.3 Analytical Interference

Most of the tissue samples collected from the Housatonic River study area by EPA were analyzed for pesticides at GERG using a gas chromatography/electron capture detection (GC/ECD) method (GERG SOP-9810). In general, GC/ECD analytical methods may be subject to several different types of interferences, including the co-elution and subsequent detection of multiple contaminants in the peak. In the case of Housatonic River tissue matrices, the presence of PCBs resulted in an overestimation of the pesticide concentrations. Because of the high concentrations of PCBs in the tissue samples and the potential interference with pesticide quantification, 10 fish tissue extracts were re-analyzed by selected ion monitoring (SIM) GC/MS. When pesticides were analyzed using this method, the results are not affected by interference from PCBs. The results from the reanalyses did not indicate the presence of heptachlor epoxide, and the concentrations of the 10 other targeted pesticides were substantially lower than was quantified by GC/ECD.

7.2.1.1.4 Elimination of Pesticides as COPCs

Based on the SIM GC/MS results, the pesticide concentrations detected by GC/ECD were adjusted to account for PCB interference, as described in Section 2.6. Comparison of the adjusted concentrations with risk-based concentrations for fish consumption resulted in the elimination of pesticides as COPCs for fish. A similar analysis was conducted for waterfowl, which resulted in the elimination of pesticides as COPCs in waterfowl. The elimination of pesticides as COPCs could result in a small underestimate of risk from the site. For example, for waterfowl, a risk calculation based on the assumption that the pesticide concentrations reported by GC/ECD were accurate results in additional RME cancer risk of 2E-06 (compared to the tPCB cancer risk of 1E-03) and a hazard index of 0.01 and 0.02 for the adult and child, respectively.

7.2.1.1.5 Absence of PCB and Dioxin/Furan Congener Data in Connecticut

Concentrations of individual congeners were not available for fish sampled from locations in Connecticut. In fish samples from Massachusetts, cancer risks from TEQ ranged from similar to three times higher than tPCB cancer risks in the PSA, and similar to two times higher in Reach 8

(Rising Pond). Assuming congener patterns are approximately the same in the Connecticut fish as in Reach 8, cancer risks evaluated as TEQ are anticipated to be similar to as much as two times higher than those presented for tPCBs.

7.2.1.2 Data Included in Fish EPC Calculation

The EPCs are based on the assumption that the concentrations in fish collected in the sampling program are generally representative of the concentrations in the fish consumed. The selection of samples to use as the basis for the EPC reflects assumptions regarding locations where people fish and the fish species, sizes, and tissues that are typically consumed.

However, there is variability in consumer preference for fish species and parts of fish consumed that are not fully accounted for in either the point or the probabilistic risk assessments. These uncertainties are described in this section. Calculations describing the impact of different consumption behaviors on the EPC are also provided here. This information is used as the basis of bounding (point) estimates of risk in Section 7.2.4.

7.2.1.2.1 Length of River Included in Each Fishing Location

The concentrations of contaminants in fish differ among different locations sampled, due to distance from the source, impoundments versus free-flowing reaches, and sediment type (cobble versus fine-grained). This risk assessment evaluated fish caught in seven separate reaches of the Housatonic River; however, exposure was separately evaluated for four areas, three of which combine data from two reaches due to similarity in concentrations of COCs.

In Massachusetts, an evaluation of the data available for whole fish for subreaches within the lower part of the PSA (performed for the ERA) indicates there is little difference in fish concentrations in this area; therefore, these data were combined. Table 7-2 gives the range, median, and 95th percentile of the distribution of tPCB concentrations of whole fish over 12 inches in length, comparable to the data set used for fillets. The fish species in this dataset are carp, goldfish, largemouth bass, and yellow perch. The range and the median for these two data sets are similar; the 95th percentile of the distribution differs by 30%.

Table 7-2

Total PCB Concentrations (mg/kg) in Whole Fish Greater than 12 Inches

	Number of Samples	Range	Median	Mean	95th UCL of the Mean	95th Percentile of Distribution
Reach 5B/C	65	14 - 424	86	103	124	216
Reach 6	43	11-447	85	120	148	273

In the Connecticut portion of the Housatonic River, because the distributions of contaminant concentrations in smallmouth bass were similar for Reaches 11 and 12, and for Reaches 14 and 15, the data were combined.

The evaluation of the risk associated with smaller stretches of the river, i.e., assuming that an angler returns to the exact same fishing spot year after year, but maintains the same fish consumption habits, is unlikely to have an impact on the risk estimate. The assessment in the four reaches in Connecticut, where the upper two reaches and lower two reaches are similar, suggests that further subdivision of the site would not result in substantially different EPCs.

7.2.1.2.2 Fish Species Consumption Preferences

In the PSA, fish species were separated into two groups based on a statistical comparison of the tPCB concentrations. Yellow perch and sunfish were grouped together because there was no statistically significant difference in their concentration distributions. Bass and bullhead were grouped together for the same reason. Based on information gathered through the MDPH survey (1997), it was assumed that, on average, fish consumption preferences are approximately the same for the two groups of fish species. However, consumption preferences and practices are expected to vary among individuals. For example, one individual may consume only bass, which is a species with higher contaminant concentrations than the perch/sunfish group, whereas a second individual may consume fish from both groups.

Table 7-3 presents the EPCs calculated for individual species in each location and the composite EPC used in the risk assessment. Data are provided for tPCBs, TEQ from PCBs and TEQ from

Table 7-3

Risk-Driving Contaminants - Concentrations for Fish Species/Location

Species/Location	Maximum Detected Concentration (mg/kg)	Distribution	UCL (mg/kg)	EPC (mg/kg)
Reaches 5 and 6 - tPCBs				
EPC used in Risk Calculations in Section 5				**14**
Species				
Brown Bullhead	90	lognormal	21	21
Largemouth Bass	151	lognormal	23	23
Sunfish	47	neither	9.9	9.9
Yellow Perch	76	neither	13	13
Reaches 5 and 6 - Furan Congener-based TEQs				
EPC used in Risk Calculations in Section 5				**0.0000096**
Species				
Brown Bullhead	0.000042	neither	0.000016	0.000016
Largemouth Bass	0.000027	lognormal	0.0000087	0.0000087
Sunfish	0.000034	neither	0.000011	0.000011
Yellow Perch	0.000024	neither	0.0000078	0.0000078
Reaches 5 and 6 - Dioxin-like PCB Congener-based TEQs				
EPC used in Risk Calculations in Section 5				**0.00028**
Species				
Brown Bullhead	0.0036	lognormal	0.00045	0.00045
Largemouth Bass	0.00087	neither	0.00032	0.00032
Sunfish	0.0012	neither	0.00028	0.00028
Yellow Perch	0.00081	neither	0.00018	0.00018
Rising Pond - tPCBs				
EPC used in Risk Calculations in Section 5				**9.4**
Species				
Brown Bullhead	13	lognormal	6.7	6.7
Largemouth Bass	5.8	lognormal	5.0	5.0
Sunfish	5.1	lognormal	4.2	4.2
Yellow Perch	25	lognormal	14	14
Rising Pond - Furan Congener-based TEQs				
EPC used in Risk Calculations in Section 5				**0.000013**
Species				
Brown Bullhead	0.000021	lognormal	0.000014	0.000014
Largemouth Bass	0.000014	lognormal	0.0000073	0.0000073
Sunfish	0.0000074	lognormal	0.0000060	0.0000060
Yellow Perch	0.000017	lognormal	0.000019	0.000017
Rising Pond - Dioxin-like PCB Congener-based TEQs				
EPC used in Risk Calculations in Section 5				**0.00013**
Species				
Brown Bullhead	0.000072	lognormal	0.000055	0.000055
Largemouth Bass	0.000094	normal	0.000067	0.000067
Sunfish	0.000066	normal	0.000051	0.000051
Yellow Perch	0.00021	lognormal	0.00028	0.00021

mg/kg = milligrams per kilogram.

furans. The tPCB EPCs for bass and bullhead in the PSA are approximately double the EPCs for perch and sunfish, and there is approximately a 50% difference between the EPCs for the individual species and the composite EPC used in the risk assessment. The risks associated with strong species preferences are evaluated in the bounding estimates presented in Section 7.2.4.

7.2.1.2.3 Data Available for Connecticut Species

EPCs for fish consumption in Connecticut were based on smallmouth bass or brown trout, rather than a composite of species. Data from individual fillets for these two species are available from four sampling locations from biennial fish surveys that have been conducted by the Academy of Natural Sciences of Philadelphia (ANS) since 1984 on behalf of GE under a Cooperative Agreement with CTDEP. The use of these two species introduces uncertainty into the risk calculation for anglers who consume other fish species.

In 2000, at the request of CTDEP, supplemental samples of bluegill, pumpkinseed, brown bullhead, and yellow perch were collected from Falls Village (a location upstream from West Cornwall) and Bulls Bridge (ANS, 2001). Fish were analyzed as composites of fillets from five fish of similar length rather than as individual fillets. At Bulls Bridge, tPCB concentrations in two composite samples of yellow perch were 0.31 mg/kg for perch of length 22.5 to 25 cm (10 to 11 inches) and 0.27 mg/kg for perch of length 28.2 to 29.6 cm (11 to 12 inches). Total PCB concentrations were 0.38 mg/kg for brown bullhead, 0.65 mg/kg for pumpkinseed, and 0.82 and 0.11 mg/kg for the two composites of bluegill. For comparison, the geometric mean concentration of smallmouth bass sampled at Bulls Bridge in 2000 was 0.91 mg/kg. No trout data were available for this location. EPCs based on only smallmouth bass consumption are likely to be overestimates if anglers consume perch, bullhead, and/or sunfish (pumpkinseed/bluegill) in addition to bass.

7.2.1.2.4 Parts of Fish Consumed

Skin-off fillets were used to represent the parts of fish consumed by anglers and their families in Massachusetts PSA and Reach 8 (Rising Pond). Skin-on fillets were used to represent the parts of fish consumed for smallmouth bass and trout in Connecticut (Reaches 10 to 15). The difference in fillet preparation method was necessitated by the different sampling protocols used in the sampling programs in the two states. A comparison of PCB concentrations in fish analyzed as skin-on and skin-off fillets indicates 2 times to 4 times higher PCB concentrations in skin-on fillets, based on the studies described below. The use of the skin-off fillet as the basis for the EPC calculation would therefore lead to a 2 times to 4 times underestimate of cancer risk and noncancer hazard for those individuals who routinely consume both the fillet and the skin. The risk would be higher still for those who prepare a "whole" fish for consumption or use the whole fish in other preparations such as making stock, as whole fish have higher tPCB concentrations than skin-on fillets, as described below. On the other hand, the use of skin-on fillets as samples in Connecticut studies will lead to an overestimate of EPC for those individuals who remove the skin. Bounding estimates of risk based on different parts of fish consumed are presented in Section 7.2.4.

The Connecticut Department of Health Services (CTDHS) sampled fish from several locations in the Housatonic River in 1979, and included bluegill fillets prepared both skin-on and skin-off (CTDHS, 1979). The mean PCB concentration of the 10 skin-off fillets was 0.5 mg/kg, while the mean PCB concentration of the 20 skin-on fillets was 1.3, between two to three times higher. Although the skin-off fillet samples were collected in Lake Zoar and the skin-on samples were collected from Bulls Bridge and Lake Lillinonah, statistical comparisons of skin-on bass fillet samples showed no significant difference in the distribution of PCB contamination concentrations at these locations. These data suggest that an EPC based on a skin-on fillet would be two to three times higher than an EPC based on skin-off fillets.

Beck (1982) sampled brown and rainbow trout in the Connecticut portion of the Housatonic River in 1979, and submitted both skin-on and skin-off fillets for PCB analysis. The mean PCB concentrations of the skin-off samples were 6 mg/kg and 5 mg/kg, for brown and rainbow trout, respectively. The mean PCB concentrations of the skin-on samples were 16 mg/kg and 18 mg/kg, respectively. Thus, for trout, PCB concentrations were two to four times higher in the skin-on samples, similar to what was measured by CTDHS for bluegill.

Bevelhimer et al. (1997) sampled largemouth and spotted bass in Tennessee and Ohio, and developed a linear equation describing the relationship of PCB concentrations in the whole body with PCB concentrations in skin-on fillets. The whole body concentrations of PCBs (sum of

Aroclors 1254 and 1260) were 2.3 times higher than the skin-on fillets based on 31 samples. Data collected in the Housatonic River support this observation; tPCB concentrations in whole fish (offal and fillets) are on average greater than 10 times higher than skin-off fillets. Therefore, the risk for individuals who consume whole fish is higher than for those individuals who consume only the fillet (skin-on or skin-off).

7.2.1.2.5 Connecticut Smallmouth Bass Size Classes

Smallmouth bass greater than 10 inches (25 cm), but less than the 12-inch (30-cm) minimum legal length were retained in the data sets because the sample size would be inadequate if they were eliminated. Because PCB concentration is correlated with fish length (age), smaller fish will have lower PCB concentrations. The use of fish smaller than the legal limit may bias the EPC low, and therefore underestimate risk.

7.2.1.3 Data Included in Waterfowl EPC Calculation

The selection of samples to use as the basis for the waterfowl EPC reflects assumptions regarding the location of hunting and the species and parts of the waterfowl consumed. For ducks, it also includes assumptions regarding the timing of hunting – prior to the fall migration.

7.2.1.3.1 Resident Ducks in Massachusetts PSA

The concentrations in duck breast tissue were measured in samples from resident waterfowl (i.e., those living in and/or hatching in the PSA during the breeding and rearing season), specifically mallards and wood ducks. The ingestion rates used for the RME (based on consuming 11 birds) and the CTE (based on consuming 5 to 6 birds) are consistent with consuming ducks bagged only during the first 2 weeks of the hunting season, prior to the fall migration of waterfowl residents in the area in the summer. This EPC is appropriate for those who consume ducks taken in the first 2 weeks of the season.

With somewhat less certainty, this EPC is also appropriate for those who consume 11 meals (RME) or 5 to 6 meals (CTE), including Canada geese from the PSA throughout the year, or some combination of meals of Canada goose and pre-migration ducks. Canada geese are year-round residents in the PSA. Based on the similarity of feeding habits, and observations of nesting and brood-rearing in the same habitat used by the mallards and wood ducks (WESTON, 2004, Appendix A), ducks and geese from the PSA are likely to have similar concentrations of PCBs and dioxin/furans as those measured in the wood ducks and mallards. However, geese that forage year-round in primarily upland habitats are not expected to have contaminant concentrations as high as the ducks sampled in the PSA.

An additional uncertainty with the waterfowl EPC is that it is based on sampling data from two species: mallards and wood ducks, which are dabbling and perching ducks, respectively. Although these species are omnivorous, their diet is rich in aquatic insects during breeding and nesting periods. At other times their diet consists mainly of vegetation. Some diving ducks (e.g., mergansers that breed in or migrate through the Housatonic River Area) consume not only aquatic insects, but also fish. Fish are likely to bioaccumulate contaminants such as PCBs and furans to a greater extent than aquatic vegetation or aquatic insects, which would lead to higher concentrations of these contaminants in diving ducks than was measured in the dabbling or perching species. This assumption could result in an underestimation of the EPC and thus risk for hunters who consume some diving ducks.

After the fall migration begins, the hunter’s bag of ducks will consist predominantly of nonresidents, i.e., ducks migrating into the Housatonic River area from other areas. To the extent that the total bag limit includes waterfowl that are non-resident after the fall migration begins, the EPC based on resident ducks will represent an overestimate of exposure.

7.2.1.3.2 Waterfowl Migrating from the PSA

Risk estimates for consumption of waterfowl from the PSA were based on mallard and wood duck data, assuming the concentrations were the same in all waterfowl in the PSA, including some species that are year-round residents (e.g., Canada goose). The specific migration routes of waterfowl species from the PSA vary and are not precisely known, and although some individuals reared in the PSA may migrate through and/or to areas of the Housatonic River in Connecticut, quantification of these individuals is not possible. However, an estimate can be obtained from the banding information collected by MassWildlife that was discussed in Section 4.2.

The banding records indicate that MassWildlife banded an average of 56 ducks per year in the PSA since 1992 (range = 16 to 116); this number can be considered the mean minimum number of duck residents in the PSA over this period. Based on observations of numbers of duck broods in the PSA made during ecological characterization conducted for the Rest of River study, it is conservatively estimated that the local population is approximately 120, and that less than half of the resident ducks are banded each year. Banding records further indicate that approximately 23% of the birds banded locally are also harvested locally by hunters. Thus, in a typical year, approximately 90 ducks that are resident in the PSA migrate out of the area. It is likely that, even if these ducks migrate along the Housatonic River and are bagged in Connecticut, these individuals will be mixed with ducks reared elsewhere. This mixing will reduce exposure to tPCBs to an unknown extent, likely to reference levels.

7.2.1.3.3 Resident Waterfowl in Connecticut Reaches

The single measurement of contaminant concentration in duck tissue from Connecticut was determined not to be useable in this risk assessment due to lack of a well-defined sample collection location. The lack of site-specific data on contaminant concentrations in duck tissue introduces an uncertainty into the risk assessment that will underestimate risk to the extent that contaminated waterfowl are raised on the river and harvested in Connecticut. However, the analysis below indicates that concentrations of tPCBs in ducks are likely to be similar to the concentrations of tPCBs detected in the reference location sampled within the Housatonic River watershed adjacent to Reach 9. In addition, although the number of ducks that may migrate into or through Connecticut from the more contaminated reaches in Massachusetts is unknown, it is likely to be a small percentage of the waterfowl present in the region during the hunting season. Thus, lack of inclusion of PCB data from waterfowl in Connecticut is not likely to result in a substantial underestimate of risk. The risk associated with consumption of ducks from the reference area (EPC = 1.0 mg/kg) is provided in Section 7.2.4.

The surficial (0 to 0.5 ft) sediment concentrations of PCBs are 50 to 1,400 times lower in Connecticut than in PSA in Massachusetts (where resident ducks were sampled). Specifically, the recent data (2001) show a maximum Connecticut sediment concentration (as presented in the HHRA, Volume IIA, Section 6) of 0.47 mg/kg, whereas the mean and maximum surficial sediment concentrations from the PSA are 24 and 668 mg/kg tPCB, respectively (BBL and QEA, 2003). If bioaccumulation is strongly associated with sediment concentrations as expected, resident Connecticut Housatonic River wood ducks would have maximum concentrations of 0.13 mg/kg (calculated by dividing the mean tPCB concentrations in PSA wood ducks by 50), which is less than the mean and median tPCB concentrations, 0.58 mg/kg and 0.21 mg/kg, respectively, in wood ducks in the Threemile Pond reference area (see Table 2-28).

7.2.1.3.4 Parts of Duck Consumed

Skin-on duck breasts were used to represent parts of ducks consumed by hunters and their families in PSA. However, some hunters and their families may also consume other portions of the duck, including legs, thighs, and organs such as the liver. For example, duck meat could be made into sausages, or the liver could be sautéed or made into a paté. Although the use of an EPC based on only breast tissue introduces some uncertainty into the EPC and the risk assessment, the extent of this uncertainty is likely to be small.

It is expected that the COPC concentrations in legs and thighs (“dark meat”) will be similar to the concentrations measured in the breast meat. Dark meat in fowl is characteristic of muscles that are used regularly. In the case of ducks, particularly wild ducks, all muscles are used regularly and therefore both breast and leg are dark meat (Gisslen, 1995). Gisslen also notes that dark meat requires more cooking time than light meat because of its higher amounts of fat and connective tissue. In addition, Gisslen indicates that the legs and breasts of ducks and geese differ in the amount of connective tissue, but not in the amount of fat, which is the most important consideration for determining whether individuals consuming legs would be exposed to greater amounts of lipophilic contaminants such as PCBs than would individuals consuming breast meat.

The concentrations of PCBs and TEQ are higher in duck liver than duck breast as shown in Table 7-4. Thus, if liver were included in the EPC for duck tissue, the EPC would have increased slightly. The mean weight of the duck breasts (wood duck and mallard combined) taken in September, when the birds were close to maturity, was 132 g. The mean weight of the livers sampled in this timeframe was 19 g. Thus, if the liver were included in the parts of duck

Table 7-4

Duck Breast Risk Driver Contaminant EPCs Compared with Duck Liver EPCs
Reaches 5 and 6

Contaminant	EPC (mg/kg)	
	Breast	**Liver**
PCBs		
PCB, TOTAL	9.7	14
2,3,7,8-TCDD TEQs		
Furan Congener-based TEQ	0.000017	0.000053
Dioxin-like PCB Congener-based TEQ	0.0019	0.0023

mg/kg = milligrams per kilogram.

Note: EPCs include non-detects at one-half the detection limit.

consumed, and the weight difference between breast and liver accounted for, the EPC for tPCB would increase from 9.7 mg/kg to 10.2 mg/kg. However, this 5% increase would be a slight overestimate if legs and thighs are also consumed.

Certain consumers may ingest only duck liver. Ingestion rates for liver for the RME can be approximated by assuming that all the liver in the 11 waterfowl bagged by RME hunters is consumed. If the mean weight of the liver is 19 grams, then the RME ingestion rate for liver is 209 g/year. Based on the other exposure parameters used for RME waterfowl consumers, and an EPC for tPCB of 14.4 mg/kg, the RME risk due to tPCB is 2E-04. This risk is five times lower than the tPCB risk calculated on the basis of breast meat consumption.

7.2.2 Uncertainty in the Exposure Assessment

Uncertainties in the exposure assessment include the selection of receptors, the prey consumed, the calculation of exposure point concentrations, the ingestion rate for each prey item, the method of food preparation, the fraction of the prey that originates in the Housatonic River (or floodplain for waterfowl), and the length of time the prey is consumed (exposure duration).

7.2.2.1 Receptors

The receptors for the fish consumption exposure pathway were defined as a recreational angler or family member who consumes at least one meal per year from the Housatonic River, or a nursing child whose mother has consumed at least one meal of Housatonic River fish while nursing. EPA attempted to identify populations that engage in subsistence fishing in both the Massachusetts and Connecticut reaches of the Housatonic River, and found no evidence that any exist at this time. If subsistence angling populations were to occur along the Housatonic River, risks from fish consumption would be higher than predicted in this risk assessment.

The receptors for the waterfowl consumption exposure pathway were defined as recreational hunters and their families who consume at least one meal per year of waterfowl bagged near Woods Pond and its backwaters. Receptors also include a nursing child whose mother has consumed at least one waterfowl meal while nursing.

7.2.2.2 Species Consumed

Residents of the Housatonic River area may consume several species of fish, several species of waterfowl, frogs, turtles, and other aquatic species from the river. Risks can be underestimated if more highly contaminated food species are not included in the risk assessment and/or if such species are ingested to a greater extent than is assumed in the risk assessment. Conversely, risks can be overestimated if the species consumed are less contaminated than the species quantified in the assessment.

Four fish species, representing the majority of the fish in the fishery (Table 4-1), were included in the assessment of the Massachusetts reaches: largemouth bass, yellow perch, brown bullhead, and sunfish (pumpkinseed and bluegill). Although other fish species may be consumed, such as trout, pike, and pickerel, these species are less abundant in the Housatonic River and/or subject to stocking, fly-fishing only, and catch and release practices in addition to the consumption advisory (Table 4-1). In addition, data on brown trout and smallmouth bass caught in the same reaches in Connecticut indicate these species have roughly similar PCB concentrations. Thus, if receptors consumed trout instead of bass and/or bullhead, the exposure point concentration is likely to be similar.

In Connecticut, fish consumption was assumed to be entirely trout or bass, and not a combination of species. To the extent that receptors consumed yellow perch and sunfish in addition to bass or trout, the exposure point concentration may be overestimated, as discussed in Section 7.2.1.2.

The Massachusetts fish consumption advisory for the Housatonic River includes frogs and turtles in addition to fish, based upon historical data. Turtles were not sampled in the current assessment because there was no indication of current harvesting for consumption. However, bullfrogs (as legs) were sampled in the Rest of River study because of anecdotal evidence of continued harvest. Table 7-5 presents a summary of the tPCB and TEQ concentrations and EPCs. When compared to fish, the concentrations in frogs were lower for tPCBs but higher for dioxin-like PCBs and furans. Because the consumption rate of frog legs by individuals is anticipated to be much lower than fish, but is not known, risks were not quantified. For an individual who consumes frog legs in addition to fish (increasing the number of site-related meals), the risks would be greater than those estimated for fish alone.

Table 7-5

Frog Leg tPCB and TEQ Data Summary and EPCs

Contaminant	Frequency of Detection	Range of Detected Concentrations (mg/kg)	25th Percentile (mg/kg)	Median (mg/kg)	75th Percentile (mg/kg)	Distribution	95% UCL (mg/kg)	EPC (mg/kg)
PCB, TOTAL	20 / 20	0.25 - 1.7	0.44	0.61	0.97	normal	0.87	0.87
Dioxin-like PCB congener-based TEQ, co-elute = 1	20 / 20	0.000016 - 0.00078	0.000035	0.00019	0.00037	lognormal	0.00065	0.00065
Dioxin-like PCB congener-based TEQ, co-elute = 0	20 / 20	0.000014 - 0.00078	0.000034	0.00019	0.00037	lognormal	0.00067	0.00067
Furan congener-based TEQ	10 / 10	0.00000059 - 0.000029	0.0000027	0.0000066	0.000018	lognormal	0.000052	0.000029

Note: Dioxin congeners not detected.

7.2.2.3 Calculation of Exposure Point Concentrations

The exposure point concentrations (EPCs) used in this risk assessment incorporate many uncertainties. The statistical uncertainties associated with sampling and calculating an upper bound of the mean are discussed in this section. Uncertainties regarding fish species consumed, parts of fish consumed, and analytical chemistry were discussed previously in Section 7.2.1.

EPCs are based on a calculated value, the 95% upper confidence limit of the mean (95% UCL). The EPC is based on a central tendency value, the mean, because the toxicity factors are based on chronic (multi-year) exposures. It is assumed that, over time, the concentrations in fish caught by an individual receptor will tend toward this mean concentration. The 95% UCL of the mean is intended to provide a high degree of confidence that the “true” mean tissue concentration, and thus the risk, is not underestimated due to uncertainties related to the extent and variability of the data.

However, the calculation of the UCL is not straightforward. Different statistical methods are appropriate depending upon the shape of the distribution of the sample concentrations in each data set being used. The methods used to calculate the shape of each distribution and the methods to calculate a UCL for three different types of distribution (normal, lognormal, and neither normal nor lognormal) are described in Section 4. The ability of six statistical methods to accurately estimate UCLs for different distribution shapes and sample sizes is detailed in Attachment 4 of the HHRA Volume I. The Hall’s bootstrap method was used for distributions that are neither normal nor lognormal. This method estimated the 95% UCL most accurately for such distributions.

The Land *H*-statistic was used to calculate 95% UCLs for data sets for which statistical tests did not reject the hypothesis of lognormality. This approach may commonly yield estimated UCLs substantially larger than necessary when distributions are not truly lognormal; for example, if variance or skewness is large (Gilbert, 1987). Singh et al. (1997) state that when sample sizes are less than 30, the method can yield large UCLs even when the underlying distribution is lognormal. Thus, in some cases the use of the *H*-statistic may overestimate the 95% UCL. However, because the *H*-statistic was used only for data sets that met statistical criteria for lognormality, any overestimate of the UCL due to the use of the Land *H*-statistic is reduced.

Uncertainty associated with the EPC was included in the probability bounds analysis by allowing the EPC to be bounded by the sample mean and the UCL (as calculated in the point estimate). This uncertainty was propagated along with other uncertainties included in the probability bounds analyses to bound the risk estimates provided by Monte Carlo risk characterizations.

7.2.2.3.1 Fish Consumption Rate

The available data regarding fish consumption rates in the Housatonic River and the Maine Angler Survey, which formed the basis for determining the consumption rate, are discussed in Section 4. That discussion includes the strengths and weaknesses of the Maine Angler Survey and the assumptions used to apply the results of this study to Housatonic River anglers. The data from the Maine Angler Survey are considered to be highly relevant to the Housatonic River Area (HRA) population. The subset of data used to calculate consumption rates, namely data from individuals who report only one fish consumer in their household, was used to provide an unbiased estimate of individual fish consumption from the perspective of how equally fish are shared among household members. The central tendency fish consumption rate calculated from the Maine Angler Survey is consistent with consumption rates calculated from other studies relevant to the HRA such as the Ebert et al. (1996) evaluation of Housatonic River data in Connecticut and the MDPH survey results (MDPH, 2001). The high-end consumption rate (RME) is within the range, but somewhat lower than would be obtained if the MDPH data for freshwater fish consumption were used as the basis of the consumption rate. For example, if the high-end rate were based on the 95th percentile of the distribution of recreationally caught fish, and 75% of the meals reported were recreationally caught, fish meals from the river would be estimated to be 78 meals/year. This is somewhat higher than the 50 meals/year (8-oz meals) derived from the Maine Angler Survey.

Point estimate consumption rates for an individual angler may be under- or overestimated depending upon how their personal fish consumption habits differ from those used for the RME and CTE. This variability is quantified in both the one-dimensional and MEE Monte Carlo analyses. Point estimate risks to individual anglers may be overestimated to the extent that anglers fish only in rivers or only in impoundments, as the fish consumption rates (other than for trout) are based on the assumption that the angler fishes in all waters in each exposure area. The uncertainty associated with this assumption is included in the probability bounds around both Monte Carlo simulations.

7.2.2.3.2 Waterfowl Consumption Rate

The waterfowl consumption rate is based on the number of waterfowl meals an individual may consume and the size of the meal. The number of meals is based on information from MDPH (2001) prior to or in response to the MDPH waterfowl consumption advisory. Although the sample size is relatively small, it is site-specific.

The size of the meal is assumed to be a waterfowl breast, with one bird constituting one meal. An estimate of 11 birds was used for the RME and 5 to 6 birds for the CTE. This number of birds (meals) is consistent with known frequency of hunting waterfowl based on data from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (USFWS, 2001). For Massachusetts, the mean number of days/year waterfowl hunting is 7 and the 95th percentile (and the maximum) is 14. Thus, the consumption rate requires less than one bird bagged per hunting trip. The number of birds required for the RME and CTE consumption rates is allowable under the bag and possession limits for waterfowl, and within the productive capacity of the area.

The meal size for waterfowl (112 g cooked, equivalent to 165 g uncooked) is based on published data for poultry consumption (Pao et al., 1982). This weight is consistent with the weight of breasts of mature ducks in the HRA. The meal size may be somewhat underestimated for goose. Thus, to the extent that goose are consumed rather than duck, the consumption rate may be underestimated.

7.2.2.3.3 Cooking Loss

Lipophilic compounds (e.g., PCBs and dioxins/furans) accumulate in the fatty parts of animals. Some loss of these compounds can occur during cooking when the fat cooks off and/or through volatilization (Sherer et al., 1993). The exposure model used in this assessment included a term to account for cooking loss. Individual reports of cooking loss for PCBs ranged from 0% for broiling and pan frying to 74% for deep-fat frying. Individual cooking methods result in different average percentages of cooking loss, although the range for each cooking method is wide. The data indicate that the most conservative cooking loss is zero. However, a weighted average of mean cooking loss that considers both the cooking loss for each cooking method, as well as the preference for that method, was used for both the CTE and RME calculations. Depending upon an individual's fish consumption habits, the use of this average loss could overestimate or underestimate cooking loss. For example, if an individual typically broils fillets in a manner that results in no cooking loss (the result in two independent studies), then the risk will be underestimated by 25%. On the other hand, if an individual always cooks fish by deep fat frying, the risk is likely to be overestimated 10% to 20%. Overall, the sensitivity of the risk results to cooking loss is small.

No cooking loss was assumed for waterfowl because whatever might be lost in cooking could be consumed in drippings used to make gravy/sauce. If cooking loss occurs through loss of fat and volatilization, as with fish, then the risk may be overestimated due to the assumption of zero cooking loss. The magnitude of this overestimate is likely to be small (20% if similar to baking/broiling of fish).

7.2.2.3.4 Fraction of Fish Consumed from the Housatonic River

The fraction of fish consumed from the Housatonic River, 0.97 for the RME and 0.5 for the CTE, was based on site-specific and regional survey data. These data indicate a substantial fraction of Housatonic River anglers (greater than 10%) fish the river all or the great majority (>95%) of the time, even in the presence of a fish consumption advisory. The data for the central tendency angler consistently indicate angling between 30% to 50% of the time, again, even in the presence of a consumption advisory. The distribution for FI used in the probabilistic analyses was developed consistent with the survey data.

The use of the fraction of time angling the Housatonic as a surrogate for the fraction of recreationally caught fish consumed from the Housatonic is a source of uncertainty. It is likely a good surrogate of consumption at the high end, where all or almost all of the angling activity is reportedly on the Housatonic River. It could result in an over- or underestimate of risk for a central tendency receptor if fishing the Housatonic resulted in smaller or larger catches than other locations.

In the point estimate and in the one-dimensional Monte Carlo probability assessment, it is assumed that the FI is constant throughout an angler's lifetime. In the MEE Monte Carlo model, the FI is assumed to vary from year to year, with no correlation between years. The difference in the estimates between the one-dimensional and MEE Monte Carlo upper-bound estimate partially reflects this difference in assumptions regarding the fraction of fish ingested from the river.

7.2.2.3.5 Fraction of Waterfowl Consumed from the Housatonic River

The fraction of waterfowl consumed from the Housatonic River, 1 for both the RME and CTE, was based on field observations of duck blinds in the area and the habits of waterfowl hunters to frequent the same duck blind. To the extent that hunters take their waterfowl from locations other than the Housatonic, this FI will result in an overestimate of risk.

7.2.2.4 Exposure Duration

There are no standard methodologies or values for determining exposure duration (ED) for recreational scenarios. The length of time an individual lives in a single residence, typically used in risk assessments for residential scenarios, may underestimate exposure duration for anglers and hunters who may move among residences in the same area, but continue to fish or hunt in the same location. Conversely, an individual may stop fishing or hunting irrespective of the location of their home. Creel surveys, such as those conducted in the Connecticut portion of the Housatonic River (Ebert et al., 1996), indicate that anglers drive some distance from home to fish in a preferred location, as judged by the observation of anglers residing in New York and Massachusetts in addition to anglers from Connecticut.

Fifty years was selected as the RME exposure duration based on the 90th percentile of the distribution for number of years consuming freshwater fish from a sample of 705 individuals in the Housatonic River area who have ever consumed freshwater fish (MDPH, 2001). Although the 95th percentile is normally used for an RME value, the 90th percentile was selected in this case because of the lack of specificity of the data regarding the length of time fishing the Housatonic River and the potential bias for overestimating exposure duration that it imposes. Exposure duration could also be based on the subsets of the study population who ever fished rivers, or had ever fished the Housatonic River. Use of these subsets would have resulted in slightly longer EDs and higher risk estimates. The 95th percentile of the distribution for number of years consuming freshwater fish is 60 years. Use of an exposure duration of 60 years rather than 50 years would result in a 20% increase in cancer risk, and would have no impact on the hazard index.

The 95th percentile of the data collected by the MDPH survey for years living in a single residence in the Housatonic River area is 45 years. The use of an exposure duration of 45 years based on the 95th percentile duration at a single residence in the HRA would result in a 10% decrease in risk.

EPA's nationwide upper-bound default assumption for living at a single residence is 30 years, which several models indicate lies between the 90th to 95th percentile of the distribution. The difference between HRA (45 years) and national data (30 years) suggests that the Housatonic River area population is less mobile (i.e., changes residence less often) than the national average, providing additional support for the use of an exposure duration for recreational activities (such as hunting and fishing) within the Housatonic River area that is higher than a national average based on residential exposure. The 95th percentile of the distribution for number of years living in the Housatonic River area is 73 years (MDPH, 2001). A comparison of this value with the length of time consuming freshwater fish suggests that the hunters and anglers at the upper end of the exposure duration distribution are lifelong Housatonic River area residents.

7.2.3 Uncertainty Associated with the Dose-Response

The toxicity values used in this risk assessment for these contaminants were the most current values published by EPA (EPA, 2004, 1997). A more detailed discussion of the toxicology of PCBs and dioxin/furans is included in Section 4 of HHRA Volume I. The following sections provide a brief discussion of the uncertainties associated with these toxicity values.

7.2.3.1 Cancer Slope Factors (CSFs)

CSFs are plausible upper-bound estimates of carcinogenic potency used to calculate cancer risk from exposure to carcinogens by relating estimates of lifetime average chemical intake to the incremental probability of an individual developing cancer over a lifetime. Because they are plausible upper-bound estimates, EPA is reasonably confident that the actual cancer risks are likely to be less than the risks estimated with the upper-bound slope factor. It is not possible to estimate how much less, but risks to some individuals could be zero.

7.2.3.1.1 PCB CSF

The CSFs for PCBs are based on animal studies using commercial mixtures. For PCBs, EPA has developed both high-end and central tendency estimates of the PCB CSF. The upper-bound and central estimate slope factors for highly chlorinated PCBs, such as those detected in the fish and waterfowl sampled in the HRA, differ by a factor of two. This difference is an approximate measure of the variability of results among rodent studies in which highly chlorinated commercial Aroclors were tested.

There are uncertainties associated with the use of animal studies to predict cancer risk in humans, both qualitatively and quantitatively through the CSF. Qualitatively, PCBs have been classified as probable human carcinogens (former EPA category B2) based on clear evidence of carcinogenicity in animal experiments and suggestive studies in human populations. Quantitatively, major sources of uncertainty in the use of animal data to predict responses in humans are: (1) the extrapolation of animal studies to human populations, (2) the extrapolation of the high experimental doses to the lower doses from environmental exposures, (3) extrapolation from (young) adult lifetime exposure in animals to less than lifetime exposures (but including the impact of early life exposures) in humans, and (4) extrapolation of results from commercial mixtures to environmental mixtures. The first three uncertainties are common to the derivation of many CSFs developed by EPA, although the extrapolation to less than lifetime exposure may be a greater uncertainty for persistent compounds such as PCBs and dioxins/furans. The extrapolation from commercial to environmental mixtures is specific to mixtures such as PCBs. This issue is summarized in Section 3.2.4.2 and discussed in HHRA Volume I, Section 4, in greater detail.

7.2.3.1.2 Dioxins, Furans, and Dioxin-like PCBs

Cancer risks from dioxins, furans, and dioxin-like PCBs were characterized using the TEQ methodology described in Section 3. Toxic equivalency factors (TEFs) developed by the World Health Organization (WHO) (Van den Berg et al., 1998) were used to calculate the TEQ for these contaminants. TEFs are order-of-magnitude estimates that do not include expressions of uncertainty in predicted dioxin-like toxicity. Some TEFs are based on cancer-related effects, and others are based on noncancer-related effects. The TEQ approach assumes congener effects are additive and does not address possible antagonism or synergism. The result of the TEQ methodology is a concentration or dose that has a potency equivalent to 2,3,7,8–TCDD. Cancer risks are characterized by multiplying the TEQ, expressed as average daily dose, with the CSF for 2,3,7,8-TCDD.

The weight of the evidence that dioxins are human carcinogens has been evaluated by several national and international organizations. EPA has withdrawn its evaluation of TCDD carcinogenicity from IRIS. The EPA evaluation in HEAST (EPA, 1997), which in turn was based on an evaluation conducted in 1985, gave a weight-of-evidence classification of B2, probable human carcinogen. More recently, the International Agency for Research on Cancer (IARC, 1997) evaluated the weight of evidence that 2,3,7,8-TCDD is a human carcinogen and concluded it was a Group 1, human carcinogen. In other words, there was adequate evidence based on human studies to consider it carcinogenic to humans.

EPA recently reviewed available epidemiology and toxicity studies on 2,3,7,8-TCDD and other dioxin-like compounds. A preliminary draft document (EPA, 2000) presents EPA's scientific reassessment of the health risks resulting from exposure to these compounds. This document has undergone review by the public as well as EPA's Science Advisory Board (SAB) (EPA, 2001b). Based on its review of epidemiology, animal toxicology and mechanistic studies, EPA considered that 2,3,7,8-TCDD met the criteria of a human carcinogen, as set forth in its cancer assessment guidelines (EPA, 1999). EPA, along with other members of an Interagency Workgroup, has asked the National Academy of Sciences (NAS) to provide an additional review to ensure that the risk estimates contained in the draft are scientifically robust and that there is a clear delineation of all associated uncertainties (EPA, 2003).

There is considerable uncertainty regarding the appropriate CSF for TCDD. The CSF derived by EPA (1985) and published in HEAST (EPA, 1997), 1.5E+05 $(mg/kg\text{-}d)^{-1}$, was used in this assessment. The CSF was derived from liver tumor incidence data in female Sprague-Dawley rats in a 2-year feeding study and extrapolated from the experimental doses given to the animals to lower doses typical of environmental exposure using a linearized multistage model. Species extrapolation from animals to humans was calculated based on a body weight ratio to the 3/4 power.

In the reassessment, EPA recommended a revised CSF of 1E+06 $(mg/kg\text{-}d)^{-1}$ to estimate upper-bound cancer risk for background intakes and incremental intakes above background, of 2,3,7,8-TCDD and other dioxin-like compounds. Use of this recommended CSF would result in an approximately 6 times increase in the cancer risk estimates associated with 2,3,7,8-TCDD and other dioxin-like compounds. Thus, the current CSF for 2,3,7,8-TCDD used in this assessment may underestimate potential risks. However, as with all upper-bound slope factors used to calculate cancer risks, EPA believes that the true risks are likely to be less than the risks estimated with the upper-bound slope factor. It is not possible to estimate how much less, but risks to some individuals could be zero.

7.2.3.2 Chronic Reference Doses (RfDs)

The chronic RfD represents an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime.

7.2.3.2.1 PCBs

The Reference Dose (RfD) for PCBs used in this assessment is based on immunological effects observed in rhesus monkeys exposed to Aroclor 1254. An uncertainty factor of 300, which accounts for sensitive members of the population and for extrapolating from animal data to human data, is incorporated into the RfD. EPA is currently reviewing new studies on noncancer effects of PCBs as part of the ongoing IRIS review process. These studies report possible associations between developmental and neurotoxic effects in children from pre-natal or post-natal exposures to PCBs. Major sources of uncertainty associated with the PCB RfDs include:

- The selection of uncertainty factors in the derivation of the RfDs, including the length of the study, the critical effect, the quality of the data set, and the variability of human population, including sensitive subpopulations.
- The assumption that the critical effects in animal studies are the critical effects in humans.
- The dose metric of average daily dose, which is applicable to bioaccumulative compounds.
- Toxicity changes resulting from PCB mixture alterations following release to the environment.

Each of these sources is described in Section 4 of HHRA Volume I.

In addition to uncertainties in the chronic RfD, there is uncertainty associated with toxic effects that may result from shorter exposure durations. The critical period of exposure for developmental effects associated with in utero exposure may be days or weeks instead of the long-term exposure assessed in this report. The potential impact of these acute (short-term) exposures was not evaluated in this assessment, which could lead to an underestimate of the risk associated with PCBs. A perspective on exposure of nursing infants is provided in Section 10 of HHRA Volume I.

7.2.3.2.2 Dioxins, Furans, and Dioxin-like PCBs

Exposure to dioxins, furans, and dioxin-like PCBs (dioxin-like compounds) has been shown to result in adverse effects on multiple organ systems in many animal species. The spectrum of effects observed depends upon dose, exposure duration, developmental stage of the organism, and the animal species (and strain). These studies suggest that, following oral exposure to dioxin-like compounds, the most sensitive effects (effects that occur at the lowest doses) are those associated with the immune and endocrine systems, as well as development (EPA, 2000; IARC, 1997). The science associated with noncancer effects of dioxin is under review by the NAS.

An RfD for dioxin-like compounds has not been developed. Further, EPA (2000) concluded that a reference dose for dioxin calculated in the manner typical of the way EPA determines RfDs would result in a dose that is significantly lower than current average background doses. RfDs are used primarily to evaluate increments of exposure from specific sources when background exposures are low and insignificant, and background exposures for dioxin-like compounds are not insignificant.

Because an RfD has not been developed for dioxins/furans, the potential for noncancer effects from exposure to dioxin-like compounds is not quantitatively evaluated in this assessment. This represents a potential underestimate of the risk associated with exposure to these contaminants at the site.

7.2.3.3 Total Cancer Risk

PCB cancer risk from congener mixtures in fish and waterfowl tissue is evaluated using a CSF based on data from highly chlorinated commercial Aroclor mixtures. It is possible that one or more of the 12 dioxin-like PCB congeners (and the furans that composed a small fraction of the Aroclor mixture) might be present in environmental mixtures in higher proportions than in the commercial Aroclors. Although the carcinogenic potency of these PCB congeners is already accounted for in the PCB CSF to the extent that they were present in the Aroclor mixture tested in the animal bioassay(s), assessing risks for tPCBs may not capture the full extent of risks from dioxin-like PCBs. Environmental mixtures, particularly those found in the food chain (in fish, for example), may have enhanced concentrations of these and other highly persistent congeners.

The dioxin-like PCB congeners can be evaluated as TEQ using the toxic equivalence approach developed for chlorinated dioxins and furans. Although PCB cancer risk can be quantified as TEQ, this approach alone may not fully account for PCB carcinogenicity because PCBs have been associated with carcinogenic mechanisms other than through its dioxin-like effects. For example, the EPA Science Advisory Board (SAB) cited the van der Plas et al. (2000) study of rats exposed to Aroclor 1260, which suggests that most of the tumor promotion potential of PCB mixtures is attributable to the nondioxin-like fraction (EPA SAB, 2001b). Because this fraction is not included in the TEQ calculation, van der Plas et al. (2000) concluded that the tumor promotion potential of PCBs might be underestimated by the TEQ approach alone.

Cancer risks from both tPCBs and PCB-congener TEQ are presented separately, and represent two toxicological evaluations of cancer risks from the environmental mixture. Although the best approach for evaluating total cancer risk would be to account for the potential enrichment of dioxin-like congeners in the environmental mixture, this approach has too much uncertainty to be adopted at the present time. The cancer risks from these separate evaluations are not summed, which is a potential underestimate of tPCB cancer risk.

7.2.4 Risk Characterization

The point estimate risk characterization is based on the combination of the exposure parameters described in Section 4 and the toxicity factors described in Section 3. The uncertainties associated with these values are described in Sections 7.2.2 and 7.2.3, respectively. The overall uncertainty in the point estimate risk characterization is not quantified. In the Monte Carlo analyses, input distributions of exposure parameters are used to reflect variability, and the output distribution of risks provides quantitative information on variability.

The propagation of uncertainties was treated quantitatively in Section 6 (probabilistic risk analysis) and further discussed in Section 7.3. The uncertainty in the point estimate risk characterization can be characterized qualitatively using a series of analyses that provide risks based on alternate exposure scenarios. Risk calculations based on alternate exposure scenarios are presented below.

7.2.4.1 Consumption of Fish by Massachusetts Anglers

The consumption pattern for Massachusetts anglers was assumed to be a mixture of bass, bullhead, perch and sunfish, with roughly half the consumption as bass or bullhead and half as perch or sunfish. The anglers were also assumed to consume skin-off fillets. However, anglers may have a strong species preference or they may consume skin-on fillets. For example, in the Maine Angler Survey (ChemRisk, 1992; Ebert-supplied additional data to EPA), 38% of the respondents who preferred bass reported they cooked it as skin-on fillets, and 58% of those who preferred yellow perch cooked it as skin-on fillet. However, individuals were not asked whether or not they consumed the skin.

Table 7-6 presents the results of cancer risk calculations for high-end consumers of fish from the PSA based on different consumption patterns. The risk characterization in Section 5 is based on consumption of skin-off fillets of mixed species, resulting in a tPCB cancer risk of 8E-03, which is indicated in bold in the table. Consumption of skin-on fillets of bass or bullhead will result in the highest risk, 3E-02, approximately 4 times higher than the risk in the main characterization.

Table 7-6

Cancer Risk (tPCB only) to RME Consumers of Fish from the PSA Based on Different Consumption Patterns

	Skin Off Fillet	**Skin On Fillet**
Bass/bullhead only	1E-02	3E-02
Perch/sunfish only	5E-03	2E-02
Mixed species	**8E-03***	2E-02

*Used for point estimate risk characterization (see Section 5)

7.2.4.2 Traditional Schaghticoke Food Preparation

The Schaghticoke Tribal Nation have expressed a desire to return to traditional fish cooking practices, which include slow cooking whole fish (minus the head) coated with mud and then wrapped in foil. To evaluate the risk associated with this practice, the following exposure assumptions were made: the contaminant concentrations in whole fish are 2.3 times higher than skin-on fillets, there is no cooking loss, bass are consumed, and the consumption rate and duration is similar to an RME recreational angler. The lifetime cancer risk associated with this behavior is 1E-03, which is approximately twice the risk associated with consumption of pan-fried skin-on bass fillets, which was mentioned by Tribal Nation members as the current preferred cooking method (Schaghticoke Tribal Nation, Personal Communication, 2004).

Representatives of the Schaghticoke Tribal Nation also stated that members consumed eel, bullhead, and carp. Samples of eel and carp were collected in Lake Zoar between 1979 and 1992, in addition to samples of smallmouth bass (BBL and QEA, 2003). In 1992, the median concentrations of American eel (skin off) and smallmouth bass (skin on, scales off) were 3.9 mg/kg and 0.9 mg/kg, respectively. In 1990, the median concentrations were 1.9 and 0.65 mg/kg for eel and smallmouth bass, respectively, and in 1988 they were 1.6 and 0.69 mg/kg for eel and smallmouth bass. These data suggest that consumption of eel instead of smallmouth bass, if prepared by the same cooking method, would result in 2 to 4 times higher risk.

7.2.4.3 Consumption of Waterfowl in Connecticut

Risks associated with waterfowl consumption in the Connecticut portion of the Housatonic River were not quantified in Section 5 because no appropriate data were available. However, as described in Section 7.2.1.3, concentrations in Connecticut are likely to be similar to or less than those detected in waterfowl in Threemile Pond, the reference area for the Massachusetts waterfowl. Using an EPC of tPCB of 1.0 mg/kg and similar consumption patterns as the Massachusetts waterfowl consumer results in an RME cancer risk of 1E-04 and a CTE cancer risk of 3E-05 for tPCB. For adults, the hazard index for the RME is 3.6 and the CTE is 1.7. For young children, the hazard index for the RME is 8.3 and the CTE is 4.

7.3 QUANTITATIVE TREATMENT OF UNCERTAINTY

The probability bounds analysis described in Section 6 propagates both variability and uncertainty in the risk assessment. This bounding approach extends and complements the Monte Carlo probabilistic analyses by allowing for a comprehensive treatment of the effects of uncertainty regarding the precise probability distribution or point estimate for each input variable as well as the nature of the dependencies of the variables in the risk model (see Attachment 5 of HHRA Volume I). The sensitivity analysis presented in Section 6 provides a quantitative measure of the relative contributions of various sources of uncertainty to the overall uncertainty in the risk estimates. Highlights of the quantitative uncertainty and sensitivity analyses are presented below.

7.3.1 Model Uncertainty

Uncertainty regarding the importance of day-to-day and year-to-year variability in frequency, duration, and magnitude of exposure across exposure events in a single individual’s lifetime was addressed by calculating risk distributions with two different modeling approaches, one-dimensional Monte Carlo analysis (one-dimensional MCA) and MEE Monte Carlo analysis. For all cancer risk estimates, the MEE approach resulted in a lower variability in risk than the one-dimensional MCA approach, and narrower bounds on uncertainty in the risk distributions. The MEE approach also calculated lower uncertainty around noncancer risk distributions; however, reduced variability was not observed for noncancer risk. Microexposure model calculations of central tendency risks were higher than those calculated with the one-dimensional model. Overall, uncertainty from the treatment of day-to-day and year-to-year variability had a minor impact on the RME range of cancer risk.

Uncertainty due to dependencies between input variables was analyzed using dependency bounds analysis. For the fish exposure pathway, potential dependency between exposure duration and body weight could result in a slight increase (or decrease) in cancer risk above (or below) that calculated by Monte Carlo simulation assuming independence. For the waterfowl exposure pathway, potential dependencies between ingestion rate, exposure frequency, exposure duration, and body weight result in uncertainty regarding the magnitude of both the cancer and noncancer risk distributions, particularly in the RME range.

7.3.2 Parameter Uncertainty

Uncertainty in the risk distribution due to variability and uncertainty regarding the precise nature and parameterization of exposure model input variables was analyzed using probability bounds analysis. A summary of the treatment of the effect of uncertainty for each input variable is presented in Table 7-7. The table summarizes the result of adding uncertainty by exchanging the precise point estimates used as inputs to the point estimate analyses with the intervals, probability distributions, and p-boxes used in the probabilistic analyses. The results presented in the rightmost column are the average effect of including uncertainty in each variable across all sites, across the one-dimensional and microexposure models, across children and adults, and across both exposure pathways. The measure of uncertainty reported in the table is the breadth of the p-box around the risk distribution. The percentage in the right-hand column quantifies the amount that the uncertainty in the p-box around the risk distribution decreases when each variable is returned, in turn, to the value used in the point estimate analyses. This is a measure of the effect of uncertainty in that variable on uncertainty in the model. A more-detailed breakdown of the effect of the quantitative modeling of uncertainty on the risk distributions can be found in Section 6. Attachment 5 of HHRA Volume I provides detailed examples of the sensitivity analysis process.

Table 7-7

Summary of Treatment of Uncertainty in the Probabilistic Analyses

Input Variable	Source of Uncertainty	Treatment of Uncertainty	Result of Treatment (Average Across All Models)
Concentration	Choice of point	Interval: [$\bar{x}$, EPC]	7.9% change in uncertainty
Cooking loss	Choice of loss distribution	P-box around all distributions with $\bar{x}$ and s^2 from EDF	10.1% change in uncertainty check
Ingestion rate (meal size)	Fish: choice of point; Waterfowl: choice of distribution	Fish: interval from d; Waterfowl: P-box around all distributions with $\bar{x}$ and s^2 from literature	Fish: 29.6% change in uncertainty Waterfowl: 34.4% change in uncertainty
Exposure frequency	Choice of distribution; data from Maine applied to Massachusetts and Connecticut	P-box around empirical distribution function +-10%	46% change in uncertainty
Exposure duration	Choice of distribution; choice of parameters for distribution	P-box around uniform (child) and around lognormal (adult) distribution; 95% C.I.s around $\bar{x}$ for parameters	42.3% change in uncertainty

Adult exposure duration is truncated to 64 years in order to meet the constraint that lifetime cancer model averaging time (including 6 years of exposure as a child) be equal to 70 years Sensitivity analysis in Section 6 shows that removing truncation would increase the RME risk estimate by a very small amount in the highest few percentiles.

7.4 REFERENCES

ANS (The Academy of Natural Sciences of Philadelphia). 2001. *PCB Concentrations in Fishes from the Housatonic River, Connecticut, 1984-2000, and in Benthic Insects, 1978-2001.* Patrick Center for Environmental Research, Report No. 01-9-F, July 23, 2001.

BBL (Blasland, Bouck & Lee, Inc.) and QEA (Quantitative Environmental Analysis, LLC). 2003. *Housatonic River – Rest of River RCRA Facility Investigation Report*. Prepared for General Electric Company.

Beck, Gerald J. 1982. PCBs in Housatonic River Fish – Statistical Analyses. January 1982.

Bevelhimer, M.S., J.J. Beauchamp, B.E. Simple, and G.R. Southworth. 1997. Estimation of Whole-Fish Contaminant Concentrations from Fish Fillet Data. ES/ER/TM-202. Report Prepared by Risk Assessment Program, Oak Ridge National Lab. for the Office of Environmental Management, U.S. Department of Energy.

ChemRisk. 1992. *Consumption of Freshwater Fish by Maine Anglers.* 24 July 1992.

CTDHS (State of Connecticut Department of Health Services). 1979. Housatonic River PCB Fish Log Book, 1979 Samples.

Ebert, E.S., S.H. Su, T.J. Barry, M.N. Gray, and N.W. Harrington. 1996. *Estimated Rates of Fish Consumption by Anglers Participating in the Connecticut Housatonic River Creel Survey*. North American Journal of Fisheries Management 16:81-89.

EPA (U.S. Environmental Protection Agency). 1985. *Health Effects Assessment Document for Polychlorinated Dibenzo-p-Dioxins.* Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, DC, EPA/600/8-84/014F.

EPA (U.S. Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final Office of Emergency and Remedial Response, Washington DC, EPA, 540/1-89/002. December 1989.

EPA (U.S. Environmental Protection Agency). 1990. National Oil and Hazardous Substances Pollution Contingency Plan. Final Rule. 40 CFR 300: 55 Federal Register, 8666-8865, 8 March 1990.

EPA (U.S. Environmental Protection Agency). 1995. EPA Risk Characterization Program. Memorandum from Administrator Carol M. Browner to Assistant Administrators, Associate Administrators, Regional Administrators, General Counsel and Inspector General on March 21, 1995. Office of the Administrator, Washington, DC.

EPA (U.S. Environmental Protection Agency). 1997. Health Effects Assessment Summary Tables Office of Research and Development. July 1997.

EPA (U.S. Environmental Protection Agency). 1999. Guidelines for Carcinogen Risk Assessment. SAB Review Draft, July 1999. NCEA-F-0644.

EPA (U.S. Environmental Protection Agency). 2000. Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Office of Research and Development, National Center for Environmental Assessment. Review Draft. EPA/600/P-00/001B(a-f).

EPA (U.S. Environmental Protection Agency). 2001a. *Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment.* Office of Emergency and Remedial Response. Washington, DC. EPA 540-R-02-002. December 2001.

EPA SAB (Environmental Protection Agency Science Advisory Board). 2001b. *Dioxin Reassessment - an SAB Review of the Office of Research and Development's Reassessment of Dioxin*. Review of the Revised Sections (Dose Response Modeling, Integrated Summary, Risk Characterization, and Toxicity Equivalency Factors) of the EPA's Reassessment of Dioxin by the Dioxin Reassessment Review Subcommittee of the EPA Science Advisory Board (SAB). EPA-SAB-EC-01-006, May 2001.

EPA (U.S. Environmental Protection Agency). 2003. *Information Sheet 3, Dioxin Reassessment Process: What is the Status of the Reassessment and How was the Reassessment Developed?* EPA Office of Research and Development. October 29, 2003. http://www.epa.gov/ncea/pdfs/dioxin/factsheets/infosheet3.pdf

EPA (U.S. Environmental Protection Agency). 2004. Integrated Risk Information System.

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold, New York.

Gisslen, W. 1995. *Professional Cooking,* 3rd ed. John Wiley & Sons, Inc. 828 p.

IARC (International Agency for Research on Cancer). 1997. Volume 69. Polychlorinated dibenzo-para-dioxins and Polychlorinated Dibenzofurans (IARC MONOGRAPH, IARC PRESS, Lyon, France p. 33.

MDPH (Massachusetts Department of Public Health). 1997. Housatonic River Area PCB Exposure Assessment Study, Final Report. Bureau of Environmental Health Assessment, Environmental Toxicology Unit. September 1997.

MDPH (Massachusetts Department of Public Health). 2001. Memo from Martha Steele, Deputy Director, Bureau of Environmental Health Assessment to Bryan Olson, EPA, Region 1 regarding Remainder of data request with respect to information gathered from questionnaires from Housatonic River Area Exposure Assessment Study as well as questionnaires completed after the study and resulting from calls to the Bureau of Environmental Health Assessment (BEHA) hotline. 10 September 2001.

Pao, E.M., K.H. Fleming, P.M. Guenther, and S.J. Mickle. 1982. *Foods Commonly Eaten by Individuals: Amount Per Day and Per Eating Occasion*. Consumer Nutrition Center, Human Nutrition Information Service, U.S. Department of Agriculture. Hyattsville, Maryland. Home Economics Research Report Number 44.

Schaghticoke Tribal Nation. 2004. Personal communication, meeting with Tribal Nation members, April 29, 2004.

Sherer, R.A., B.W. Found, and P.S. Price. 1993. The effect of cooking processes on persistent lipophilic compounds in edible fish tissue using PCB as an example. Environmental Conference. TAPPI Proceedings.

Singh, A.K., A. Singh, and M. Engelhardt. 1997. *The Lognormal Distribution in Environmental Applications*. EPA/600/R-97/006.

Tillitt, D, D. Papoulias, and D. Buckler. 2003a. *Fish Reproductive Health Assessment in PCB Contaminated Regions of the Housatonic River, Massachusetts, USA: Investigations of Causal Linkages Between PCBs and Fish Health.* Final Report of Phase I Studies. Prepared for U.S. Fish and Wildlife Service, Concord, NH and U.S. Environmental Protection Agency, Boston, MA. July 2, 2003.

Tillitt, D, D. Papoulias, and D. Buckler. 2003b. *Fish Reproductive Health Assessment in PCB Contaminated Regions of the Housatonic River, Massachusetts, USA: Investigations of Causal Linkages Between PCBs and Fish Health.* Final Report of Phase II Studies. Prepared for U.S. Fish and Wildlife Service, Concord, NH and U.S. Environmental Protection Agency, Boston, MA. July 8, 2003.

USFWS (United States Fish and Wildlife Service). 2001. *National Survey of Fishing, Hunting, and Wildlife Associated Recreation*. Prepared by the United States Census Bureau. Washington, DC.

Van den Berg, Martin, Linda Birnbaum, Albertus T.C. Bosveld, Bjorn Brunstrom, Philip Cook, Mark Feeley, John P. Giesy, Annika Hanberg, Ryuichi Hasegawa, Sean W. Kennedy, Timothy Kubiak, John Christian Larsen, F.X. Rolaf van Leeuwen, A.K. Djien Liem, Cynthia Nolt, Richard E. Peterson, Lorenz Poellinger, Stephen Safe, Dieter Schrenk, Donald Tillitt, Mats Tysklind, Maged Younes, Fredrik Waern, and Tim Zacharewski. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs, for humans and wildlife. *Environmental Health Perspectives* 106(12):775-792.

van der Plas, S.A., H. Sundberg, H. van den Berg, G. Scheu, P. Wester, S. Jensen, Ake Bergman, J. de Boer, J.H. Koeman, and A. Brouwer. 2000. Contribution of planar (0-1 *Ortho*) and Nonplanar (2-4 *Ortho*) Fractions of Aroclor 1260 to the Induction of Altered Hepatic Foci in Female Sprague Dawley Rats. *Toxicol Appl Pharm* 169: 255-268.

WESTON (Weston Solutions, Inc.). 2004. *Ecological Risk Assessment of the General Electric (GE)/Housatonic River Site, Rest of River, Appendix A, Ecological Characterization of the Housatonic River*. Prepared for U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. DCN GE-100504-ACJS. November 12, 2004.

8. RISK SUMMARY

8.1 INTRODUCTION

Both point estimate and probabilistic approaches were used in this risk assessment to characterize the upper and central tendency risk to individuals who consume fish and waterfowl. Both approaches were used to evaluate potential cancer risks and noncancer health effects to children and adults from fish consumption for each of the four separate areas, the PSA (Reaches 5 and 6), Rising Pond (Reach 8), West Cornwall/Bulls Bridge (Reaches 11 and 12), and Lake Lillinonah/Lake Zoar (Reaches 14 and 15), and from waterfowl consumption in the PSA. Consistent with EPA guidance, point estimate risks were calculated for both upper (RME) and central tendency (CTE) exposures, and probabilistic analyses were used to calculate a range of high-end risk percentiles corresponding to the RME and to calculate the CTE percentile (median). The probabilistic analyses consisted of Monte Carlo simulation (with both one-dimensional and microexposure event (MEE) analyses) and probability bounds analysis (PBA). Attachment C.7 compares the results obtained using PBA to address uncertainty with a two-dimensional Monte Carlo approach.

The Monte Carlo simulations provide information on the likelihood of exceeding a risk level of concern. Both the one-dimensional and MEE simulations provide information on variability and more fully illustrate where the point estimates (both RME and CTE) lie in the risk range. The Monte Carlo simulations provide distributions of risk (rather than single values) that represent the frequencies of different risk levels experienced by a population and express the variability among individuals in the population in terms of their individual characteristics and specific exposure.

The probability bounds analysis was conducted to provide bounding estimates of the risk distributions. In particular, the probability bounds delineated how variability and uncertainty regarding each point estimate or probability distribution selected to represent inputs may contribute to the uncertainty in the distribution of estimated risks. The probability bounds also show the effect of uncertainty regarding the dependencies between inputs (i.e., whether an exposure variable was dependent on or independent of the others). Probability bounds analyses, which were conducted for both the one-dimensional Monte Carlo analysis and the MEE analysis, provide plausible extremes of both the shape and the extent of the risk distribution.

8.2 POINT ESTIMATE AND MONTE CARLO SIMULATION RESULTS

A combination of upper and average values for exposure parameters was used in the point estimate approach to calculate the RME risk, and average values were used to calculate the CTE risk. In the probabilistic assessments, the RME risk and CTE risk were obtained from the risk distribution. EPA defines the high or upper end of the distribution of risk, or RME range, as generally between the 90th and 99.9th percentiles, whereas the CTE risk is generally the 50th percentile (EPA, 2001).

Table 8-1 provides the RME and CTE cancer results from the point estimate and the 95th percentile and 50th percentile (median) of the two Monte Carlo simulations (one-dimensional and MEE). The 95th percentile is the approximate midpoint of the RME range and is the recommended starting point for risk management decisions (EPA, 2001). Alternative percentiles within the RME range may be selected to account for the level of confidence in the estimated risk distribution.

8.2.1 Comparison of Point Estimate and Monte Carlo Simulation Results

Table 8-1 summarizes the excess lifetime cancer risks for the RME and CTE receptors for each of the fish and waterfowl risk evaluations. For fish consumption, point estimate RME cancer risks range from 4E-04 to 1E-02 and CTE cancer risks range from 2E-05 to 9E-04. The cancer risks are similar for tPCB and TEQ. For waterfowl consumption, the RME risk is 1E-03 and the CTE risk is 1E-04 for tPCB. In contrast to fish consumption, cancer risk due to TEQ is 20 to 40 times higher than risk from tPCB.

The tPCB concentrations are based on the same data set in the point estimate and probabilistic models. However, the point estimate TEQ concentration is based on contributions from dioxin-like PCBs, furans and dioxins, while the Monte Carlo simulation (and probability bounds) TEQ concentrations are based only on dioxin-like PCBs. This represents a 5% to 10% difference in the TEQ concentration and risk. It does not affect the values and comparisons in the tables, which are presented with one significant figure.

Table 8-1

Cancer Risk from Fish and Waterfowl Consumption: Point Estimate, One-Dimensional Monte Carlo, and Microexposure Event Analyses

	RME Range			Central Tendency Range		
	RME Point Estimate	**95th Percentile 1-D Monte Carlo**	**95th Percentile MEE**	**CTE Point Estimate**	**50th Percentile 1-D Monte Carlo**	**50th Percentile MEE**
tPCB Risk						
Fish Consumption, Primary Study Area	8E-03	2E-03	1E-03	3E-04	3E-04	5E-04
Fish Consumption, Rising Pond (Reach 8)	5E-03	2E-03	8E-04	2E-04	2E-04	3E-04
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	6E-04	2E-04	1E-04	2E-05	2E-05	4E-05
Trout Consumption, West Cornwall Area (Reach 11)	6E-04	2E-04	1E-04	3E-05	3E-05	5E-05
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	4E-04	1E-04	7E-05	2E-05	2E-05	3E-05
Waterfowl Consumption	1E-03	1E-03	9E-04	1E-04	2E-04	3E-04
TEQ Risk						
Fish Consumption, Primary Study Area	1E-02	3E-03	2E-03	9E-04	4E-04	7E-04
Fish Consumption, Rising Pond (Reach 8)	6E-03	2E-03	9E-04	4E-04	2E-04	4E-04
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	NA	NA	NA	NA	NA	NA
Trout Consumption, West Cornwall Area (Reach 11)	NA	NA	NA	NA	NA	NA
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	NA	NA	NA	NA	NA	NA
Waterfowl Consumption	2E-02	2E-02	1E-02	4E-03	2E-03	5E-03

As indicated in Table 8-1, the point estimate RME cancer risks from tPCBs and TEQ for fish consumption (all locations) are two to four times higher than the 95th percentile of the risk calculated using the one-dimensional Monte Carlo simulations. In general, the point estimate RME risks are between the 99th and 99.5th percentile of the Monte Carlo simulations (see Table 6-6). The point estimate RME cancer risks for tPCBs and TEQ for fish consumption (all locations) are six to eight times higher than the 95th percentile MEE risk. The point estimate risks are greater than the 99% percentile MEE risks (see Table 6-8). The point estimate CTE cancer risks from tPCBs and TEQ for fish consumption are at or very near the 50th percentile risk of the one-dimensional Monte Carlo simulation. The 50th percentile of the MEE simulation generally yields somewhat higher risks than the point estimate CTE risk and the one-dimensional simulation.

For waterfowl consumption, the tPCB RME point estimate risk is close to the 95th percentile risk of both the one-dimensional Monte Carlo simulation and the MEE simulation. The CTE point estimate tPCB waterfowl consumption risk is slightly less than the 50th percentile one-dimensional risk and the 50th percentile MEE risk. The TEQ RME point estimate risk is equal to the 95th percentile and 99th percentile of the one-dimensional Monte Carlo simulation and MEE simulation, respectively (see Tables 6-10 and 6-12). The waterfowl tPCB CTE point estimate risk is one-half the 50th percentile risk of the one-dimensional Monte Carlo simulation (between the 25th and 50th percentile) and below the 25th percentile for the MEE simulation. The TEQ CTE point estimate risk is between the one-dimensional and MEE simulation 50th percentile estimates.

Table 8-2 summarizes the noncancer hazards for the RME and CTE risk evaluations for both adults and children. For adult fish consumers, the point estimate HI for the RME ranges from 13 to 230. HIs are higher for child fish consumers, ranging from 31 to 550. As observed with the cancer risk, the noncancer hazard decreases proceeding downstream from the GE facility. For waterfowl consumption, the RME HI is 35 and the CTE HI is 17 for adults. The values are approximately two times higher for children.

For both the adult and child, the fish consumption RME point estimate HIs are approximately twice the 95th percentile of both Monte Carlo simulations, placing it between the 95th and 99th

Table 8-2

Total PCB Noncancer Hazards from Fish and Waterfowl Consumption: Point Estimate, One-Dimensional Monte Carlo, and Microexposure Event Analyses

	RME Range			Central Tendency Range		
	RME Point Estimate	95th Percentile 1-D Monte Carlo	95th Percentile MEE	CTE Point Estimate	50th Percentile 1-D Monte Carlo	50th Percentile MEE
Hazard Index - Adult						
Fish Consumption, Primary Study Area	230	120	130	33	10	13
Fish Consumption, Rising Pond (Reach 8)	150	83	83	22	7.1	8.4
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	18	10	10	2.6	0.85	1.0
Trout Consumption, West Cornwall Area (Reach 11)	18	12	13	3.1	1.0	1.3
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	13	7.0	7.2	1.9	0.60	0.73
Waterfowl Consumption	35	76	57	17	7.2	8.7
Hazard Index - Child						
Fish Consumption, Primary Study Area	550	260	270	76	23	26
Fish Consumption, Rising Pond (Reach 8)	360	180	180	51	15	18
Bass Consumption, West Cornwall to Bulls Bridge (Reaches 11 &12)	43	21	22	5.9	1.9	2.2
Trout Consumption, West Cornwall Area (Reach 11)	42	24	29	7.3	2.2	2.9
Bass Consumption, Lakes Lillinonah and Zoar (Reaches 14 & 15)	31	15	15	4.3	1.3	1.6
Waterfowl Consumption	81	140	120	39	15	17

percentiles (see Tables 6-7 and 6-9). The CTE point estimate HIs are about three times higher than the 50th percentile of the risk distribution identified in the Monte Carlo simulations, placing it in approximately the 75th percentile for the child and adult.

For waterfowl consumption, the point estimate HI for the RME adult is between the 75th and 90th percentiles of the one-dimensional Monte Carlo simulation and is close to the 90th percentile of the MEE simulation. The point estimate HI for the RME child is between the 90th and 95th percentiles of the one-dimensional Monte Carlo simulation and is close to the 90th percentile of the MEE simulation. The waterfowl consumption CTE tPCB HI point estimates for the adult and child are approximately the 75th percentile of the one-dimensional Monte Carlo and the MEE simulations (see Tables 6-11 and 6-13).

Results from probabilistic analyses, such as the Monte Carlo simulations and probability bounds analyses, are more easily illustrated using graphs than tables. Figure 8-1 provides the results of the tPCB cancer risk analysis for the one-dimensional Monte Carlo simulation of fish consumption in the PSA (the analogous figure for the MEE analysis [Figure 6-41] shows generally similar results). Figures 8-2 and 8-3 are similar figures summarizing the noncancer tPCB hazard quotient for adults and children, respectively. PCBs are the only COPC evaluated for noncancer hazards, with the exception of methylmercury in the PSA, where the contribution to the HI is less than 1%. Thus, in this risk assessment, the hazard index and the tPCB hazard quotient are numerically the same.

In Figures 8-1, 8-2 and 8-3, the x-axis is the cancer risk or hazard quotient. The y-axis is the exceedance probability (EP), and is related to the percentile as follows:

$$\text{Percentile} = 1 - \text{EP}$$

For example, an EP = 0.1 is the 90th percentile of the risk and means that the probability is 0.1 that the associated risk level will be exceeded.

The blue line shows the results of the one-dimensional Monte Carlo simulation. The yellow lines that bracket the one-dimensional simulation are the dependency bounds and the green curves that bracket both the one-dimensional Monte Carlo and dependency bounds are the probability bounds. The probability bounds curves show the effect of variability and uncertainty

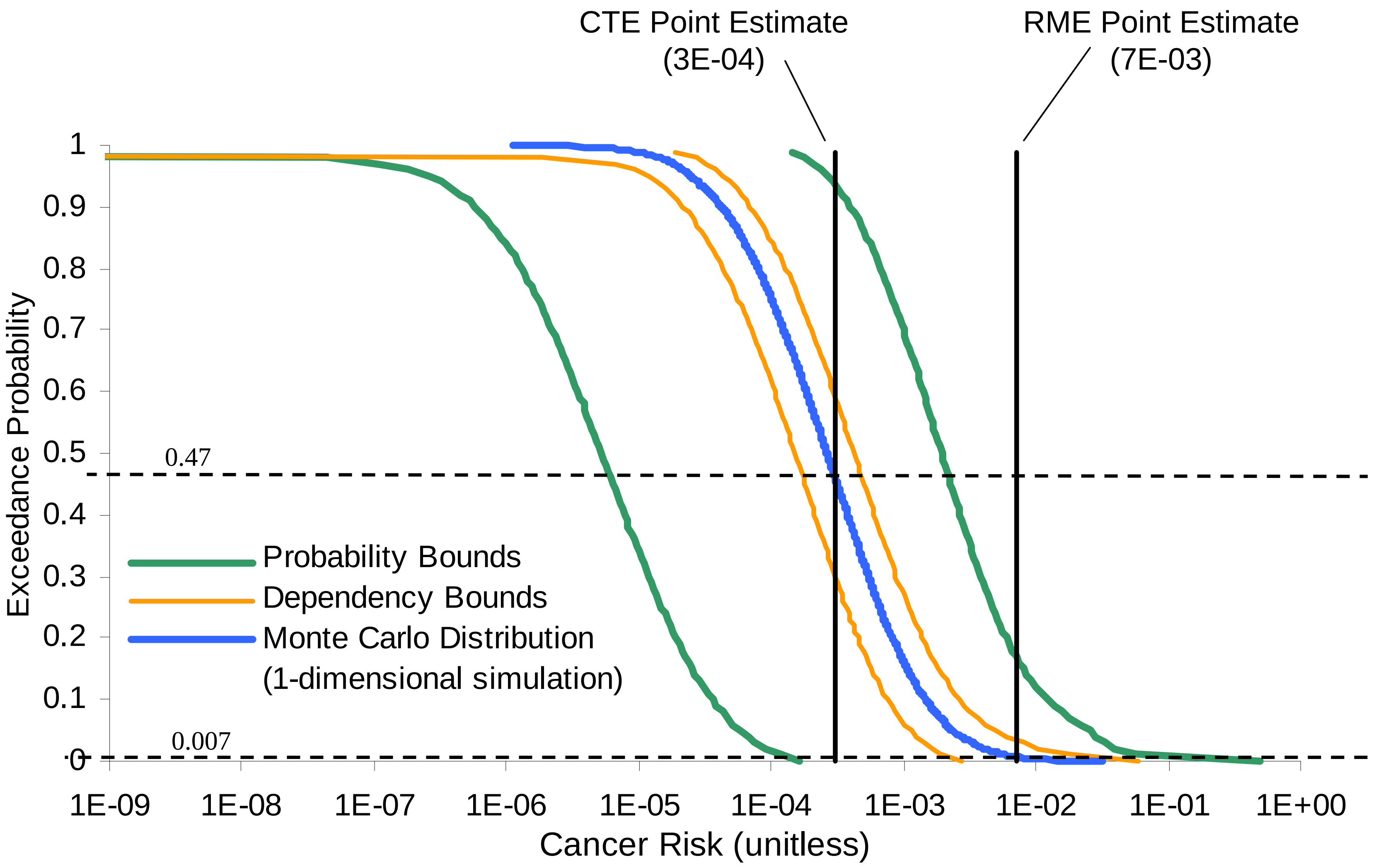


Figure 8-1

Cancer Risk Summary for Fish Consumption, Primary Study Area- tPCBs

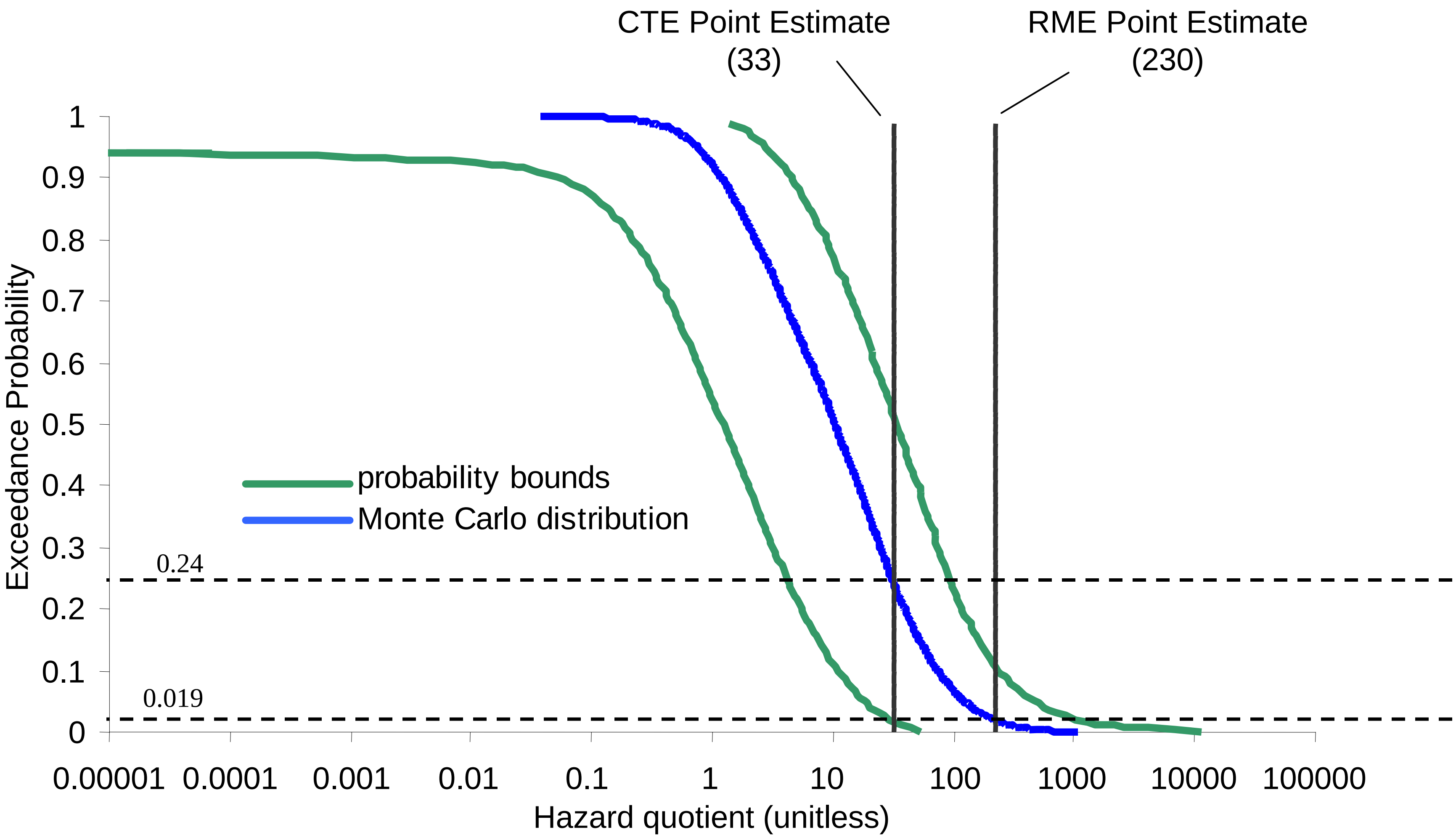


Figure 8-2
Summary of Noncancer Hazards for Adult Fish Consumption,
Primary Study Area

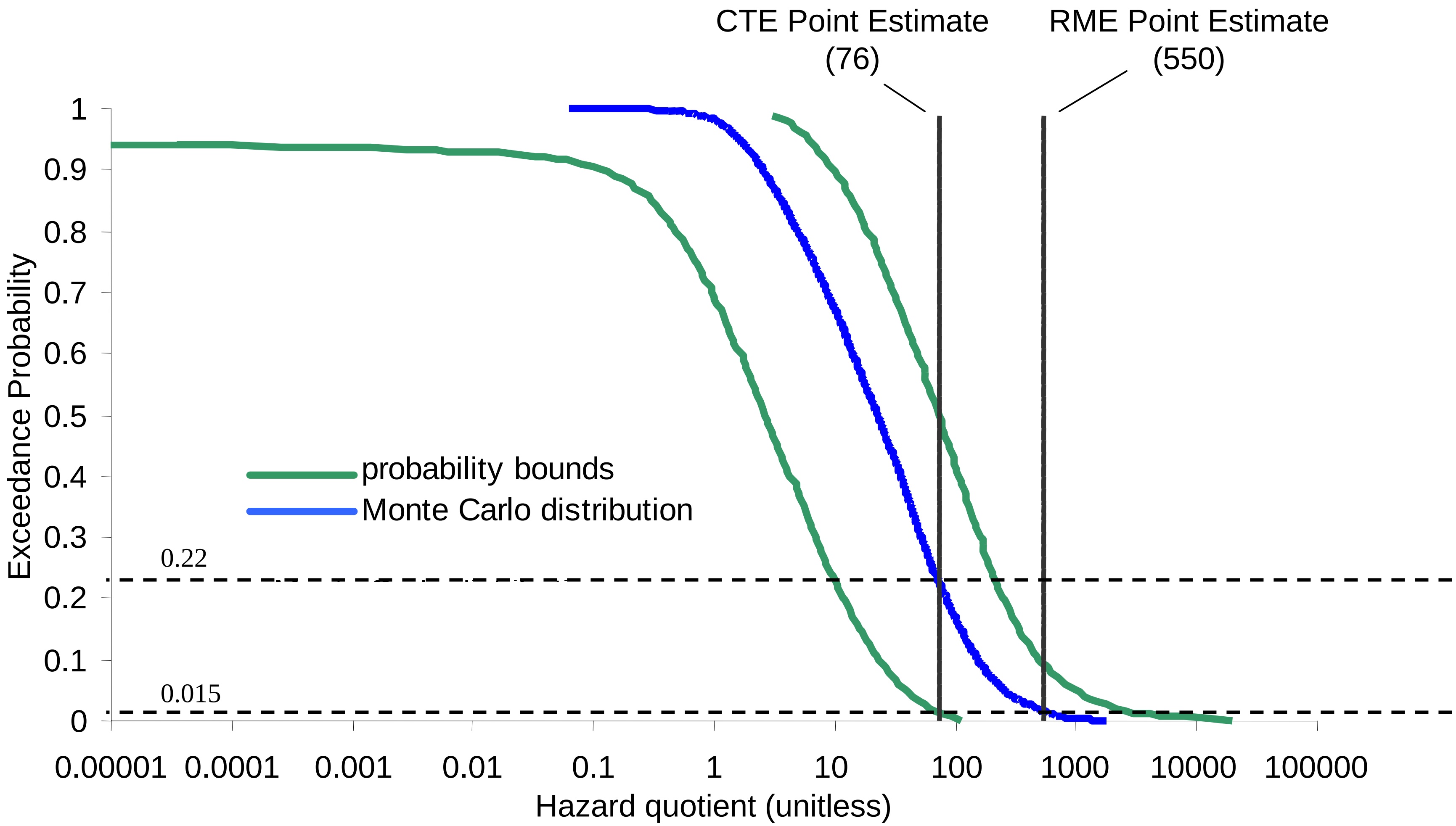


Figure 8-3
Summary of Noncancer Hazards for Child Fish Consumption,
Primary Study Area

for each point estimate input, the shape and parameterization of probability distribution inputs, and the nature of dependencies that may exist between input variables in the exposure equation.

The vertical black lines show where the CTE and RME point estimates fall on the risk curves. The dashed horizontal lines indicate the exceedance probability (EP) associated with the CTE and RME point estimates. For example, in Figure 8-1, the RME and CTE point estimates correspond to the EPs of 0.007 and 0.47, respectively, which can be stated in percentile terms as the 99th percentile and 53rd percentile of the one-dimensional Monte Carlo curve. The uncertainty associated with the point estimates for cancer risk can also be estimated from Figure 8-1. For example, the RME point estimate could correspond to percentiles ranging from approximately the 82nd percentile to the 100th percentile if all the uncertainties were taken into account (i.e., the values of 1-EP for the point estimate risks based on the green probability bounds curves instead of the blue one-dimensional Monte Carlo curve). Similarly, Figure 8-2 indicates that, for adults, the point estimate RME corresponds to the 98.1th percentile while the CTE corresponds to the 76th percentile. The RME point estimate uncertainty could range from approximately the 86th to the 100th percentile.

8.2.2 Comparison of Risks of Fish and Waterfowl Consumption

Table 8-1 can be used to compare the cancer risks associated with waterfowl and fish consumption in Woods Pond and its backwaters (PSA). For the RME point estimate, tPCB cancer risk associated with fish consumption is eight times higher than the risks from waterfowl consumption. However, a comparison of the 95th percentiles of the Monte Carlo simulations indicates the cancer risks due to tPCBs are similar for fish and waterfowl consumption. The difference between the point estimate and Monte Carlo simulation results in the comparison of fish and waterfowl risks may be due to the inclusion of a distribution for FI for fish but the treatment of FI as 1 in ducks. This difference has little impact on the point estimate RME, but will reduce the Monte Carlo 95th percentile risk for fish compared to waterfowl by approximately half (see Section 8.2.4). In addition, the spread of the ingestion rate distribution is larger for fish (the RME IR is 4 times higher than the CTE) than for waterfowl (the RME IR is 2 times higher than the CTE). This higher variability has a larger impact on the point estimate risk, where it is assumed to be correlated with exposure duration, than in the Monte Carlo simulations, where independence is assumed. The central tendency estimates of cancer risks indicate 1.5 to 3 times higher tPCB cancer risk from fish consumption than waterfowl consumption for the point estimate and the Monte Carlo simulations.

A different pattern is seen when comparing the cancer risk associated with TEQ RME and CTE point estimates and upper end and central tendency Monte Carlo simulations, indicating a higher cancer risk associated with consumption of waterfowl than fish. The difference is approximately a factor of two for the point estimate, and 2 to 5 times for the Monte Carlo simulations.

Table 8-2 can be used to compare the noncancer hazard (tPCB only) associated with waterfowl and fish consumption in Woods Pond and its backwaters. For the RME point estimate, noncancer hazards (for adults and children) associated with fish consumption are approximately 7 times higher than waterfowl consumption. A comparison of the 95th percentiles of the Monte Carlo simulations indicates the fish consumption hazard is approximately 2 times higher than waterfowl consumption. The central tendency results also suggest higher tPCB noncancer hazards associated with consumption of fish compared to waterfowl, ranging from 2 times higher for the point estimate to approximately 1.5 times higher for the Monte Carlo simulations.

8.2.3 Comparison of Risks of Fish Consumption from Different Locations

Tables 8-1 and 8-2 can be used to compare the risk of consuming fish caught at various locations on the Housatonic River. For example, the RME point estimate cancer risk from tPCBs decreases steadily from the PSA (which includes Woods Pond and its backwaters), to Rising Pond, to West Cornwall/Bulls Bridge, and finally to Lakes Lillinonah and Zoar. The decrease between the Massachusetts reaches (PSA and Rising Pond) and Connecticut reaches (West Cornwall, Bulls Bridge, and Lakes Lillinonah and Zoar) would likely have been greater if the fish species and fillet data had been more comparable. As discussed in Section 7, the risks would likely have been higher in Massachusetts had the fish data been based on skin-on fillets as they were in Connecticut. In addition, the risks are higher when based on bass (or trout) alone, rather than the mix of fish species used in the assessment of the Massachusetts reaches. As shown in Table 7-6, if the species/fillet type in the PSA had been similar to those in Connecticut, the estimated RME cancer risk would increase nearly four times, from 8E-03 to 3E-02. Conversely, if the species/fillet type used in the analysis of Massachusetts fish had been used in

Connecticut, the tPCB risks (other than trout) calculated for West Cornwall, Bulls Bridge, and Lakes Lillinonah and Zoar would have been lower.

8.2.4 Influence of Model Assumptions

A comparison of the differences between the point estimate and Monte Carlo simulations for cancer risk and noncancer hazard indicates that the point estimate RME predictions are further on the upper tail of the distribution for cancer risk than for noncancer hazard (Tables 8-1 and 8-2). The point estimate RME cancer risks are above the 99th percentile of the Monte Carlo simulations, while the RME point estimate noncancer hazards are between the 95th and 99th percentile. Stated another way, the RME point estimates for cancer risk from fish consumption are 2 to 4 times higher than the 95th percentile of the 1-D Monte Carlo simulations and 6 to 8 times higher than the MEE Monte Carlo simulation. In contrast, the RME point estimates for noncancer hazard from fish consumption are less than 2 times higher than the Monte Carlo simulations, which are similar to each other.

The difference between the results in the cancer and noncancer risk estimates reflects the influence of assumptions about the independence of ingestion rate and exposure duration. The Monte Carlo simulations for cancer risk assume the ingestion rate and exposure duration are independent of each other. In contrast, the point estimate RME calculation for cancer risk is based on an upper-end ingestion rate and an upper-end exposure duration, which is equivalent to assuming that these parameters are positively correlated. Assuming independence would have been equivalent to setting one of these variables to a central tendency value. For example, using a central tendency value for exposure duration would have reduced the point estimate RME risks by a factor of 2, with a risk estimate between the 95th and 99th percentile of the predictions of the one-dimensional Monte Carlo simulation. Very few data are available regarding whether these two variables are correlated, and which approach is more appropriate. In the exposure calculation for noncancer effects, the exposure duration is canceled out by the averaging time term, and thus exposure duration does not enter into the calculation.

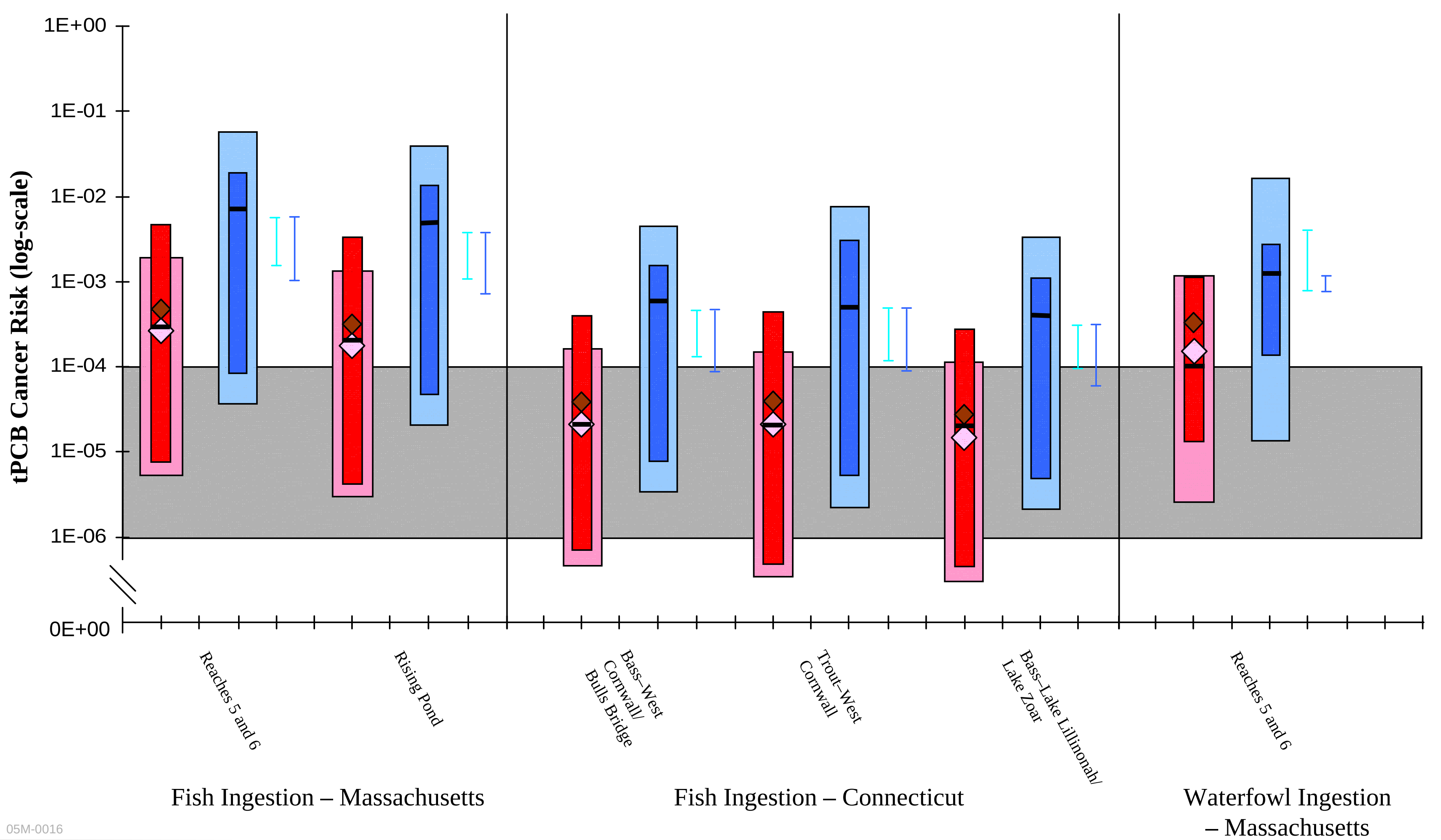
The point estimate RME calculation also assumes that the FI, the fraction of fish ingested from each exposure location, is correlated with consumption rate and exposure duration; an upper end value of each was used in the RME calculation. The MEE Monte Carlo simulation model assumes no correlations among these variables, and that the FI varies from year to year. This effectively reduces the FI to a central tendency value for all receptors over the course of a lifetime. The one-dimensional Monte Carlo simulation also assumes that the FI is not correlated with exposure duration and consumption rate, but each fish consumer has the same FI for a lifetime. Thus, there are receptors in the distribution who consume fish only from a particular location. This difference in the treatment of FI in the Monte Carlo simulations is likely the reason that, for the upper end of the cancer risk estimates, the 1-D model predictions are about double those of the MEE, while the predictions of the two Monte Carlo simulations are about the same for the HI. It may also account, in part, for the difference in cancer risk predictions between the point estimate and Monte Carlo simulation models.

8.3 RELATIONSHIP BETWEEN RISK ESTIMATES AND THE EPA RISK RANGE

The results of the point and probabilistic risk assessments were compared to the EPA risk range. The EPA cancer risk range identified in the National Contingency Plan (NCP) (EPA, 1990) is approximately 1E-06 to 1E-04, or an increased probability of developing cancer of 1 in 1,000,000 to 1 in 10,000 over a 70-year lifetime.

Where the cumulative site risk to an individual based on the RME exceeds the 1E-04 lifetime excess cancer risk end of the risk range, action is generally warranted at a site. For sites where the cumulative site risk to an individual based on the RME is less than 1E-04, action generally is not warranted, but may be warranted if a chemical-specific standard that defines acceptable risk is violated or if there are noncancer effects or an adverse environmental impact that warrants action. EPA may also decide that a lower level of risk is unacceptable and that action is warranted where, for example, there are uncertainties in the risk assessment results. Once EPA has decided to take an action, EPA has expressed a preference for cleanups achieving the more-protective end of the range (i.e., 1E-06), although strategies achieving reductions in site risks anywhere in the risk range may be deemed acceptable by EPA (EPA, 1991). HIs of less than 1 indicate that adverse health effects associated with the exposure scenario are unlikely to occur. EPA considers action when the HI exceeds 1.

Figures 8-4 through 8-7 provide summaries of the tPCB and dioxin-like PCB TEQ cancer risks and tPCB hazard indices calculated using the point estimate, Monte Carlo simulation, and

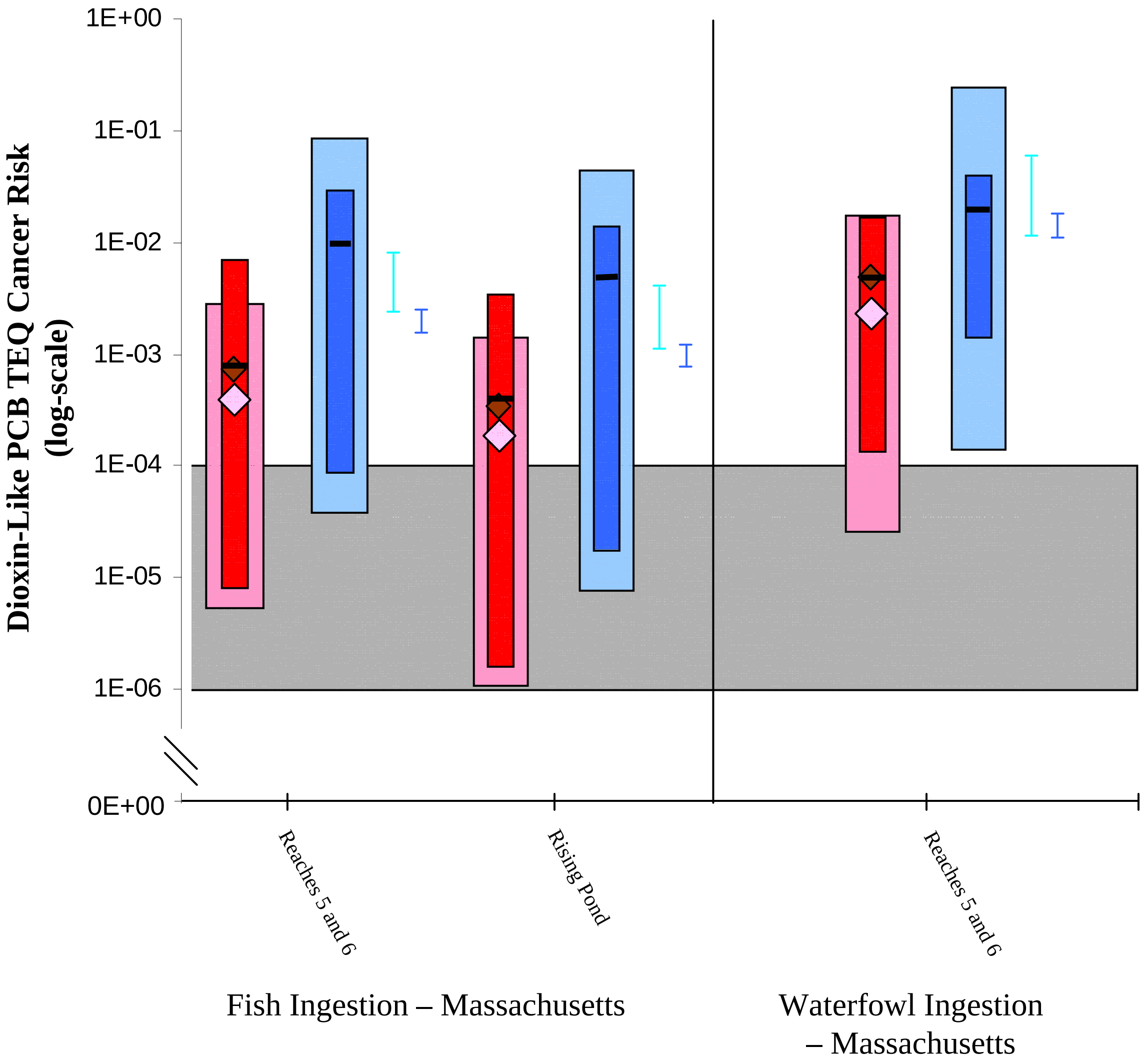


05M-0016

▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
▭ = Median calculated with one-dimensional probability bounds analysis.
▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
▭ = RME range calculated with one-dimensional probability bounds analysis.
▨ = EPA risk range (1E-06 to 1E-04).

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 8-4
Relationship Between Point Estimate, Monte Carlo, and Probability Bounds Analyses for tPCB Cancer Risk from Fish and Waterfowl Consumption



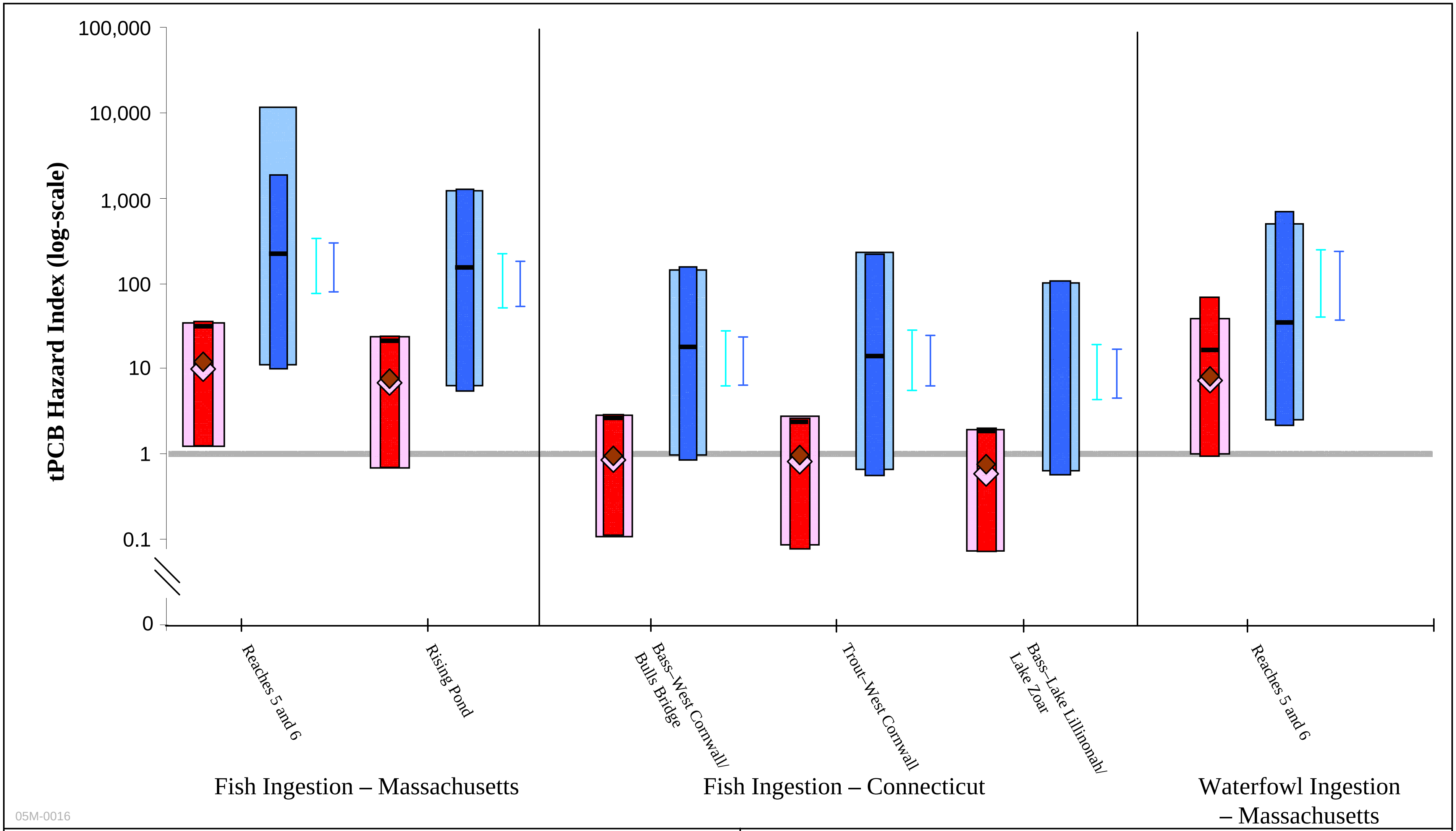
05M-0016

▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
■ = Median calculated with microexposure probability bounds analysis.
■ = Median calculated with one-dimensional probability bounds analysis.

▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
■ = RME range calculated with microexposure probability bounds analysis.
■ = RME range calculated with one-dimensional probability bounds analysis.
■ = EPA risk range (1E-06 to 1E-04).

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 8-5
Relationship between Point Estimate, Monte Carlo, and Probability Bounds Analyses for Dioxin-Like PCB TEQ Cancer Risk from Fish and Waterfowl Consumption

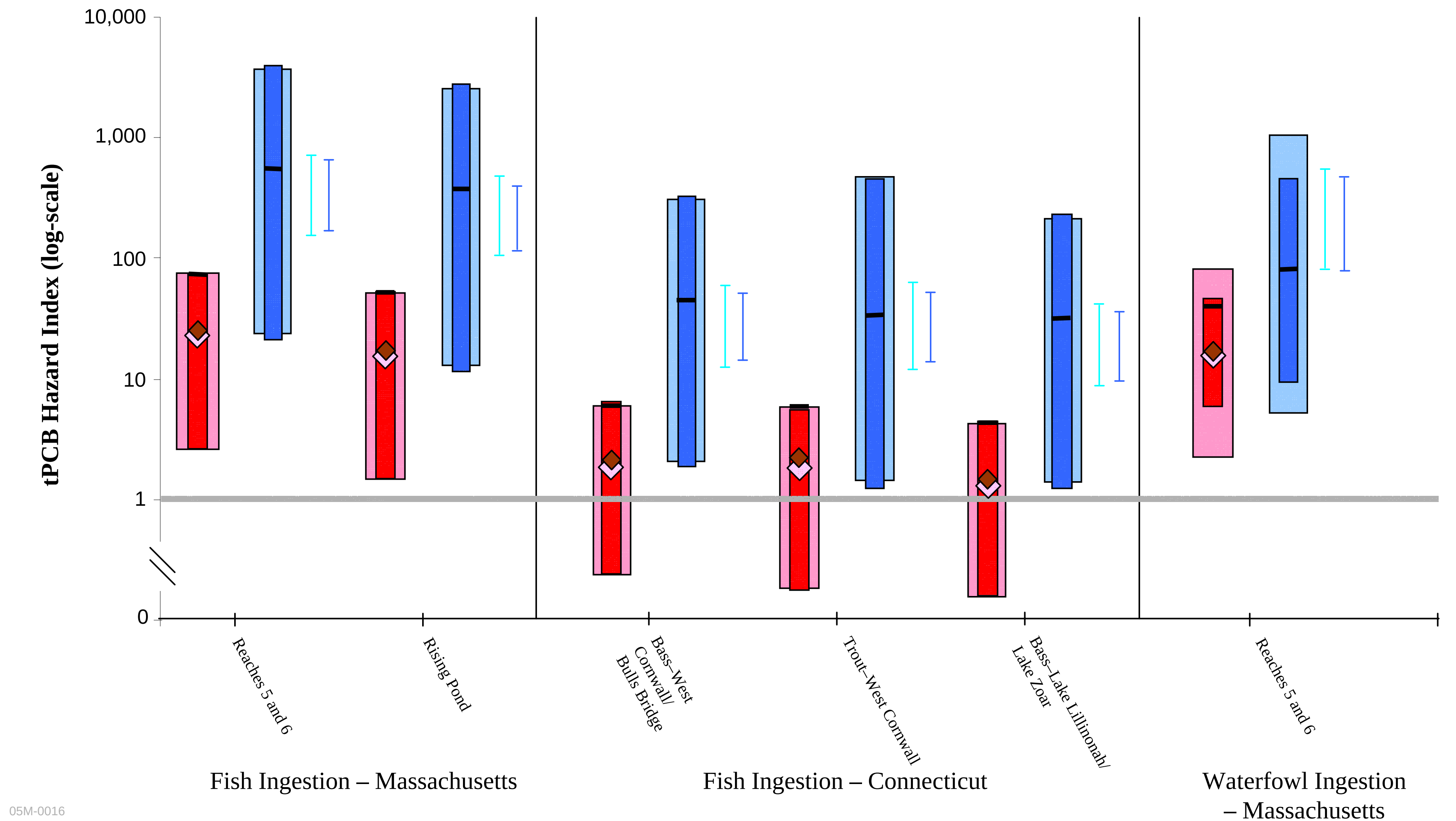


▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
▭ = Median calculated with one-dimensional probability bounds analysis.

▬ = RME point estimate.
I = Microexposure Monte Carlo simulation RME range.
I = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
▭ = RME range calculated with one-dimensional probability bounds analysis.
▬ = EPA hazard benchmark

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 8-6
Relationship Between Point Estimate, Monte Carlo, and Probability Bounds Analyses for tPCB Hazard Indices from Fish and Waterfowl Consumption by Adults



▬ = CTE point estimate.
◆ = Microexposure Monte Carlo simulation median.
◇ = One-dimensional Monte Carlo simulation median.
🟥 = Median calculated with microexposure probability bounds analysis.
▭ = Median calculated with one-dimensional probability bounds analysis.
▬ = RME point estimate.
Ɪ = Microexposure Monte Carlo simulation RME range.
Ɪ = One-dimensional Monte Carlo simulation RME range.
🟦 = RME range calculated with microexposure probability bounds analysis.
▭ = RME range calculated with one-dimensional probability bounds analysis.
━ = EPA hazard benchmark

Fish and Waterfowl Risk Assessment
GE/Housatonic River Site
Rest of River

Figure 8-7
Relationship Between Point Estimate, Monte Carlo, and Probability Bounds Analyses for tPCB Hazard Indices from Fish and Waterfowl Consumption by Children

probability bounds approaches, and a comparison of these cancer risks and hazard indices to the EPA risk range. The red bars summarize the results for the central tendency exposures for each of the fish and waterfowl exposure locations, and the blue bars summarize the results for the upper end of the exposure range. EPA guidelines for cancer risks and noncancer health effects are noted by a gray shaded area and a gray line, respectively.

Using Figure 8-4 as an example, the red diamonds represent the median (50th percentile) cancer risk calculated using the one-dimensional Monte Carlo simulation (light red) and the MEE simulation (dark red). The black horizontal lines (on the red bars) represent the point estimate results for the CTE. For example, the central tendency cancer risk from tPCB due to consumption of fish caught in the PSA is 3E-04 for both the point estimate CTE and the median of the one-dimensional Monte Carlo simulation. The median of the MEE simulation indicates a higher cancer risk (5E-04). The light and dark bands of red correspond to the uncertainty around the median of the one-dimensional and MEE Monte Carlo simulations, respectively, that was calculated in the probability bounds analysis.

EPA guidance (EPA, 2001) suggests risk managers select the RME from what is considered the high, or upper (i.e., 90th to 99.9th) percentiles of risk when using a probabilistic assessment. The blue vertical lines represent the RME risk range calculated using the one-dimensional Monte Carlo simulation (light blue) and the MEE simulation (dark blue). The black horizontal lines (on the blue bars) represent the point estimate results for the RME. The light and dark bands of blue correspond to the uncertainty surrounding the high-end percentiles of the one-dimensional and MEE Monte Carlo simulations, respectively, calculated with probability bounds analysis.

8.3.1 Cancer Risks

8.3.1.1 Total PCBs

Figure 8-4 summarizes the tPCB results from fish consumption at the four locations, with bass and trout evaluated separately at West Cornwall, and from waterfowl consumption in the PSA. This figure represents data presented in Tables 6-6, 6-8, 6-10, and 6-12.

Fish consumption tPCB cancer risks calculated with the point estimate RME and in the high-end range (the 90th to 99th percentile) of both the one-dimensional and MEE Monte Carlo simulations are above the upper end of the EPA risk range for all locations. The Monte Carlo simulations represent best estimates of the risk at the specified percentile, given that the assumptions about the parameter values and specified models are reasonable. In Massachusetts reaches, the cancer risks from tPCB RME risks generally exceed the upper end of the EPA risk range (1E-04), even if all the uncertainty associated with the data and models is taken into account. However, if all the uncertainty in the input values or parameterizations that produced the least risk were combined simultaneously and were "true," a combination that has a low probability, the uncertainty associated with the one-dimensional Monte Carlo model indicates that the risks could be between 1E-04 and 1E-05. In the similarly unlikely event that the input values and parameterizations that produced the highest risk were simultaneously correct, the cancer risk could be as high as 6E-02 at the 99th percentile.

A comparison of the tPCB cancer risks calculated with the point estimate CTE and the 50th percentile of the Monte Carlo simulations indicate that the "best estimate" central tendency risks for tPCB in Reaches 5 and 6 and in Rising Pond are above the EPA risk range, whereas the "best estimate" central tendency risks for tPCB in West Cornwall, Bulls Bridge, and Lakes Lillinonah and Zoar are in the risk range. The probability bounds analyses indicate that when all of the uncertainty around the median is included, the tPCB cancer risks in the Massachusetts reaches may be substantially above (between 1E-03 and 1E-02) to within the EPA risk range (between 1E-05 and 1E-06). The uncertainty bounds associated with the central tendency risks in West Cornwall and the lower reaches straddle the risk range.

The final two bars on Figure 8-4 summarize the range of tPCB cancer risks due to waterfowl ingestion. As with fish ingestion, the high-end tPCB cancer risk estimates are above the EPA risk range in the point estimate and both Monte Carlo simulations. The uncertainty around the high-end range for the one-dimensional Monte Carlo simulation ranges from a high of 2E-02 at the 99th percentile to a low of 1E-05 for the 90th percentile. In the MEE model, even the low end of the uncertainty at the 90th percentile is 1E-04, the upper bound of the EPA risk range. The central tendency tPCB cancer risks based on the CTE and Monte Carlo simulations are 1E-04 or higher. Accounting for all of the uncertainty, the results indicate that the central tendency risk could be greater than 1E-03 or less than 1E-05.

8.3.1.2 TEQ

Figure 8-5 summarizes the dioxin-like PCB TEQ results from fish consumption at the two locations in Massachusetts where congener data were available and from waterfowl consumption in the PSA. This figure represents data presented in Tables 6-6, 6-8, 6-10, and 6-12.

The dioxin-like PCB TEQ cancer risks based on the fish consumption point estimate RME and the 90th to 99th percentiles of both Monte Carlo simulations are above the upper end of the EPA risk range. If all the uncertainty in the input values or parameterizations that produced the least risk were combined simultaneously and were “true,” a combination that has a low probability, the uncertainty associated with the one-dimensional Monte Carlo model indicates that the risks could be between 1E-04 and 1E-05. In the similarly unlikely event that the input values and parameterizations that produced the highest risk were simultaneously correct, the cancer risk could be as high as 3E-02 at the 99th percentile. The dioxin-like PCB TEQ cancer risks calculated with the point estimate CTE and the 50th percentile of the Monte Carlo simulations indicate that the central tendency risks are also greater than the upper end of the EPA risk range. The probability bounds analyses indicate that when all of the uncertainty in input values, parameterizations, and models around the median is included, the TEQ cancer risk estimate could be as high as 7E-03 to as low as 5E-06 for Reaches 5 and 6.

The final two bars in Figure 8-5 summarize the range of dioxin-like PCB TEQ cancer risks due to waterfowl ingestion. As with fish ingestion, the RME TEQ cancer risk estimates are above the EPA risk range in the point estimate and both Monte Carlo simulations. The central tendency risk estimates are also above the upper end of the cancer risk range; however, the lower bound of the uncertainty around the central tendency risks for the one-dimensional Monte Carlo simulation may be within above the EPA cancer risk range.

8.3.2 Hazard Indices

8.3.2.1 Total PCBs

Figures 8-6 and 8-7 summarize the results for adults and children from fish consumption at the four locations evaluated, with bass and trout evaluated separately at West Cornwall, and from waterfowl consumption in the PSA. The data presented in this figure have been provided in tabular form in Tables 6-7, 6-9, 6-11, and 6-13.

The tPCB HIs based on both the adult and child fish consumption point estimate and Monte Carlo simulations for the RME receptors are above the EPA benchmark of 1 for all locations. For children at all locations, the uncertainty analyses for both Monte Carlo simulations indicate that the EPA benchmark is exceeded even at the 90th percentile of the distribution, and in the unlikely event that the input values and parameterizations that produced the lowest risk are simultaneously correct. In the Massachusetts reaches, HIs for central tendency child receptors (50th percentile of the Monte Carlo distributions) exceed the benchmark of 1, even when all the uncertainty is considered. In Connecticut reaches, Monte Carlo simulations indicate that the adult central tendency receptors have HIs near 1, whereas the child central tendency receptors have HIs of 1 to 3, above the EPA risk range. Including the uncertainty in all the input values, parameterization and models, the HI for central tendency receptors in Connecticut may be above or below the EPA benchmark of 1.

The final two bars on Figures 8-6 and 8-7 summarize the noncancer hazards due to waterfowl ingestion. Both the high-end and central tendency HIs for children and adults are above the EPA benchmark of 1, even if all the uncertainty in the input values or parameterizations that produced the least risk are combined simultaneously.

8.4 REFERENCES

EPA (U.S. Environmental Protection Agency). 1990. National Oil and Hazardous Substances Pollution Contingency Plan. Final Rule. 40 CFR 300: 55 *Federal Register* 8666-8865, 8 March 1990.

EPA (U.S. Environmental Protection Agency). 1991. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, Memorandum from Don R. Clay to Division Directors, 22 April 1991.

EPA (U.S. Environmental Protection Agency). 2001. *Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment.* Office of Emergency and Remedial Response, Washington, DC. EPA 540-R-02-002. December 2001.

LIST OF ATTACHMENTS

ATTACHMENT C.1

DEVIATIONS FROM THE SUPPLEMENTAL INVESTIGATION WORK PLAN

ATTACHMENT C.1

DEVIATIONS FROM THE SUPPLEMENTAL INVESTIGATION WORK PLAN

INTRODUCTION

This attachment discusses differences in the approaches proposed for use in the fish and waterfowl risk assessment as presented in the *Supplemental Investigation Work Plan for the Lower Housatonic River* (WESTON, 2000) and those actually used in the completion of the assessment. The general topics are called out as headings below, followed by text from the SIWP and a discussion of the deviations and rationale for these deviations.

DISCUSSION OF DEVIATIONS

Presentation of Summary Statistics

SIWP

> Summary tables will be prepared for each site, by medium and exposure scenario, that present the following information for site-related data:
>
> - List of contaminants detected at the site.
> - Frequency of detection.
> - Range of detected concentrations.
> - Range of sample quantitation limits.
> - Arithmetic mean concentration of non-transformed data.
> - Standard deviation of the mean.
> - Distribution of data (normal, lognormal, neither).
> - 95% UCL of the arithmetic mean.
> - Exposure point concentration (EPC).

Deviation/Rationale

The arithmetic mean concentration of non-transformed data, and the standard deviation of the mean were not included in the summary statistic tables. These two descriptive statistics are sensitive to outliers and skewness within a data set. To present a more accurate description of the data, the mean and standard deviation were replaced by the median and inner-quartile (i.e., 50th and 25th and 75th percentile) values.

Distribution Determination

SIWP

> Site data will be evaluated initially by the Shapiro-Wilk *W*-test to determine whether data are normally or lognormally distributed, after which the appropriate summary statistics will be calculated.

Deviation/Rationale

Distributions were determined using either the Shapiro-Wilk or the Lilliefors test statistic based on sample size. Shapiro-Wilk is best applied to data sets less than 50 samples. For data sets with more than 50 samples, the Lilliefors test statistic was used.

95% UCL Calculation for Data Sets Neither Normally Nor Lognormally Distributed

SIWP

> The 95% UCL of the mean for COPCs will be calculated in accordance with EPA guidelines presented in *Supplemental Guidance to RAGS: Calculating the Concentration Term* EPA, 1992. The appropriate formula (dependent on the type of distribution) will be used to estimate the 95% UCL of the mean.

Deviation/Rationale

The 95% UCL of the mean for COPCs was calculated in accordance with updated EPA guidance *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA, 2002, EPA, 1992). Consistent with this guidance, Hall's modified bootstrap was used to calculate the 95% UCL of the mean for data sets that are neither normal nor lognormal.

Addition of Dioxin and Furan Congener TEQs to Yield Total 2,3,7,8-TCDD TEQ Exposures and Risks

SIWP

> Indicated the TEQs from dioxin and furan congeners would be added to yield total 2,3,7,8-TCDD TEQ exposures and risks.

Deviation/Rationale

Dioxin and furan congener-based TEQs were not added in order to more easily determine which contaminants are contributing more to risk since furan congeners are often associated with PCBs and dioxin congeners are not.

Use of Two Cancer Risk Calculation Approaches

SIWP

Potential cancer risk will be calculated by multiplying the estimated LADD intake that is calculated for a chemical through an exposure route by the exposure-route-specific (oral, inhalation, or dermal) CSF, as follows:

$$\text{Risk} = \text{LADD} * \text{CSF}$$

where:

LADD = Lifetime average daily dose; intake averaged over a 70-year lifetime as mg chemical/kg-body weight per day

CSF = Chemical- and route-specific cancer slope factor $(\text{mg/kg-day})^{-1}$

Deviation/Rationale

Because some calculated cancer risks were greater than 1E-02, a second cancer risk calculation approach needed to be used based on EPA guidance (EPA, 1989). For individual contaminants with a cancer risk greater than 1E-02, the one-hit equation was applied as follows:

$$\text{Risk} = 1 - \text{EXP}(-\text{LADD} * \text{CSF})$$

where:

EXP = Constant (base of the natural log, equal to 2.718)

LADD = Lifetime average daily dose; intake averaged over a 70-year lifetime as mg contaminant/kg-body weight per day

CSF = Contaminant-specific cancer slope factor $(\text{mg/kg-day})^{-1}$.

REFERENCES

EPA (U.S. Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final.

EPA (U.S. Environmental Protection Agency). 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. May 1992.

EPA (U.S. Environmental Protection Agency). 2002. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites.* Draft. OSWER 9285.6-10 Office of Emergency and Remedial Response, Washington, DC. December 2002.

WESTON (Roy F. Weston, Inc.). 2000. *Supplemental Investigation Work Plan for the Lower Housatonic River,* Volumes 1 and II. Prepared for U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. 22 February 2000.

ATTACHMENT C.2

HISTORICAL DATA REVIEW

ATTACHMENT C.2

HISTORICAL DATA REVIEW

BACKGROUND

A number of historical data sets exist for the Housatonic River that needed to be evaluated to determine if and how the data might be used in the human health and ecological risk assessments and other components of the Housatonic River Project. The evaluation process must be rigorous and transparent. This protocol describes a procedure comprising six criteria that were used to determine the useability of data sets and provides guidance on the application of these criteria to the review of historical data sets.

RECOMMENDED PROCEDURE

The process for evaluating data sets against the six criteria is summarized in Table 1, "Proposed Decision Criteria Matrix." The six criteria to be used in evaluating historical data sets are:

- Criterion 1: Overall quality and level of detail in reports
- Criterion 2: Formal documentation of procedures
- Criterion 3: Analytical methods used and detection limits achieved
- Criterion 4: Data review, validation, and quality assurance
- Criterion 5: Assessment of data quality indicators
- Criterion 6: Data history and overall apparent data quality

These evaluation criteria are similar to those described in *Guidance for Data Useability in Risk Assessment* (EPA, 1992), but have been modified to better fit the needs of the Housatonic River Project. EPA Criterion III ("Data Sources") was found to be not applicable because it deals with determining whether a single study is sufficiently comprehensive to have considered all or most COPCs. As this issue has already been adequately investigated via the current data, it is not a factor in evaluating the useability of historical data sets. Criterion 6, which does not appear in the EPA guidance, was created to allow consideration of the age of a data set and to allow a somewhat more subjective evaluation of the apparent overall quality of the study from which it was developed. Each of the six criteria is defined in terms of four levels of useability:

- Level A: Acceptable, unrestricted use

- Level B: Acceptable, some use restrictions may apply
- Level C: Conditionally acceptable for limited uses
- Level D: Conditionally acceptable, use with caution

The remainder of this protocol provides detailed guidance for evaluating each data set and assigning a score for each criterion. In addition to a separate score for each of the criteria, each data set will be assigned an overall score that will be equivalent to the lowest score applied to any single criterion, e.g. a data set that is ranked Level A for four of the criteria and Level B for two would be considered Level B overall. It is important to note that the results of this procedure do not determine whether a data set may be used for a particular purpose but rather are intended to alert investigators to potential limitations in the data. The decision to use or not use a given data point or data set remains the responsibility of the individual investigator and must be made in the context of the particular study.

Criterion 1: Overall Quality and Level of Detail in Reports

Overview: This criterion applies to the technical report and/or narrative that accompanies a data set. This information is needed to evaluate the study design and procedures, allowing a determination of the likely overall quality of the data. It also allows the data evaluator to determine if the procedures were followed properly or if there were any deviations from the work plan. In general, the more of this type of information that is provided to support a data set, the greater the degree of confidence in the data. Isolated data sets, i.e., those that are not supported by sufficient background information, cannot be evaluated fully for useability and therefore can only be considered useable if the investigator considers carefully the potential issues surrounding their use and employs caution in any decision to use such data.

As will be the case for all criteria discussed in this Protocol, four different conditions are described which result in a data set being scored from Level A (the highest score, indicating a data set can be used without restriction) to Level D (conditionally useable with caution). Data evaluators should score data sets following these descriptions. It is recognized that this process is somewhat subjective and, evaluators are expected to use professional judgment in awarding a score.

Level A: Acceptable, unrestricted use

For this criterion, a Level A data set must be accompanied by a narrative report that provides complete details of the study design and includes at least some discussion of the underlying reasons for selecting the stated sampling locations and methods. The sampling locations must be provided accurately and precisely and the procedure(s) used to locate the stations should also be provided. The analytical methods followed should be fully described, including supporting information such as detection limits, qualifiers, and procedures for handling non-detects.

Level B: Acceptable, some use restrictions may apply

A Level B data set is one accompanied by a narrative report that generally provides an adequate description of the study and its methods, but does not meet the stringent requirements for Level A. Examples of deficiencies that might cause a data set to be downgraded to Level B would include failure to specify how sampling stations were located, or failure to specify how non-detects were treated. In such cases, the data are considered to be generally useable, but some consideration should be given to the potential for reaching erroneous conclusions if, to continue with the two previous examples, the sampling locations were only approximately located or if non-detects were reported as blanks or zero values. This evaluation must be performed in the context of the actual use of the data by each investigator.

Level C: Conditionally acceptable for limited uses

The intention of the Level C score for this criterion is to identify data sets that are accompanied by reports that are largely insufficient for proper evaluation, but which may contain data on parameters for which such limitations are less important or for uses, such as trend analysis, that may not require data that can be rigorously reviewed. It is also intended to apply to data sets that may have certain critical historical data that are necessary for a particular study and cannot be obtained from another source. In such cases, the investigators must proceed carefully and understand the limitations that will likely be imposed on their conclusions.

Level D: Conditionally acceptable, use with caution

Level D data sets will in general exist independently of a written narrative report and will therefore not be dependable with regard to design and methodology. Such data sets should not be used unless there is no reasonable alternative data source.

Criterion 2: Formal Documentation of Procedures

Overview: This criterion applies to what is thought of as "formal" Quality Assurance documentation that is currently required for all studies done under contract to EPA and is also typically prepared for studies that have a reasonable probability of being closely scrutinized, particularly as part of legal proceedings. This documentation consists of four general types of records: Work Plans and/or Quality Assurance Project Plans (QAPP), chain-of-custody, standard operating procedures (SOP) or protocols, and field/analytical records.

Work Plans, which may be separate from or combined with a QAPP, describe the procedures to be employed in a study to ensure that the work is conducted properly and completely. They are expected to be complete and prepared in sufficient detail so that different properly trained professionals could conduct the work scope in the exact same manner.

Chain-of-custody, at a minimum, allows the reviewer to ensure that a data point is clearly linked to a particular geographic location and date/time. So-called "full-scale" chain-of-custody is the documentation that also ensures a particular sample has been handled properly and not tampered with. In general, full-scale chain-of-custody is necessary for enforcement or cost recovery.

SOPs or protocols are written detailed procedures that describe clearly how the components of a study (typically field and laboratory procedures) are to be carried out. In general, the term SOP applies to "standardized" procedures that are usually part of a company's routine way of conducting business and are applicable to all projects; protocols are specialized or non-routine procedures that may be prepared for a specific project or task. The same level of detail applies to either, and the two terms are intended to be equivalent for the purposes of this data evaluation. SOPs/protocols may be incorporated into Work Plans or QAPPs or may be stand-alone documents.

Field and analytical records are less standardized, but are intended to provide a permanent record of what was actually done as part of the study. Such records may be critical to resolving issues in data interpretation and are necessary if a data set is to achieve a Level A rating.

Level A: Acceptable, unrestricted use

To achieve a Level A rating, a data set must be accompanied by the full suite of documentation described above, including full-scale chain-of custody.

Level B: Acceptable, some use restrictions may apply

Level B for this criterion is intended to describe data sets that in general have the documentation described above, but for which the documentation may be insufficient, inadequate, or poorly prepared in some areas that are deemed to be non-critical. For example, a data set that appears to have SOPs in place for the majority of the field procedures but is lacking SOPS for some procedures may be graded Level B. Similarly, a data set that was sent to a recognized analytical laboratory and analyzed using standard procedures may be graded Level B even if the actual SOP from the laboratory cannot be obtained. This rating would also apply to data sets for which the necessary documentation is not currently available but can be easily accessed or provided by a third party if necessary.

Level C: Conditionally acceptable for limited uses

Level C for this criterion is primarily intended to apply to data sets that are lacking much of the necessary documentation but are believed to be of high quality because of the evaluator's knowledge regarding the source, i.e., the company or principal investigator. It is also intended to apply to data derived from recognized laboratories that may no longer be in business or may be difficult to correspond with for other reasons. In these cases, it is assumed that the study was conducted in a manner consistent with a documented Level A or B study, but the documentation was never prepared or is otherwise unavailable.

Level D: Conditionally acceptable, use with caution

Data sets for which none or very little of the required documentation is available and about which there is insufficient information to qualify for Level C will carry the warning “use with caution” - the choice of whether such data are acceptable for use in a study or for a particular purpose will remain the responsibility of the individual investigator.

Criterion 3: Analytical Methods Used and Detection Limits Achieved

Overview: This criterion concerns both the actual analytical methods used to develop the data and the application of those methods to achieve sufficiently low detection limits. In general, it is preferable that the methods used in a study are routine and federally documented. In practice, this means either approved EPA methods or ASTM methods, with the EPA methods generally being preferred. Although other types of analytical methods may be useable for a particular study or study component if properly documented, there is an element of uncertainty introduced.

Detection limits actually achieved must be sufficiently low in comparison with concentrations that are known or likely to be of concern for the particular project, by which is meant the “end use” project (in this case the Housatonic River Project), not necessarily the project for which the data were originally developed. The general expectation is that the Practical Quantitation Limit (PQL) should be below the Project Action Limit (PAL), which dictates that the Method Detection Limit (MDL) should generally be less than 20% of the PAL. MDLs and PQLs near the PAL introduce additional uncertainty and may also compromise the identification of particular analytes.

Level A: Acceptable, unrestricted use

To achieve a Level A rating, all analytes of interest in the data set must have been quantified using standard EPA-approved analytical methods current as of the date the study was conducted, or well-documented and accepted ASTM methods. MDLs achieved must be as specified in the method descriptions. For truly unrestricted use, the PQLs should be at or below concentrations known or expected, based on other information such as EPA guidance or criteria, to be of concern (PALs).

Level B: Acceptable, some use restrictions may apply

The Level B rating for this criterion is intended to apply to those data sets that were developed using non-standard methods, but which have been sufficiently documented to satisfy the evaluator that the data are equivalent in quality to data developed via EPA or ASTM methods. Level B data sets for this criterion would also include data that were analyzed by EPA or ASTM methods that have since been revised to improve detection limits or analyte identification but which were current at the time of the study. Implicit in this criterion is the assessment that the modification to the procedures does not in some way invalidate the previous version of the method.

Level C: Conditionally acceptable for limited uses

Level C data sets for this criterion would include data that were developed using non-standard methods that have not been well-documented but which are believed to be of sufficient quality to be used with consideration of their potential limitations. In general, this level is intended to apply to data sets that might have been developed using experimental or developmental methods by highly qualified firms, laboratories, or individuals.

Level D: Conditionally acceptable, use with caution

Data sets developed using unknown analytical methods, developed using non-standard or poorly documented methods about which nothing more is known, or data sets developed using methods that are otherwise considered to derive from questionable methods will be judged to be Level D.

Criterion 4: Data Review, Validation, and Quality Assurance

Overview: This criterion deals with the range and variety of QA and QC methods available to ensure that the data are of known quality. These include such methods and procedures as blank samples, spikes, and duplicates. Further, it also concerns the review conducted on the data following receipt from the analytical laboratory; such review typically falls into two categories: various data completeness reviews and formal validation. The latter usually requires that the appropriate QC procedures were built into the sample collection and analysis process.

Level A: Acceptable, unrestricted use

The Level A rating for this criterion is reserved for data sets that have undergone a formal validation process. Although it is preferable that all data in the data set were part of batches that were formally validated, the data set may be judged to be Level A if the level of validation was reduced to a subset of the data for well-documented reasons consistent with known quality of laboratory performance. For example, the WESTON tissue data being developed by GERG would be considered a Level A data set in spite of the fact that currently only approximately 15% of the data receive formal validation. This reduction was warranted by consistently high performance at GERG which allowed the level of validation to be reduced as a cost-saving measure.

Level B: Acceptable, some use restrictions may apply

Level B data sets are those which have been subjected to a rigorous data review that has been fully described and documented but which have not received formal data validation. Such a review would typically include examination of completeness and should be accompanied by data for blanks and duplicates. Another example of Level B data set for this criterion might be a data set that is accompanied by satisfactory data from performance evaluation (P/E) samples but has not had formal data validation. It is assumed that a Level B study would have been conducted with established written QA/QC procedures and that a review is conducted to ensure compliance with these procedures.

Level C: Conditionally acceptable for limited uses

A rating of Level C will be applied to data sets that have received limited documented review or for which QA/QC procedures were not properly specified, but which are believed to be of reasonable quality due to other known factors.

Level D: Conditionally acceptable, use with caution

Data sets that have received no documented review or for which the level of review is not known will be considered Level D.

Criterion 5: Assessment of Data Quality Indicators

Overview: Data quality indicators (DQIs) are a means of defining data quality in terms of data quality objectives. This criterion is concerned with the following five DQIs: precision, accuracy, representativeness, completeness, and comparability (PARCC) and the additional DQI of sensitivity, which is related to Criterion 3, above. As part of the evaluation of a data set for Criterion 5, each of these DQIs must be evaluated against the goals established in the planning phase of the study. A detailed description of the individual DQIs and their application is beyond the scope of this Protocol but both are readily available from EPA and other sources.

Level A: Acceptable, unrestricted use

To achieve a rating of Level A, data sets must have been developed as part of a study that had pre-defined DQIs for all or most of the six parameters. Further, each of the DQIs should have been substantially achieved by the study. Alternatively, if a study failed to achieve one or more of its established DQIs but then provided a discussion of the implications of that failure and concluded that the DQOs were still achieved, that study could also receive a Level A rating at the discretion of the evaluator.

Level B: Acceptable, some use restrictions may apply

For this criterion, Level B is intended to apply to data sets that were developed without formal DQIs being established as part of the planning process, but which did evaluate (or allow the evaluator to obtain) the DQIs achieved after the fact. In effect, this rating indicates that DQIs were achieved that were consistent with those for Level A data sets and that would likely have been established had the planning process included them.

Level C: Conditionally acceptable for limited uses

Level C data sets include those data sets that also did not have DQIs established in the planning phase of the study and, further, appear to have not satisfied what might be considered reasonable standards for one or more of the non-critical DQI parameters (i.e. completeness, comparability). For example, 90% is a typical completeness goal. A data set that established a completeness goal of 90% and achieved it would (for this one parameter) be considered Level A. A data set that achieved

90% completeness in the absence of a specified goal would be Level B. A data set that achieved 70% completeness would be Level C. Data from such a data set may be used if, at the discretion of the investigator, the failure to achieve a reasonable completeness did not unduly limit or bias the data for a particular analyte.

Level D: Conditionally acceptable, use with caution

Data sets are considered to be Level D for this criterion if it is not possible to evaluate the typical DQIs or if the study failed to achieve a reasonable result for one or more of the critical DQIs.

Criterion 6: Data History and Overall Apparent Data Quality

Overview: This criterion is somewhat more subjective than the preceding ones and is intended to allow the evaluator to exercise a greater degree of professional judgment regarding a data set. Because of changes in methodology, both field and analytical, and the inability at times to obtain answers to specific questions for older data sets, their use can be questionable. In addition, it is recognized that conditions in the study area are changeable with time and data developed some years previous may not represent present conditions. This criterion also recognizes that trained evaluators may use many indicators, including personal knowledge of individuals and organizations, that are not easily captured in an objective rating scheme.

Level A: Acceptable, unrestricted use

Level A will apply only to data sets developed in whole or in substantial part recently, typically defined as within the last 10 years, and for which the evaluator has no reason to question their validity. In addition, to qualify for Level A, the study that produced the data must have used methods that are consistent with current practice and there should be some objective indication that the proposed methods were actually followed conscientiously by the individuals conducting the work. In effect, this rating indicates that the study is fully equivalent to the work currently being conducted by WESTON and its subcontractors.

Level B: Acceptable, some use restrictions may apply

Level B for this criterion is essentially equivalent to Level A, but the study and data are older than 10 years or the stringent standards of Level A with regard to methods and practices either are not satisfied or cannot be determined. To qualify for Level B, however, the study must still have produced data that are equivalent to what would have been produced using current methodologies. Nonetheless, investigators should examine such data sets carefully to ensure that the particular data and data uses would not be invalidated by the age of the data.

Level C: Conditionally acceptable for limited uses

Level C applies if, in the professional opinion of the evaluator, portions of the data appear to be of questionable quality based primarily on the methods used and/or the apparent adherence to those methods during the performance of the work. Other data from the study may be useable, but investigators should exercise caution and should use such data only if necessary.

Level D: Conditionally acceptable, use with caution

Data sets will be considered Level D if, in the professional opinion of the evaluator, the data are of questionable quality due to methodology or any other reason. This assessment may be made in spite of acceptable performance on any or all of the more objective criteria discussed above.

REFERENCES

EPA (U.S. Environmental Protection Agency). 1992. *Guidance for Data Useability in Risk Assessment (Part A) Final.* Office of Emergency and Remedial Response, Washington, DC. PB92-963356.

Table 1

Proposed Decision Criteria Matrix for Evaluating Useability of Historical Data in Human Health Risk Assessment

	Level A - Acceptable, unrestricted use	Level B - Acceptable, some use restrictions may apply	Level C - Conditionally acceptable for limited uses	Level D - Conditionally acceptable, use with caution
Criterion 1: Overall quality and level of detail in report(s)	Accompanying report provides complete description of study design and sample location(s) with justification and rationale	Report is generally complete and well-written but lacks sufficient detail in a few areas. Sampling locations specified, but not located with GPS or equivalent.	Accompanying report is incomplete but does provide sufficient information for one or more parameters of interest. Sampling locations may not be well specified.	No information available on background and conduct of study. Significant questions regarding sampling locations.
Criterion 2: Formal documentation of procedures	Work Plan, Quality Assurance Plan, Chain-of-custody records, SOPs, and similar field and laboratory documentation exists and is available for review	Documentation exists for most areas but is insufficient or lacking in a few areas considered non-critical	Documentation generally not available but sufficient information is known or available via other sources to establish validity of field and analytical procedures	Documentation non-existent, not available for review, or status unknown
Criterion 3: Analytical methods used and detection limits achieved	Analytical procedures follow documented standard methods such as EPA or ASTM	Analytical procedures non-standard but sufficiently documented to establish validity of and ensure confidence in data	Analytical procedures non-standard and not well-documented, but data are believed to be valid due to other information provided	Insufficient information provided or available via other sources to establish validity of data
Criterion 4: Data review, validation, and quality assurance	Study incorporated all or most of the full range of QA/QC procedures, e.g., blanks, spikes, dups, data review, and data validation.	Study generally employed and documented established QA/QC procedures but did not conduct data validation	Non-standard or incomplete QA/QC procedures were followed.	No QA/QC procedures employed or documented.
Criterion 5: Assessment of data quality indicators	Study had established Data Quality Indicators and data substantially meet all acceptability criteria for completeness, comparability, representativeness, precision, accuracy	Data Quality Indicators not established, but data appear to meet minimum standards for DQIs	Data Quality Indicators not established; data appear to not satisfy minimum standards for one or more non-critical DQIs	Data fail to meet minimum standards for one or more critical DQIs, or not possible to evaluate DQIs
Criterion 6: Data History and Overall Apparent Data Quality	Data are recent (i.e. within past 10 years), reported in standard units, and are reasonable and internally consistent. Methods followed meet current standards for scientific investigation and were followed consistently.	Data appear to be of acceptable quality but derive from a study conducted prior to 1995. Methods may not meet current standards but are judged to have produced data equivalent to current methodologies.	Portions of the data appear to be of questionable quality due to age, changes in methods, and/or failure to follow current standards for scientific investigation.	The overall data quality is questionable due to outmoded methodologies, poor performance and/or apparent lack of consistency with current standards.

ATTACHMENT C.3

RAW DATA

DATA TABLES

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H3-TF03BB01-0-8C20	EPA_COE	Brown Bullhead	10/20/98	25	2.05928	0.08	0.08	
H3-TF03LB01-0-8C20	EPA_COE	Largemouth Bass	10/20/98	31	1.33127	0.03	0.03	
H3-TF03LB01-1-8C20	EPA_COE	Largemouth Bass	10/20/98	31	1.02025	0.04	0.04	
H3-TF03LB03-0-8C20	EPA_COE	Largemouth Bass	10/20/98	37	2.95838	0.2	0.18	
H3-TF07LB01-0-8S29	EPA_COE	Largemouth Bass	09/30/98	40.0	5.64359	0.9		
H3-TF07LB02-0-8S29	EPA_COE	Largemouth Bass	09/30/98	35.0	22.01959	1		
H3-TF07LB05-0-8S29	EPA_COE	Largemouth Bass	09/30/98	35.0	6.38453	0.2	0.2	
H3-TF08LB08-0-8S30	EPA_COE	Largemouth Bass	09/30/98	46.0	8.55072	0.4	0.4	
H3-TF08LB09-0-8S30	EPA_COE	Largemouth Bass	09/30/98	33.0	13.33649	0.8	0.8	
H3-TF09BB01-0-8S30	EPA_COE	Brown Bullhead	09/30/98	26	10.26643	2	2 J	
H3-TF09LB11-0-8S30	EPA_COE	Largemouth Bass	09/30/98	38	25.26079	2	2 J	
H3-TF09LB12-0-8S30	EPA_COE	Largemouth Bass	09/30/98	39.5	151.09842	7.6 J	7.6 J	
H3-TF09LB15-0-8S30	EPA_COE	Largemouth Bass	09/30/98	33	15.83615	4.3 J		
H3-TF10BB02-0-8S30	EPA_COE	Brown Bullhead	09/30/98	26	12.78059	3.9	3.9 J	
H3-TF10BB03-0-8S30	EPA_COE	Brown Bullhead	09/30/98	20	6.75996	0.5	0.5 J	
H3-TF10LB16-0-8S30	EPA_COE	Largemouth Bass	09/30/98	42.5	39.3466	1.8 J	1.8 J	
H3-TF10LB17-0-8S30	EPA_COE	Largemouth Bass	09/30/98	37	7.54906	0.5 J	0.5 J	
H3-TF10LB17-1-8S30	EPA_COE	Largemouth Bass	09/30/98	37	15.97553	1.3	1.3 J	
H3-TF10LB19-0-8S30	EPA_COE	Largemouth Bass	09/30/98	31	3.09625	0.4	0.4 J	
H3-TF11BB01-0-8C19	EPA_COE	Brown Bullhead	10/20/98	30.4	1.22943	0.02	0.02	
H3-TF11BB02-0-8C19	EPA_COE	Brown Bullhead	10/20/98	33.4	2.74634	0.08	0.08	
H3-TF11BB03-0-8C19	EPA_COE	Brown Bullhead	10/20/98	33.5	6.28971	0.07	0.07	
H3-TF11BB04-0-8C19	EPA_COE	Brown Bullhead	10/20/98	26.6	3.59268	0.25	0.25	
H3-TF11BB04-0-8S30	EPA_COE	Brown Bullhead	10/01/98	23.3	4.79244	1.9	1.9 J	
H3-TF11BB05-0-8C19	EPA_COE	Brown Bullhead	10/20/98	25.9	8.24526	0.6	0.59	
H3-TF11BB05-0-8S30	EPA_COE	Brown Bullhead	10/01/98	29.5	20.27923	1.6	1.6 J	
H3-TF11BB06-0-8C19	EPA_COE	Brown Bullhead	10/20/98	19.9	3.10894	0.11		
H3-TF11BB07-0-8C19	EPA_COE	Brown Bullhead	10/20/98	22.6	3.03199	0.19		
H3-TF11BB07-0-8S30	EPA_COE	Brown Bullhead	09/30/98	30.9	9.09184	1.5	1.5	
H3-TF11BB08-0-8C20	EPA_COE	Brown Bullhead	10/20/98	23.5	0.92827	0.03	0.03	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H3-TF11BB09-0-8C20	EPA_COE	Brown Bullhead	10/20/98	26.1	2.30822	0.09	0.09	
H3-TF11BB10-0-8C20	EPA_COE	Brown Bullhead	10/20/98	27	0.40645	0.03	0.03	
H3-TF11BB11-0-8C20	EPA_COE	Brown Bullhead	10/20/98	27.6	2.72078	0.04	0.04	
H3-TF11LB22-0-8S30	EPA_COE	Largemouth Bass	10/01/98	41.5	4.3449	0.5	0.5 J	
H3-TF11LB23-0-8S30	EPA_COE	Largemouth Bass	10/01/98	34.5	5.4767	0.5 J		
H3-TF11LB24-0-8S30	EPA_COE	Largemouth Bass	10/01/98	37	82.65609	7.2 J		
H4-TFWPBB01-0-8C21	EPA_COE	Brown Bullhead	10/21/98	30	11.76548	1	1.03	
H4-TFWPBB01-0-8S30	EPA_COE	Brown Bullhead	10/01/98	30.0	44.97181	2.9	2.9	
H4-TFWPBB01-1-8C21	EPA_COE	Brown Bullhead	10/21/98	30	19.64147	1.8	1.78	
H4-TFWPBB02-0-8C01	EPA_COE	Brown Bullhead	10/01/98	29.5	27.23799	2.9		
H4-TFWPBB02-0-8C21	EPA_COE	Brown Bullhead	10/21/98	27	19.60534	1.6	1.59	
H4-TFWPBB03-0-8C01	EPA_COE	Brown Bullhead	10/01/98	26	20.30066	1.2	1.2 J	
H4-TFWPBB03-0-8C21	EPA_COE	Brown Bullhead	10/21/98	30.5	9.47491	0.6	0.6	
H4-TFWPBB04-0-8C01	EPA_COE	Brown Bullhead	10/01/98	27	18.67837	1.5		
H4-TFWPBB04-0-8C21	EPA_COE	Brown Bullhead	10/21/98	28	16.98332	1.3	1.34	
H4-TFWPBB05-0-8C01	EPA_COE	Brown Bullhead	10/01/98	27.4	18.28808	2.2	2.2 J	
H4-TFWPBB05-0-8C21	EPA_COE	Brown Bullhead	10/21/98	25	6.18432	0.7	0.71	
H4-TFWPBB06-0-8C01	EPA_COE	Brown Bullhead	10/01/98	25.7	14.0896	1.6		
H4-TFWPBB06-0-8C21	EPA_COE	Brown Bullhead	10/21/98	27	19.97692	2.1		
H4-TFWPBB07-0-8C01	EPA_COE	Brown Bullhead	10/01/98	23.0	9.98464	1.1	1.1 J	
H4-TFWPBB07-0-8C21	EPA_COE	Brown Bullhead	10/21/98	26	7.83601	1	0.99	
H4-TFWPBB08-0-8C01	EPA_COE	Brown Bullhead	10/01/98	25.0	13.18094	1.2	1.2 J	
H4-TFWPBB08-0-8C21	EPA_COE	Brown Bullhead	10/21/98	27	5.21935	0.7		
H4-TFWPBB09-0-8C01	EPA_COE	Brown Bullhead	10/01/98	25.0	14.25138	2		
H4-TFWPBB09-0-8C21	EPA_COE	Brown Bullhead	10/21/98	28.1	12.61219	0.3		
H4-TFWPBB10-0-8C01	EPA_COE	Brown Bullhead	10/01/98	30	23.58088	1.9	1.9 J	
H4-TFWPBB11-0-8C01	EPA_COE	Brown Bullhead	10/01/98	29.4	11.37169	0.3	0.3 J	
H4-TFWPBB12-0-8C01	EPA_COE	Brown Bullhead	10/01/98	30	90.21707	1.9		
H4-TFWPBB13-0-8C01	EPA_COE	Brown Bullhead	10/01/98	27.4	7.34771	0.5	0.5 J	
H4-TFWPBB14-0-8C01	EPA_COE	Brown Bullhead	10/01/98	29.0	8.4675	1		

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H4-TFWPBB15-0-8C01	EPA_COE	Brown Bullhead	10/01/98	30.2	22.29519	1	1 J	
H4-TFWPBB16-0-8C01	EPA_COE	Brown Bullhead	10/01/98	26	6.57099	0.4 J		
H4-TFWPLB01-0-8S30	EPA_COE	Largemouth Bass	10/01/98	33.0	7.24572	0.9	0.9	
H4-TFWPLB01-0-9Y13	EPA_COE	Largemouth Bass	05/13/99	32				0.1 U
H4-TFWPLB01-1-8S30	EPA_COE	Largemouth Bass	10/01/98	33.0	6.28766	0.6	0.6	
H4-TFWPLB02-0-9Y13	EPA_COE	Largemouth Bass	05/13/99	31.5				0.1 U
H4-TFWPLB03-0-8S30	EPA_COE	Largemouth Bass	10/01/98	33.0	6.11945	0.7	0.7	
H4-TFWPLB03-0-9Y13	EPA_COE	Largemouth Bass	05/13/99	34.4				0.3
H4-TFWPLB03-1-9Y13	EPA_COE	Largemouth Bass	05/13/99	34.4				0.1 U
H4-TFWPLB04-0-8S30	EPA_COE	Largemouth Bass	10/01/98	33.0	10.73934	0.3		
H4-TFWPLB04-0-9Y13	EPA_COE	Largemouth Bass	05/13/99	33				0.2
H4-TFWPLB05-0-9Y13	EPA_COE	Largemouth Bass	05/13/99	35.5				0.1 U
H4-TFWPLB06-0-8C01	EPA_COE	Largemouth Bass	10/01/98	33.0	3.55948	0.5	0.5	
H4-TFWPLB06-0-9Y13	EPA_COE	Largemouth Bass	05/13/99	31.5				0.1
H4-TFWPLB07-0-8C01	EPA_COE	Largemouth Bass	10/01/98	38.0	2.43179	0.3	0.3	
H4-TFWPLB11-0-8C01	EPA_COE	Largemouth Bass	10/01/98	35.5	5.53611	0.2		
H4-TFWPLB12-0-8C01	EPA_COE	Largemouth Bass	10/01/98	33.5	6.28418	0.3		
H4-TFWPLB13-0-8C01	EPA_COE	Largemouth Bass	10/01/98	38	9.98139	0.3		
H4-TFWPLB14-0-8C01	EPA_COE	Largemouth Bass	10/01/98	37	5.15863	0.2	0.2 J	
H4-TFWPLB15-0-8C01	EPA_COE	Largemouth Bass	10/01/98	40	4.8221	0.2	0.2 J	
H4-TFWPLB17-0-8C01	EPA_COE	Largemouth Bass	10/01/98	35.5	11.47063	0.3	0.3 J	
H4-TFWPLB21-0-8C01	EPA_COE	Largemouth Bass	10/01/98	34	3.71419	0.2	0.2 J	
H4-TFWPLB22-0-8C01	EPA_COE	Largemouth Bass	10/01/98	31.4	9.20097	0.3	0.3 J	
H4-TFWPLB23-0-8C01	EPA_COE	Largemouth Bass	10/01/98	32.7	11.36232	0.3	0.3 J	
H3-TF03BG01-0-8C20	EPA_COE	Bluegill	10/21/1998	16.5	5.46542	0.15	0.15	
H3-TF03PS01-0-8C02	EPA_COE	Pumpkinseed	10/3/1998	16.3	7.27664	1.1	1.1	
H3-TF03YP01-0-8C02	EPA_COE	Yellow Perch	10/2/1998	29.4	50.25485	1.3	1.3	
H3-TF03YP01-0-8C19	EPA_COE	Yellow Perch	10/19/1998	24.5	4.38698	0.1	0.1	
H3-TF03YP01-1-8C19	EPA_COE	Yellow Perch	10/19/1998	24.5	1.30028	0.05	0.05	
H3-TF03YP02-0-8C02	EPA_COE	Yellow Perch	10/3/1998	28	16.93319	0.8 J	0.8 J	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H3-TF03YP02-0-8C19	EPA_COE	Yellow Perch	10/19/1998	24.5	0.78561	0.5	0.51	
H3-TF03YP03-0-8C02	EPA_COE	Yellow Perch	10/3/1998	27.2	9.53842	0.7 J	0.7 J	
H3-TF03YP03-1-8C02	EPA_COE	Yellow Perch	10/3/1998	27.2	8.20793	0.4 J	0.4 J	
H3-TF03YP04-0-8C02	EPA_COE	Yellow Perch	10/3/1998	25	4.80535	0.6 J	0.6 J	
H3-TF03YP05-0-8C02	EPA_COE	Yellow Perch	10/3/1998	22.5	11.3869	0.7 J		
H3-TF03YP06-0-8C02	EPA_COE	Yellow Perch	10/3/1998	24.8	4.9741	0.8 J		
H3-TF03YP07-0-8C02	EPA_COE	Yellow Perch	10/3/1998	26.2	8.15478	0.7 J	0.7 J	
H3-TF03YP08-0-8C02	EPA_COE	Yellow Perch	10/3/1998	25.5	6.66622	0.5 J	0.5 J	
H3-TF03YP09-0-8C02	EPA_COE	Yellow Perch	10/3/1998	23.5	4.06258	2.1 J	2.1 J	
H3-TF03YP10-0-8C02	EPA_COE	Yellow Perch	10/3/1998	24.9	13.10223	1.5 J	1.5 J	
H3-TF03YP11-0-8C02	EPA_COE	Yellow Perch	10/3/1998	22.8	11.42721	1 J	1 J	
H3-TF03YP12-0-8C02	EPA_COE	Yellow Perch	10/3/1998	24.6	20.47405	0.6 J		
H3-TF03YP13-0-8C02	EPA_COE	Yellow Perch	10/3/1998	25.1	4.68379	0.4 J	0.4 J	
H3-TF03YP14-0-8C02	EPA_COE	Yellow Perch	10/3/1998	25.2	10.85027	0.6 J		
H3-TF03YP15-0-8C02	EPA_COE	Yellow Perch	10/3/1998	28.6	5.04444	0.6 J	0.6 J	
H3-TF03YP16-0-8C02	EPA_COE	Yellow Perch	10/3/1998	24.5	6.56764	0.5 J		
H3-TF03YP17-0-8C02	EPA_COE	Yellow Perch	10/3/1998	22.8	11.17856	0.7 J		
H3-TF03YP18-0-8C02	EPA_COE	Yellow Perch	10/3/1998	21	8.21325	0.4 J	0.4 J	
H3-TF03YP19-0-8C02	EPA_COE	Yellow Perch	10/3/1998	21.6	5.40371	0.5 J		
H3-TF03YP20-0-8C02	EPA_COE	Yellow Perch	10/3/1998	24.4	3.17434	1.5 J	1.5 J	
H3-TF03YP21-0-8C02	EPA_COE	Yellow Perch	10/3/1998	25.1	7.7682	0.5 J		
H3-TF03YP22-0-8C02	EPA_COE	Yellow Perch	10/3/1998	22.5	5.62188	0.6 J		
H3-TF03YP23-0-8C02	EPA_COE	Yellow Perch	10/3/1998	23.2	5.50327	0.8 J		
H3-TF07PS07-0-8S29	EPA_COE	Pumpkinseed	9/30/1998	17.0	7.89024	0.9		
H3-TF07PS08-0-8S29	EPA_COE	Pumpkinseed	9/30/1998	16.5	4.12942	0.4	0.4	
H3-TF07YP01-0-8S29	EPA_COE	Yellow Perch	9/30/1998	27.5	75.67096	2.9	2.9	
H3-TF07YP01-1-8S29	EPA_COE	Yellow Perch	9/30/1998	27.5	11.15887	0.6	0.6	
H3-TF07YP03-0-8S29	EPA_COE	Yellow Perch	9/30/1998	31.0	8.98014	1.1	1.1	
H3-TF07YP03-1-8S29	EPA_COE	Yellow Perch	9/30/1998	31.0	13.35997	1.1	1.1	
H3-TF07YP04-0-8S29	EPA_COE	Yellow Perch	9/30/1998	26.5	4.7311	0.7	0.7	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H3-TF07YP05-0-8S29	EPA_COE	Yellow Perch	9/30/1998	26.0	4.49074	1		
H3-TF07YP06-0-8S29	EPA_COE	Yellow Perch	9/30/1998	26.5	6.60452	0.5	0.5	
H3-TF08PS01-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	15.0	4.4257	0.5	0.5	
H3-TF08PS02-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	15.0	4.448	2.3		
H3-TF08YP07-0-8S30	EPA_COE	Yellow Perch	9/30/1998	26.0	3.40597	1.3		
H3-TF08YP08-0-8S30	EPA_COE	Yellow Perch	9/30/1998	27.0	6.80333	0.7		
H3-TF08YP09-0-8S30	EPA_COE	Yellow Perch	9/30/1998	28.0	4.98218	1		
H3-TF08YP10-0-8S30	EPA_COE	Yellow Perch	9/30/1998	24.0	8.12887	0.8		
H3-TF08YP11-0-8S30	EPA_COE	Yellow Perch	9/30/1998	24.0	5.57526	0.7	0.7	
H3-TF09PS01-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	16.5	7.06284	1.6	1.6 J	
H3-TF09PS02-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	15	7.78099	0.5		
H3-TF09PS03-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	16.6	1.39632	0.3		
H3-TF09PS04-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	15	5.01027	1.2		
H3-TF09PS05-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	17	5.02623	0.5		
H3-TF09YP12-0-8S30	EPA_COE	Yellow Perch	9/30/1998	30	7.10803	2.4 J	2.4 J	
H3-TF09YP13-0-8S30	EPA_COE	Yellow Perch	9/30/1998	28	6.04564	0.9	0.9 J	
H3-TF09YP14-0-8S30	EPA_COE	Yellow Perch	9/30/1998	27.5	7.59019	0.8		
H3-TF09YP15-0-8S30	EPA_COE	Yellow Perch	9/30/1998	27	7.06583	1.1	1.1 J	
H3-TF09YP16-0-8S30	EPA_COE	Yellow Perch	9/30/1998	26	11.78438	0.4		
H3-TF10PS01-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	16.8	4.62771	0.9		
H3-TF10PS02-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	16.8	6.27039	0.4		
H3-TF10PS03-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	17	5.35443	0.4		
H3-TF10PS04-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	18.3	9.90669	0.9		
H3-TF10PS05-0-8S30	EPA_COE	Pumpkinseed	9/30/1998	18	3.14402	0.3	0.3 J	
H3-TF10YP17-0-8S30	EPA_COE	Yellow Perch	9/30/1998	29	7.82914	0.015		
H3-TF10YP18-0-8S30	EPA_COE	Yellow Perch	9/30/1998	28.5	5.60093	0.4		
H3-TF10YP18-1-8S30	EPA_COE	Yellow Perch	9/30/1998	28.5	5.7659	0.8		
H3-TF10YP20-0-8S30	EPA_COE	Yellow Perch	9/30/1998	28	4.3578	0.7 J		
H3-TF10YP20-1-8S30	EPA_COE	Yellow Perch	9/30/1998	28	5.04294	0.6 J		
H3-TF10YP21-0-8S30	EPA_COE	Yellow Perch	9/30/1998	27.5	10.96868	1.7	1.7 J	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H3-TF10YP22-0-8S30	EPA_COE	Yellow Perch	9/30/1998	27	8.16072	1.4		
H3-TF11PS01-0-8C19	EPA_COE	Pumpkinseed	10/20/1998	17	7.47915	0.4		
H3-TF11PS01-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	16.2	10.24357	0.7	0.7 J	
H3-TF11PS02-0-8C19	EPA_COE	Pumpkinseed	10/20/1998	18	5.4811	0.4		
H3-TF11PS02-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	17	7.78489	1	1 J	
H3-TF11PS03-0-8C19	EPA_COE	Pumpkinseed	10/20/1998	16.5	5.55373	0.5	0.46	
H3-TF11PS03-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	17	5.36632	0.9	0.9 J	
H3-TF11PS04-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	17.5	6.17005	0.5	0.48	
H3-TF11PS04-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	17	10.37457	0.4	0.4 J	
H3-TF11PS05-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	18.5	6.3904	0.6	0.62	
H3-TF11PS05-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	16.9	5.46806	0.9	0.9 J	
H3-TF11PS06-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	19.6	4.34387	0.7	0.65	
H3-TF11YP01-0-8C20	EPA_COE	Yellow Perch	10/20/1998	28.5	5.64918	0.5	0.54	
H3-TF11YP23-0-8S30	EPA_COE	Yellow Perch	10/1/1998	30.9	4.16224	1.1	1.1 J	
H3-TF11YP24-0-8S30	EPA_COE	Yellow Perch	10/1/1998	29.5	3.37158	3		
H3-TF11YP25-0-8S30	EPA_COE	Yellow Perch	10/1/1998	26.7	4.24436	0.5	0.5 J	
H3-TF11YP26-0-8S30	EPA_COE	Yellow Perch	10/1/1998	26.8	3.53259	0.4	0.4 J	
H4-TFWPPS01-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	17.7	1.79158	0.4	0.45	
H4-TFWPPS01-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	17.4	8.72667	1.1	1.1	
H4-TFWPPS02-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	20	2.28924	0.6	0.56	
H4-TFWPPS02-0-8S30	EPA_COE	Pumpkinseed	10/1/1998	19.0	3.84653	1.4	1.4	
H4-TFWPPS02-1-8C21	EPA_COE	Pumpkinseed	10/21/1998	20	2.44446	0.5	0.5	
H4-TFWPPS03-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	16.6	5.38253	0.5		
H4-TFWPPS04-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	16.8	3.46918	1.2	1.2	
H4-TFWPPS04-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	18.4	5.51826	0.6		
H4-TFWPPS05-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	16.5	4.16368	0.1		
H4-TFWPPS05-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	17.2	4.1789	0.7		
H4-TFWPPS06-0-8C21	EPA_COE	Pumpkinseed	10/20/1998	17.5	5.89803	0.3	0.27	
H4-TFWPPS07-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	18.5	4.23238	0.5		
H4-TFWPPS07-0-8C21	EPA_COE	Pumpkinseed	10/20/1998	16.2	2.15366	0.5		

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H4-TFWPPS08-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	17	10.44983	0.7	0.7 J	
H4-TFWPPS08-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	16.6	3.58393	0.3	0.31	
H4-TFWPPS09-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	16	5.88158	0.7	0.7 J	
H4-TFWPPS09-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	17	6.97135	0.8		
H4-TFWPPS10-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	17	4.34926	0.3		
H4-TFWPPS10-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	18.8	4.83165	0.3	0.35	
H4-TFWPPS11-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	16	5.10912	0.5		
H4-TFWPPS11-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	19.2	1.11078	0.2	0.23	
H4-TFWPPS12-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	18	10.97381	1.4	1.4 J	
H4-TFWPPS12-0-8C21	EPA_COE	Pumpkinseed	10/21/1998	17.9	4.6687	0.4	0.36	
H4-TFWPPS13-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	16	6.37555	0.5		
H4-TFWPPS14-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	14.5	11.69399	1.2	1.2 J	
H4-TFWPPS15-0-8C01	EPA_COE	Pumpkinseed	10/1/1998	18.5	47.45448	5.6	5.6 J	
H4-TFWPYP01-0-8S30	EPA_COE	Yellow Perch	10/1/1998	21.7	0.66409	0.006		
H4-TFWPYP02-0-8S30	EPA_COE	Yellow Perch	10/1/1998	19.7	0.63294	0.004		
H4-TFWPYP03-0-8S30	EPA_COE	Yellow Perch	10/1/1998	21.1	2.10485	1	1	
H4-TFWPYP04-0-8S30	EPA_COE	Yellow Perch	10/1/1998	24.6	4.59716	1.1	1.1	
H4-TFWPYP05-0-8C01	EPA_COE	Yellow Perch	10/1/1998	25.2	4.21174	0.8	0.8	
H4-TFWPYP06-0-8C01	EPA_COE	Yellow Perch	10/1/1998	24.2	2.54179	0.7	0.7	
H4-TFWPYP07-0-8C01	EPA_COE	Yellow Perch	10/1/1998	25.5	4.16503	1.2	1.2	
H4-TFWPYP08-0-8C01	EPA_COE	Yellow Perch	10/1/1998	26.8	0.54488	0.008		
H4-TFWPYP09-0-8C01	EPA_COE	Yellow Perch	10/1/1998	22.7	4.40325	1.2	1.2	
H4-TFWPYP10-0-8C01	EPA_COE	Yellow Perch	10/1/1998	24.0	6.35362	0.1	0.1	
H4-TFWPYP11-0-8C01	EPA_COE	Yellow Perch	10/1/1998	19.7	4.7117	0.9	0.9	
H4-TFWPYP12-0-8C01	EPA_COE	Yellow Perch	10/1/1998	21.2	0.69436	0.012		
H4-TFWPYP13-0-8C01	EPA_COE	Yellow Perch	10/1/1998	21.9	6.13039	1.4	1.4	
H4-TFWPYP14-0-8C01	EPA_COE	Yellow Perch	10/1/1998	21.4	0.72986	0.006		
H4-TFWPYP15-0-8C01	EPA_COE	Yellow Perch	10/1/1998	29.4	5.69461	0.8	0.8	
H4-TFWPYP16-0-8C01	EPA_COE	Yellow Perch	10/1/1998	25.6	1.27703	0.009		
H4-TFWPYP17-0-8C01	EPA_COE	Yellow Perch	10/1/1998	26.2	3.64084	1	1	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-1

Reaches 5 and 6 tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)	Percent Lipids (Other)
H4-TFWPYP18-0-8C01	EPA_COE	Yellow Perch	10/1/1998	28.7	2.24568	1.4 J	1.4 J	
H4-TFWPYP19-0-8C01	EPA_COE	Yellow Perch	10/1/1998	26.9	4.49881	1.1		
H4-TFWPYP20-0-8C01	EPA_COE	Yellow Perch	10/1/1998	27	5.61325	0.8	0.8 J	
H4-TFWPYP21-0-8C01	EPA_COE	Yellow Perch	10/1/1998	24.6	3.53437	0.3		
H4-TFWPYP22-0-8C01	EPA_COE	Yellow Perch	10/1/1998	24.2	6.10032	0.6		
H4-TFWPYP23-0-8C01	EPA_COE	Yellow Perch	10/1/1998	24.1	2.89303	0.6		
H4-TFWPYP24-0-8C01	EPA_COE	Yellow Perch	10/1/1998	27.4	3.55136	0.6	0.6 J	
H4-TFWPYP25-0-8C01	EPA_COE	Yellow Perch	10/1/1998	25.9	3.45007	0.4	0.4 J	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-2

Rising Pond tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)
H5-TFRPBB01-0-8C02	EPA_COE	Brown Bullhead	10/02/98	24	1.51921	0.6	0.6
H5-TFRPBB02-0-8C02	EPA_COE	Brown Bullhead	10/03/98	26.2	4.26965	1.9	1.9
H5-TFRPBB03-0-8C02	EPA_COE	Brown Bullhead	10/03/98	23.3	1.728528	1.5	1.5
H5-TFRPBB04-0-8C02	EPA_COE	Brown Bullhead	10/03/98	26.6	0.78381	0.5	0.5
H5-TFRPBB05-0-8C02	EPA_COE	Brown Bullhead	10/03/98	24.6	1.173326	0.7	0.7
H5-TFRPBB06-0-8C02	EPA_COE	Brown Bullhead	10/03/98	25.6	1.149379	0.8	0.8
H5-TFRPBB07-0-8C02	EPA_COE	Brown Bullhead	10/03/98	23.4	1.361639	0.8 J	0.8 J
H5-TFRPLB01-0-8C02	EPA_COE	Largemouth Bass	10/02/98	34.5	5.321987	0.2	0.2
H5-TFRPLB02-0-8C02	EPA_COE	Largemouth Bass	10/02/98	29.8	4.799097	0.2	0.2
H5-TFRPLB03-0-8C02	EPA_COE	Largemouth Bass	10/02/98	39.7	2.783301	0.3	0.3
H5-TFRPLB04-0-8C02	EPA_COE	Largemouth Bass	10/02/98	35.7	2.801814	0.4	0.4
H5-TFRPLB08-0-8C02	EPA_COE	Largemouth Bass	10/02/98	36.2	3.489639	0.3	0.3
H5-TFRPLB09-0-8C02	EPA_COE	Largemouth Bass	10/02/98	42.5	4.606492	0.4	0.4
H5-TFRPLB11-0-8C02	EPA_COE	Largemouth Bass	10/02/98	37.5	2.45481	0.3	0.3
H5-TFRPLB12-0-8C02	EPA_COE	Largemouth Bass	10/02/98	33.9	1.693812	0.4	0.4
H5-TFRPLB13-0-8C02	EPA_COE	Largemouth Bass	10/02/98	36	3.59859	0.5	0.5
H5-TFRPLB14-0-8C02	EPA_COE	Largemouth Bass	10/02/98	37.7	5.83816	0.3	
H5-TFRPLB15-0-8C02	EPA_COE	Largemouth Bass	10/02/98	32.5	4.826577	0.5	0.5
H5-TFRPPS01-0-8C02	EPA_COE	Pumpkinseed	10/02/98	16	3.245938	0.5	0.5
H5-TFRPPS02-0-8C02	EPA_COE	Pumpkinseed	10/02/98	15.2	1.746916	0.4	0.4
H5-TFRPPS03-0-8C02	EPA_COE	Pumpkinseed	10/02/98	17.2	3.314315	0.5	0.5
H5-TFRPPS04-0-8C02	EPA_COE	Pumpkinseed	10/02/98	15.5	4.272557	0.3	0.3
H5-TFRPPS05-0-8C02	EPA_COE	Pumpkinseed	10/02/98	15.5	3.96241	0.3	0.3
H5-TFRPPS06-0-8C02	EPA_COE	Pumpkinseed	10/02/98	15.5	3.570692	0.9	0.9
H5-TFRPPS07-0-8C02	EPA_COE	Pumpkinseed	10/02/98	17.0	1.481257	0.4	0.4
H5-TFRPPS08-0-8C02	EPA_COE	Pumpkinseed	10/02/98	15.3	2.473762	0.4	0.4
H5-TFRPPS09-0-8C02	EPA_COE	Pumpkinseed	10/02/98	16.4	5.09666	1	1
H5-TFRPPS10-0-8C02	EPA_COE	Pumpkinseed	10/02/98	14.9	0.758886	0.3	0.3

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-2

Rising Pond tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)
H5-TFRPPS11-0-8C02	EPA_COE	Pumpkinseed	10/02/98	14.4	2.423074	0.5	0.5
H5-TFRPPS12-0-8C02	EPA_COE	Pumpkinseed	10/02/98	16.4	3.913313	0.2	0.2
H5-TFRPPS13-0-8C02	EPA_COE	Pumpkinseed	10/02/98	14.5	1.826053	0.3	0.3
H5-TFRPYP01-0-8C02	EPA_COE	Yellow Perch	10/02/98	29	13.063785	0.3	0.3
H5-TFRPYP01-1-8C02	EPA_COE	Yellow Perch	10/02/98	29	13.366487	0.6	0.6
H5-TFRPYP03-0-8C02	EPA_COE	Yellow Perch	10/02/98	28	2.140278	0.8	0.8
H5-TFRPYP04-0-8C02	EPA_COE	Yellow Perch	10/02/98	26	3.154507	0.4	0.4
H5-TFRPYP05-0-8C02	EPA_COE	Yellow Perch	10/02/98	26	3.819726	0.3	0.3
H5-TFRPYP06-0-8C02	EPA_COE	Yellow Perch	10/02/98	21.0	1.557206	0.5	0.5
H5-TFRPYP07-0-8C02	EPA_COE	Yellow Perch	10/02/98	21.0	5.186589	0.8	0.8
RP-BB-01-9935	GE_BIOTA	Brown Bullhead	11/10/98	26.2	4.53	1.47	
RP-BB-02-9936	GE_BIOTA	Brown Bullhead	11/10/98	27	5.03	1.57	
RP-BB-03-9937	GE_BIOTA	Brown Bullhead	11/10/98	24	4.93	0.659	
RP-BB-04-9938	GE_BIOTA	Brown Bullhead	11/10/98	25.9	13	2.79	
RP-BB-05-9939	GE_BIOTA	Brown Bullhead	11/10/98	23.2	9.66	1.01	
RP-BB-06-9940	GE_BIOTA	Brown Bullhead	11/10/98	26	7.53	1.86	
RP-BB-07-9941	GE_BIOTA	Brown Bullhead	11/10/98	25.7	3.35	1.2	
RP-BB-08-9942	GE_BIOTA	Brown Bullhead	11/10/98	27.8	6.99	2.41	
RP-BB-09-9943	GE_BIOTA	Brown Bullhead	11/10/98	22.1	4.73	1.11	
RP-BB-10-9944	GE_BIOTA	Brown Bullhead	11/10/98	27.7	3.33	1.55	
RP-BB-11-9945	GE_BIOTA	Brown Bullhead	11/10/98	26.6	4.67	1.56	
RP-BB-12-9946	GE_BIOTA	Brown Bullhead	11/10/98	23.5	3.69	1.3	
RP-BB-13-9947	GE_BIOTA	Brown Bullhead	11/10/98	24.4	5.04	1.55	
RP-BB-14-9948	GE_BIOTA	Brown Bullhead	11/10/98	25.2	7.18	3.27	
RP-BB-15-9949	GE_BIOTA	Brown Bullhead	11/10/98	25	2.69	1.47	
RP-YP-01-9959	GE_BIOTA	Yellow Perch	11/10/98	18.6	5.6	0.607	
RP-YP-02-9960	GE_BIOTA	Yellow Perch	11/10/98	19.5	5.76	0.465	
RP-YP-03-9961	GE_BIOTA	Yellow Perch	11/10/98	19.1	6.91	1.05	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-2

Rising Pond tPCB Fillet Data Used in the Fish Risk Assessment

Field Sample ID	Source	Species	Collection Date	Fish Length (cm)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)
RP-YP-04-9962	GE_BIOTA	Yellow Perch	11/10/98	27.2	4.52	0.678	
RP-YP-05-9963	GE_BIOTA	Yellow Perch	11/10/98	27.5	8.85	0.99	
RP-YP-06-9964	GE_BIOTA	Yellow Perch	11/10/98	26.8	24.9	0.708	
RP-YP-07-9965	GE_BIOTA	Yellow Perch	11/10/98	26.6	21.5	1.65	
RP-YP-08-9966	GE_BIOTA	Yellow Perch	11/10/98	21.2	7	0.552	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Table C.3-3

West Cornwall tPCB Trout Fillet Data Used in the Fish Risk Assessment

Sample ID	Source	Collection Date	Fish Length (cm)	% Lipids	PCB, total (mg/kg)
HR98-WCWS3-3137	GE	10/1/1998	27.2	1.62	1.8
HR98-WCWS3-3138	GE	10/1/1998	29	1.52	1.3
HR98-WCWS3-3139	GE	10/1/1998	24.5	0.74	1.3
HR98-WCWS3-3141	GE	10/1/1998	26.5	1.04	1.3
HR98-WCWS3-3136	GE	10/1/1998	26	0.29	1.2
HR98-WCWS3-3144	GE	10/1/1998	27.9	0.55	1
HR98-WCWS3-3140	GE	10/1/1998	26.7	2.26	1.2
HR98-WCWS3-3143	GE	10/1/1998	25.8	2.74	2.4
HR98-WCWS3-3142	GE	10/1/1998	28.4	1.21	1.3
HR98-WCWS3-1233	GE	10/1/1998	45.2	5.29	11
HR98-WCWS3-1232	GE	10/1/1998	40.5	1.21	4.1
HR98-WCWS3-1231	GE	10/1/1998	35.5	4.47	5.1
HR98-WCWS3-1230	GE	10/1/1998	38.2	1.88	3.2
HR98-WCWS3-3145	GE	10/1/1998	29.7	2.27	1.2
HR98-WCWS2-3149	GE	8/1/1998	33.7	5.03	4.3
HR98-WCWS1-1229	GE	8/1/1998	40.7	6.77	3.1
HR98-WCWS2-3332	GE	8/1/1998	28	4.04	1.8
HR98-WCWS1-1228	GE	8/1/1998	39	2.93	2.9
HR98-WCWS2-3150	GE	8/1/1998	37.5	3.65	1.6
HR98-WCWS2-3333	GE	8/1/1998	27.3	4.63	1.4
HR98-WCWS2-1235	GE	8/1/1998	29.6	1.07	1.2
HR98-WCWS1-3331	GE	8/1/1998	25.7	1.08	1.2
HR98-WCWS1-3330	GE	8/1/1998	28.5	1.44	1.2
HR98-WCWS1-3328	GE	8/1/1998	27.8	1.92	1.5
HR98-WCWS1-3335	GE	8/1/1998	32.4	5.77	3
HR98-WCWS1-1227	GE	8/1/1998	36.5	2.44	2.9
HR98-WCWS2-3329	GE	8/1/1998	26.7	0.61	2.1
HR98-WCWS2-1234	GE	8/1/1998	24.7	1.23	2.3
HR98-WCWS2-3334	GE	8/1/1998	29.9	0.95	1.5
HR98-WCWS2-3148	GE	8/1/1998	25.7	3.67	1.2
F-2753	GE	10/24/2000	27.2	2.1	1.382641392
F-2778	GE	8/24/2000	27.9	1.7	1.850795128
F-2789	GE	8/24/2000	28.7	6.1	1.192060691

Table C.3-3

West Cornwall tPCB Trout Fillet Data Used in the Fish Risk Assessment

Sample ID	Source	Collection Date	Fish Length (cm)	% Lipids	PCB, total (mg/kg)
F-2752	GE	10/24/2000	28.8	2.2	2.110442139
F-2785	GE	8/24/2000	29.3	3.3	1.064341448
F-2754	GE	10/24/2000	29.3	3.9	1.511772099
F-2773	GE	10/24/2000	29.4	2.2	1.42172335
F-2748	GE	10/24/2000	29.5	2.6	1.468145008
F-2750	GE	10/24/2000	29.7	2.9	0.922404379
F-2772	GE	8/24/2000	29.9	0.9	1.128575482
F-2763	GE	8/24/2000	29.9	3.5	0.996572469
F-2758	GE	10/24/2000	29.9	2.5	0.890917224
F-2760	GE	10/24/2000	30.1	1.4	0.881222323
F-2762	GE	8/24/2000	30.3	4.3	1.523399971
F-2767	GE	8/24/2000	30.3	5.1	1.644912285
F-2790	GE	8/24/2000	30.5	6.6	1.027171848
F-2755	GE	8/24/2000	30.5	5.3	1.455280641
F-2747	GE	10/24/2000	30.5	2.7	0.704672381
F-2751	GE	10/24/2000	30.5	3.6	1.714457435
F-2777	GE	8/24/2000	30.7	6.0	1.759752837
F-2787	GE	8/24/2000	31.0	7.3	1.860840025
F-2775	GE	8/24/2000	31.0	4.2	1.46801889
F-2761	GE	10/24/2000	31.3	3.8	1.842100729
F-2765	GE	8/24/2000	31.4	4.4	1.524937699
F-2766	GE	8/24/2000	31.5	1.5	1.767719415
F-2749	GE	10/24/2000	31.6	1.3	0.695451118
F-2776	GE	8/24/2000	32.0	0.9	1.592836292
F-2788	GE	8/24/2000	32.2	4.4	1.224555751
F-2774	GE	10/24/2000	32.2	1.7	1.230978107
F-2786	GE	8/24/2000	32.3	4.4	1.05243145

Note: PCB, total based on congener sums.

Table C.3-4

West Cornwall/Bulls Bridge tPCB Smallmouth Bass Fillet Data Used in the Fish Risk Assessment

Sample ID	Location	Source	Collection Date	Fish Length (cm)	% Lipids	PCB, total (mg/kg)
HR98-WCWS3-1188	Cornwall	GE	10/1/1998	27.5	0.2	0.35
HR98-WCWS2-1192	Cornwall	GE	8/1/1998	31.6	0.62	1.2
HR98-WCWS2-1193	Cornwall	GE	8/1/1998	31.2	1.25	0.51
HR98-WCWS1-1194	Cornwall	GE	8/1/1998	34.2	0.67	1.3
HR98-WCWS1-1191	Cornwall	GE	8/1/1998	37.8	0.734	1.7
HR98-WCWS2-1195	Cornwall	GE	8/1/1998	38.4	1.31	0.33
HR98-WCWS2-1189	Cornwall	GE	8/1/1998	25.6	0.77	0.65
HR98-WCWS1-1190	Cornwall	GE	8/1/1998	26.6	0.91	1.9
HR98-WCWS1-1187	Cornwall	GE	8/1/1998	28.8	0.3	0.77
HR98-WCWS1-1196	Cornwall	GE	8/1/1998	31.7	0.82	0.83
F-2792	Cornwall	GE	8/24/2000	26.5	1.7	0.7302863
F-2791	Cornwall	GE	8/24/2000	28.1	1.3	1.554367642
F-2794	Cornwall	GE	8/24/2000	29.5	1.4	0.598076651
F-2795	Cornwall	GE	8/24/2000	30.6	2.3	0.62743895
F-2796	Cornwall	GE	8/24/2000	31.0	1.5	1.615574894
F-2793	Cornwall	GE	8/24/2000	31.5	0.9	0.25931881
F-2799	Cornwall	GE	8/24/2000	32.9	N/A	1.514517089
F-2797	Cornwall	GE	8/24/2000	35.0	1.2	0.568662684
F-2798	Cornwall	GE	8/24/2000	35.6	1.1	1.17389939
F-2800	Cornwall	GE	8/24/2000	38.5	1.0	1.315353669
HR98-BBBS2-1198	Bulls Bridge	GE	10/1/1998	29.1	1.59	0.87
HR98-BBBS2-1197	Bulls Bridge	GE	10/1/1998	25.4	1.41	0.36
HR98-BBBS1-1206	Bulls Bridge	GE	8/1/1998	45.7	0.93	1.3
HR98-BBBS1-1199	Bulls Bridge	GE	8/1/1998	26.5	0.94	0.98
HR98-BBBS1-1202	Bulls Bridge	GE	8/1/1998	29.3	2.2	0.65
HR98-BBBS1-1201	Bulls Bridge	GE	8/1/1998	26.7	0.16	1.5
HR98-BBBS1-1204	Bulls Bridge	GE	8/1/1998	28.3	3.85	0.78
HR98-BBBS1-1200	Bulls Bridge	GE	8/1/1998	27.9	0.3	0.56
HR98-BBBS1-1203	Bulls Bridge	GE	8/1/1998	27.4	1.86	1.3
HR98-BBBS1-1205	Bulls Bridge	GE	8/1/1998	32.2	2.03	1.1
F-2816	Bulls Bridge	GE	8/17/2000	25.8	1.4	0.748684089
F-2817	Bulls Bridge	GE	8/17/2000	26.5	1.4	0.65444113
F-2818	Bulls Bridge	GE	8/17/2000	26.9	1.4	0.739365066

Table C.3-4

West Cornwall/Bulls Bridge tPCB Smallmouth Bass Fillet Data Used in the Fish Risk Assessment

Sample ID	Location	Source	Collection Date	Fish Length (cm)	% Lipids	PCB, total (mg/kg)
F-2813	Bulls Bridge	GE	10/24/2000	27.0	2.4	1.416256028
F-2821	Bulls Bridge	GE	8/17/2000	32.0	1.9	0.596289848
F-2814	Bulls Bridge	GE	10/25/2000	33.8	2.2	1.990749703
F-2820	Bulls Bridge	GE	10/24/2000	35.1	2.1	0.792203326
F-2815	Bulls Bridge	GE	10/25/2000	35.9	2.6	1.05108883
F-2822	Bulls Bridge	GE	8/17/2000	36.8	1.9	1.04546805
F-2819	Bulls Bridge	GE	8/17/2000	38.9	1.8	0.770803906

Note: PCB, total based on congener sums.

Table C.3-5

Lake Lillinonah/Lake Zoar tPCB Smallmouth Bass Fillet Data Used in the Fish Risk Assessment

Sample ID	Location	Source	Collection Date	Fish Length (cm)	% Lipids	PCB, total (mg/kg)
HR98-LLBS2-1216	Lake Lillinonah	GE	10/1/1998	31.2	0.64	0.67
HR98-LLBS2-1214	Lake Lillinonah	GE	10/1/1998	32.9	0.65	0.93
HR98-LLBS2-1212	Lake Lillinonah	GE	10/1/1998	26.3	0.67	0.25
HR98-LLBS1-1209	Lake Lillinonah	GE	8/1/1998	28.2	1.32	0.97
HR98-LLBS1-1208	Lake Lillinonah	GE	8/1/1998	28.7	0.37	0.8
HR98-LLBS1-1213	Lake Lillinonah	GE	8/1/1998	28.2	0.6	0.61
HR98-LLBS1-1210	Lake Lillinonah	GE	8/1/1998	34.6	1.37	0.93
HR98-LLBS1-1211	Lake Lillinonah	GE	8/1/1998	36.4	1.02	0.98
HR98-LLBS1-1215	Lake Lillinonah	GE	8/1/1998	31.5	3.88	1.3
HR98-LLBS1-1207	Lake Lillinonah	GE	8/1/1998	30.4	1.93	0.91
F-2823	Lake Lillinonah	GE	8/14/2000	27.3	0.7	0.354958046
F-2801	Lake Lillinonah	GE	8/14/2000	28.4	1.1	0.409155996
F-2802	Lake Lillinonah	GE	8/14/2000	31.5	1.3	0.418840646
F-2803	Lake Lillinonah	GE	8/14/2000	32.6	1.4	0.360520783
F-2805	Lake Lillinonah	GE	8/14/2000	33.5	1.2	0.330326693
F-2806	Lake Lillinonah	GE	8/14/2000	34.4	2.1	0.386400554
F-2804	Lake Lillinonah	GE	8/14/2000	34.7	1.1	0.22505558
F-2825	Lake Lillinonah	GE	8/14/2000	36.4	1.9	0.718028946
F-2807	Lake Lillinonah	GE	8/14/2000	36.6	2.4	0.706315808
F-2808	Lake Lillinonah	GE	8/14/2000	42.0	3.5	1.173117408
HR98-LZBS2-1224	Lake Zoar	GE	10/1/1998	27.6	0.58	1.3
HR98-LZBS2-1222	Lake Zoar	GE	10/1/1998	34	1.53	0.79
HR98-UZBS1-1226	Lake Zoar	GE	8/1/1998	52	3.69	2.9
HR98-LZBS1-1223	Lake Zoar	GE	8/1/1998	26.1	0.43	0.36
HR98-UZBS1-1225	Lake Zoar	GE	8/1/1998	27.4	0.78	0.58
HR98-LZBS1-1221	Lake Zoar	GE	8/1/1998	36.6	0.95	0.64
HR98-LZBS1-1220	Lake Zoar	GE	8/1/1998	28.8	0.89	0.47
HR98-LZBS1-1219	Lake Zoar	GE	8/1/1998	27.5	2.14	0.83
HR98-LZBS1-1217	Lake Zoar	GE	8/1/1998	27.6	0.84	0.71
HR98-LZBS1-1218	Lake Zoar	GE	8/1/1998	26.6	0.34	0.23
F-2809	Lake Zoar	GE	8/15/2000	26.3	1.1	0.19394632
F-2829	Lake Zoar	GE	8/15/2000	26.8	1.0	0.153401683
F-2826	Lake Zoar	GE	10/26/2000	27.0	1.1	0.216409813

Table C.3-5

Lake Lillinonah/Lake Zoar tPCB Smallmouth Bass Fillet Data Used in the Fish Risk Assessment

Sample ID	Location	Source	Collection Date	Fish Length (cm)	% Lipids	PCB, total (mg/kg)
F-2827	Lake Zoar	GE	10/26/2000	27.4	0.8	0.222988966
F-2824	Lake Zoar	GE	8/15/2000	28.8	0.9	0.236818021
F-2810	Lake Zoar	GE	8/15/2000	28.8	1.4	0.112047263
F-2828	Lake Zoar	GE	10/26/2000	30.1	1.1	0.431721284
F-2811	Lake Zoar	GE	8/15/2000	30.4	1.7	0.517705041
F-2812	Lake Zoar	GE	8/15/2000	32.6	1.7	0.347854261
F-2830	Lake Zoar	GE	8/15/2000	43.6	1.5	0.73530334

Note: PCB, total based on congener sums.

Table C.3-6

Reaches 5 and 6 tPCB Breast Data Used in the Waterfowl Risk Assessment

Field Sample ID		Species	Collection Date	Sample Weight (g)	PCB, Total (mg/kg)	Percent Lipids (GC)	Percent Lipids (GC/MS)
082998SB02	H3	Wood Duck	08/29/98	81.3	4.747847	2.4	6.6
082998SB05	H3	Wood Duck	08/29/98	20.3	7.125841	0.9	3.9
082998SB08	H3	Wood Duck	08/29/98	46.5	6.49403	0.7	1.5
082998SB11	H3	Wood Duck	08/29/98	91.1	4.86226	2.4	7
082998SB14	H3	Wood Duck	08/29/98	57.1	6.838475	0.6	2.2
082998SB17	H3	Wood Duck	08/29/98	97.2	11.68524	2.3	5.1
082998SB20	H3	Wood Duck	08/29/98	62.1	5.097102	1.1	4
082998SB23	H3	Wood Duck	08/29/98	45.3	10.26267	2.1	7.4
082998SB25	H3	Wood Duck	08/29/98	47.3	12.199184	2.6	8.9
082998SB27	H4	Wood Duck	08/29/98	35.1	3.306973	0.2	1
082998SB30	H4	Wood Duck	08/29/98	33.1	4.625461	0.2	1.2
082998SB33	H4	Wood Duck	08/29/98	28.3	7.402329	0.2	0.8
082998SB37	H4	Mallard	08/29/98	189.1	11.204734	2.1	5.1
082998SB40	H3	Mallard	08/29/98	99.4	1.593342	0.5	1.9
082998SB43	H3	Mallard	08/29/98	47.5	7.804711	1.4	2.1
082998SB46	H3	Mallard	08/29/98	45.5	5.570359	0.4	1.7
091198SB64	H4	Wood Duck	09/11/98	63.6	2.672672	3.7	11.9
091198SB65	H4	Wood Duck	09/11/98	62.2	3.910445	7.1	11.7
091598SB16	H4	Wood Duck	09/15/98	64.5	7.551391	6.5	17.6
091598SB02	H4	Wood Duck	09/15/98	136.5	6.00491	5.2	9.1
091598SB05	H4	Wood Duck	09/15/98	113.6	17.854407	7.3	14.1
091598SB08	H4	Wood Duck	09/15/98	125.1	3.251182	9.4	26
091598SB11	H4	Wood Duck	09/15/98	129.4	5.889291	13.2	24.2
091598SB14	H4	Wood Duck	09/15/98	65.1	9.817624	6.5	19.2
091598SB18	H4	Wood Duck	09/15/98	118.7	8.737407	9	29.8
091598SB21	H4	Wood Duck	09/15/98	127.1	3.711664	16.5	28.9
091598SB24	H4	Wood Duck	09/15/98	120.5	1.059623	2.2	5.9
091698SB02	H4	Mallard	09/16/98	198.1	19.340147	5.6	8.1

082898SB23 = duplicate of 082898SB25
091198SB64 = duplicate of 091198SB65
091598SB14 = duplicate of 091598SB16

Table C.3-7

SIM GC/MS and GC/ECD Analyses - Pesticide Results

FIELD SAMPLE ID	LOCATION ID	CAPTION	SIM GC/MS Method	Data Flag	GC/ECD Method	Data Flag
H3-TO03YP01-0-8C02	TO03YP01	4,4'-DDD	107.38		151.56	
H3-TO10LB16-0-8S30	TO10LB16	4,4'-DDD	95.05		192.44	J
H3-TW08GF01-0-8S30	TW08GF01	4,4'-DDD	127.26	J	1644.57	
H3-TW10WS02-0-0G23	TW10WS02	4,4'-DDD	100.38		107.43	
H3-TW11GF04-0-8S30	TW11GF04	4,4'-DDD	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	4,4'-DDD	2.00	U	77.94	
H4-TOWPYP22-0-8C01	TOWPYP22	4,4'-DDD	31.60		55.84	
H4-TWWPGF12-0-8C01	TWWPGF12	4,4'-DDD	25.49		241.17	
H4-TWWPGF16-0-8C01	TWWPGF16	4,4'-DDD	1.86	U	386.14	
H4-TWWPGF18-0-8C01	TWWPGF18	4,4'-DDD	2.72		276.51	
H3-TO03YP01-0-8C02	TO03YP01	4,4'-DDE	166.71		274.98	
H3-TO10LB16-0-8S30	TO10LB16	4,4'-DDE	253.77		701.36	J
H3-TW08GF01-0-8S30	TW08GF01	4,4'-DDE	67.31		647.44	
H3-TW10WS02-0-0G23	TW10WS02	4,4'-DDE	201.50		309.13	
H3-TW11GF04-0-8S30	TW11GF04	4,4'-DDE	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	4,4'-DDE	218.65		556.98	
H4-TOWPYP22-0-8C01	TOWPYP22	4,4'-DDE	141.00		484.84	
H4-TWWPGF12-0-8C01	TWWPGF12	4,4'-DDE	1.95	U	810.38	
H4-TWWPGF16-0-8C01	TWWPGF16	4,4'-DDE	1.86	U	1203.08	
H4-TWWPGF18-0-8C01	TWWPGF18	4,4'-DDE	46.77		998.98	
H3-TO03YP01-0-8C02	TO03YP01	4,4'-DDT	1.98	U	62.43	
H3-TO10LB16-0-8S30	TO10LB16	4,4'-DDT	0.08	J	1.96	UJ
H3-TW08GF01-0-8S30	TW08GF01	4,4'-DDT	0.87	J	1.91	U
H3-TW10WS02-0-0G23	TW10WS02	4,4'-DDT	0.93	J	26.87	
H3-TW11GF04-0-8S30	TW11GF04	4,4'-DDT	0.43	J	0.43	J
H4-TOWPLB11-0-8C01	TOWPLB11	4,4'-DDT	2.00	U	59.95	
H4-TOWPYP22-0-8C01	TOWPYP22	4,4'-DDT	0.41	J	1.95	U
H4-TWWPGF12-0-8C01	TWWPGF12	4,4'-DDT	0.57	J	1.95	U
H4-TWWPGF16-0-8C01	TWWPGF16	4,4'-DDT	1.86	U	1.87	U
H4-TWWPGF18-0-8C01	TWWPGF18	4,4'-DDT	3.73		1.98	U
H3-TO03YP01-0-8C02	TO03YP01	CIS-NONACHLOR	4.79		1.98	U
H3-TO10LB16-0-8S30	TO10LB16	CIS-NONACHLOR	5.31	J	551.47	J
H3-TW08GF01-0-8S30	TW08GF01	CIS-NONACHLOR	7.14		1160.22	
H3-TW10WS02-0-0G23	TW10WS02	CIS-NONACHLOR	6.17	J	321.32	
H3-TW11GF04-0-8S30	TW11GF04	CIS-NONACHLOR	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	CIS-NONACHLOR	3.92	J	338.78	
H4-TOWPYP22-0-8C01	TOWPYP22	CIS-NONACHLOR	2.47		388.02	

Table C.3-7

SIM GC/MS and GC/ECD Analyses - Pesticide Results

FIELD SAMPLE ID	LOCATION ID	CAPTION	SIM GC/MS Method	Data Flag	GC/ECD Method	Data Flag
H4-TWWPGF12-0-8C01	TWWPGF12	CIS-NONACHLOR	1.57	J	437.46	
H4-TWWPGF16-0-8C01	TWWPGF16	CIS-NONACHLOR	0.81	J	639.06	
H4-TWWPGF18-0-8C01	TWWPGF18	CIS-NONACHLOR	0.73	J	519.21	
H3-TO03YP01-0-8C02	TO03YP01	DIELDRIN	1.98	U	14.98	
H3-TO10LB16-0-8S30	TO10LB16	DIELDRIN	1.96	U	3.89	J
H3-TW08GF01-0-8S30	TW08GF01	DIELDRIN	1.91	U	1.91	U
H3-TW10WS02-0-0G23	TW10WS02	DIELDRIN	1.86	U	35.30	
H3-TW11GF04-0-8S30	TW11GF04	DIELDRIN	1.74	J	1.74	J
H4-TOWPLB11-0-8C01	TOWPLB11	DIELDRIN	36.81	J	17.01	
H4-TOWPYP22-0-8C01	TOWPYP22	DIELDRIN	4.12	J	13.89	
H4-TWWPGF12-0-8C01	TWWPGF12	DIELDRIN	1.95	U	213.22	
H4-TWWPGF16-0-8C01	TWWPGF16	DIELDRIN	1.86	U	335.17	
H4-TWWPGF18-0-8C01	TWWPGF18	DIELDRIN	1.99	U	247.35	
H3-TO03YP01-0-8C02	TO03YP01	HEPTACHLOR EPOXIDE	1.98	U	20.70	
H3-TO10LB16-0-8S30	TO10LB16	HEPTACHLOR EPOXIDE	1.96	U	1.96	UJ
H3-TW08GF01-0-8S30	TW08GF01	HEPTACHLOR EPOXIDE	1.91	U	1.91	U
H3-TW10WS02-0-0G23	TW10WS02	HEPTACHLOR EPOXIDE	1.86	U	7.04	
H3-TW11GF04-0-8S30	TW11GF04	HEPTACHLOR EPOXIDE	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	HEPTACHLOR EPOXIDE	2.00	U	2.00	U
H4-TOWPYP22-0-8C01	TOWPYP22	HEPTACHLOR EPOXIDE	1.95	U	1.95	U
H4-TWWPGF12-0-8C01	TWWPGF12	HEPTACHLOR EPOXIDE	1.95	U	23.00	
H4-TWWPGF16-0-8C01	TWWPGF16	HEPTACHLOR EPOXIDE	1.86	U	1.87	U
H4-TWWPGF18-0-8C01	TWWPGF18	HEPTACHLOR EPOXIDE	1.99	U	16.99	
H3-TO03YP01-0-8C02	TO03YP01	O,P'-DDD	8.04	J	499.95	
H3-TO10LB16-0-8S30	TO10LB16	O,P'-DDD	1.96	U	673.74	J
H3-TW08GF01-0-8S30	TW08GF01	O,P'-DDD	1.91	U	1094.71	
H3-TW10WS02-0-0G23	TW10WS02	O,P'-DDD	21.87		735.57	
H3-TW11GF04-0-8S30	TW11GF04	O,P'-DDD	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	O,P'-DDD	2.00	U	772.05	
H4-TOWPYP22-0-8C01	TOWPYP22	O,P'-DDD	1.95	U	633.38	
H4-TWWPGF12-0-8C01	TWWPGF12	O,P'-DDD	1.95	U	568.19	
H4-TWWPGF16-0-8C01	TWWPGF16	O,P'-DDD	1.86	U	825.73	
H4-TWWPGF18-0-8C01	TWWPGF18	O,P'-DDD	0.90	J	589.19	
H3-TO03YP01-0-8C02	TO03YP01	O,P'-DDE	1.98	U	1.98	U
H3-TO10LB16-0-8S30	TO10LB16	O,P'-DDE	1.96	U	1.96	UJ
H3-TW08GF01-0-8S30	TW08GF01	O,P'-DDE	1.91	U	1.91	U
H3-TW10WS02-0-0G23	TW10WS02	O,P'-DDE	0.75	J	32.31	

Table C.3-7

SIM GC/MS and GC/ECD Analyses -
Pesticide Results

FIELD SAMPLE ID	LOCATION ID	CAPTION	SIM GC/MS Method	Data Flag	GC/ECD Method	Data Flag
H3-TW11GF04-0-8S30	TW11GF04	O,P'-DDE	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	O,P'-DDE	0.91	J	18.61	
H4-TOWPYP22-0-8C01	TOWPYP22	O,P'-DDE	1.95	U	1.95	U
H4-TWWPGF12-0-8C01	TWWPGF12	O,P'-DDE	1.95	U	52.84	
H4-TWWPGF16-0-8C01	TWWPGF16	O,P'-DDE	1.86	U	64.36	
H4-TWWPGF18-0-8C01	TWWPGF18	O,P'-DDE	1.99	U	51.48	
H3-TO03YP01-0-8C02	TO03YP01	O,P'-DDT	0.17	J	942.20	
H3-TO10LB16-0-8S30	TO10LB16	O,P'-DDT	0.16	J	159.06	J
H3-TW08GF01-0-8S30	TW08GF01	O,P'-DDT	50.86		1193.32	
H3-TW10WS02-0-0G23	TW10WS02	O,P'-DDT	1.31	J	440.67	
H3-TW11GF04-0-8S30	TW11GF04	O,P'-DDT	0.18	J	0.18	J
H4-TOWPLB11-0-8C01	TOWPLB11	O,P'-DDT	0.26	J	1176.45	
H4-TOWPYP22-0-8C01	TOWPYP22	O,P'-DDT	0.21	J	813.91	
H4-TWWPGF12-0-8C01	TWWPGF12	O,P'-DDT	1.01	J	893.75	
H4-TWWPGF16-0-8C01	TWWPGF16	O,P'-DDT	0.34	J	1210.83	
H4-TWWPGF18-0-8C01	TWWPGF18	O,P'-DDT	1.22	J	1188.02	
H3-TO03YP01-0-8C02	TO03YP01	OXYCHLORDANE	1.71	J	1.98	U
H3-TO10LB16-0-8S30	TO10LB16	OXYCHLORDANE	1.96	U	36.81	J
H3-TW08GF01-0-8S30	TW08GF01	OXYCHLORDANE	1.91	U	56.08	
H3-TW10WS02-0-0G23	TW10WS02	OXYCHLORDANE	1.86	U	30.96	
H3-TW11GF04-0-8S30	TW11GF04	OXYCHLORDANE	1.90	U	1.90	U
H4-TOWPLB11-0-8C01	TOWPLB11	OXYCHLORDANE	5.35	J	29.22	
H4-TOWPYP22-0-8C01	TOWPYP22	OXYCHLORDANE	13.48		33.52	
H4-TWWPGF12-0-8C01	TWWPGF12	OXYCHLORDANE	1.95	U	1.95	U
H4-TWWPGF16-0-8C01	TWWPGF16	OXYCHLORDANE	1.86	U	1.87	U
H4-TWWPGF18-0-8C01	TWWPGF18	OXYCHLORDANE	3.24		1.98	U
H3-TO03YP01-0-8C02	TO03YP01	TRANS-NONACHLOR	1.98	U	18.34	
H3-TO10LB16-0-8S30	TO10LB16	TRANS-NONACHLOR	17.74	J	20.76	J
H3-TW08GF01-0-8S30	TW08GF01	TRANS-NONACHLOR	18.18	J	1.91	U
H3-TW10WS02-0-0G23	TW10WS02	TRANS-NONACHLOR	15.51	J	21.21	
H3-TW11GF04-0-8S30	TW11GF04	TRANS-NONACHLOR	0.75	J	0.75	J
H4-TOWPLB11-0-8C01	TOWPLB11	TRANS-NONACHLOR	11.36	J	16.06	
H4-TOWPYP22-0-8C01	TOWPYP22	TRANS-NONACHLOR	5.76	J	7.99	
H4-TWWPGF12-0-8C01	TWWPGF12	TRANS-NONACHLOR	1.95	U	63.68	
H4-TWWPGF16-0-8C01	TWWPGF16	TRANS-NONACHLOR	1.86	U	125.68	
H4-TWWPGF18-0-8C01	TWWPGF18	TRANS-NONACHLOR	1.31	J	56.83	

SUMMARY DATA TABLES

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03BB01-0-8C20	H3-TF03LB01-0-8C20	H3-TF03LB01-1-8C20	H3-TF03LB03-0-8C20	H3-TF07LB01-0-8S29	H3-TF07LB02-0-8S29	H3-TF07LB05-0-8S29
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	10/20/98	10/20/98	10/20/98	10/20/98	09/30/98	09/30/98	09/30/98
Fish Length (cm)	25	31	31	37	40.0	35.0	35.0
PCBs							
PCB, Total	2.05928	1.33127	1.02025	2.95838	5.64359	22.01959	6.38453
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,4,6,7,8-HPCDF	0.0000046 U	0.0000041 U	0.0000046 U	0.0000014 J			0.00002
1,2,3,4,7,8,9-HPCDF	0.0000046 U	0.0000041 U	0.0000046 U	0.000001 J			0.0000049 U
1,2,3,4,7,8-HXCDD	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,4,7,8-HXCDF	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,6,7,8-HXCDD	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,6,7,8-HXCDF	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,7,8,9-HXCDD	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,7,8,9-HXCDF	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,7,8-PECDD	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
1,2,3,7,8-PECDF	0.0000045 J	0.000009	0.00001	0.0000035 J			0.00002
2,3,4,6,7,8-HXCDF	0.0000046 U	0.0000041 U	0.0000046 U	0.000005 U			0.0000049 U
2,3,4,7,8-PECDF	0.0000068	0.0000015 J	0.0000016 J	0.0000019 J			0.0000066
2,3,7,8-TCDD	0.0000009 U	0.0000008 U	0.0000009 U	0.000001 U			0.000001 U
2,3,7,8-TCDF	0.000003	0.0000024	0.0000027	0.0000034			0.0000099
OCDD	0.0000092 U	0.0000081 U	0.0000092 U	0.00001 U			0.0000099 U
OCDF	0.0000092 U	0.0000081 U	0.0000092 U	0.00001			0.0000099 U
Dioxin-Like PCB Congeners							
PCB-105	0.00576	0.00555	0.00587	0.0357	0.01946 J	0.07808	0.07021 J
PCB-114	0.0002 U	0.0002 U	0.0002 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U
PCB-118	0.03018	0.01952	0.01467	0.06464	0.09073	0.30214	0.09181
PCB-126	0.00231	0.00107	0.00118	0.00028	0.00039	0.00156	0.00059
PCB-149/123	0.10537	0.06622	0.05005	0.13969	0.27261	1.05089	0.39209
PCB-156	0.0087	0.00608	0.00525	0.00444	0.03206	0.20538	0.00019 U
PCB-167	0.0049	0.00349	0.00261	0.01218	0.02289	0.10914	0.02742
PCB-169	0.00002 J	0.00001 J	0.00003 J	0.00007 J	0.0001	0.00011	0.00007
PCB-189	0.00175	0.00116	0.00088	0.00276	0.00757	0.02715	0.00731
PCB-201/157/173	0.00427	0.00353	0.00291	0.00525	0.01363	0.08765	0.011
PCB-77	0.0063	0.00254	0.00232	0.00034	0.00043	0.00184	0.00215
PCB-81	0.00219	0.00077	0.00081	0.00002 J	0.00001 J	0.00033	0.00019 U
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00593	0.00432 J	0.00339	0.00598	0.02203	0.02499	0.01252
1,2,4,5-Tetrachlorobenzene	0.00129 J	0.00038 J	0.00025 J	0.00205 U	0.00548	0.0043	0.00375
4,4'-DDD	0.00146 J	0.00046 J	0.0003 J	0.01116	0.0034	0.00874	0.01746
4,4'-DDE	0.00199 U	0.00198 UJ	0.00197 U	0.01573	0.00751	0.01157	0.00899
4,4'-DDT	0.00199 U	0.00198 UJ	0.00197 U	0.00162 J	0.00191 U	0.00195 U	0.00193 U
Aldrin	0.00199 U	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
alpha-BHC	0.00005 J	0.00008 J	0.00197 U	0.00027 J	0.00191 U	0.00195 U	0.00193 U
alpha-Chlordane	0.00199 U	0.00198 UJ	0.00197 U	0.00129 J	0.00191 U	0.00195 U	0.00193 U
beta-BHC	0.00199 U	0.00198 UJ	0.00197 U	0.00001 J	0.00191 U	0.00195 U	0.00193 U
Chlorpyrifos	0.00199 U	0.00003 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00004 J
cis-Nonachlor	0.00467	0.0026 J	0.00198	0.0019 U	0.00903	0.04041	0.00193 U
delta-BHC	0.00199 U	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
Dieldrin	0.00014 J	0.00198 UJ	0.00197 U	0.00248	0.00191 U	0.00092 J	0.00037 J
Endosulfan II	0.00199 U	0.00198 UJ	0.00197 U	0.00481	0.00191 U	0.00195 U	0.0095
Endrin	0.00199 U	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
gamma-BHC (Lindane)	0.00199 U	0.00001 J	0.00197 U	0.0019 U	0.00018 J	0.00009 U	0.00007 J
gamma-Chlordane	0.00008 J	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
Heptachlor	0.00199 U	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
Heptachlor epoxide	0.00199 U	0.00198 UJ	0.00197 U	0.00069 J	0.00191 U	0.00195 U	0.00193 U
Hexachlorobenzene	0.0002 J	0.0002 J	0.0001 J	0.00041 J	0.00056 J	0.00081 J	0.00038 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03BB01-0-8C20	H3-TF03LB01-0-8C20	H3-TF03LB01-1-8C20	H3-TF03LB03-0-8C20	H3-TF07LB01-0-8S29	H3-TF07LB02-0-8S29	H3-TF07LB05-0-8S29
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	10/20/98	10/20/98	10/20/98	10/20/98	09/30/98	09/30/98	09/30/98
Fish Length (cm)	25	31	31	37	40.0	35.0	35.0
Mirex	0.00199 U	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
o,p'-DDD	0.00478	0.00391 J	0.003	0.01226	0.02105	0.06767	0.01992
o,p'-DDE	0.00199 U	0.00198 UJ	0.00197 U	0.0019 U	0.00191 U	0.00195 U	0.00193 U
o,p'-DDT	0.00493	0.00365 J	0.00281	0.009	0.02495	0.06186	0.02229
Oxychlordane	0.00016 J	0.0001 J	0.00006 J	0.0019 U	0.001 J	0.00195 U	0.00193 U
Pentachloroanisole	0.00005 J	0.00004 UJ	0.00001 U	0.00007 U	0.00011 J	0.0001 J	0.00014 U
Pentachlorobenzene	0.00295	0.00179 J	0.00136 J	0.00183 J	0.00775	0.01063	0.00454
Toxaphene	0.01994 U	0.01978 U	0.01972 U	0.01898 U	0.01914 U	0.01947 U	0.01927 U
trans-Nonachlor	0.00023 J	0.00198 UJ	0.00197 U	0.00105 J	0.00032 J	0.00164 J	0.00069 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.08	0.03	0.04	0.2	0.9	1	0.2
Percent Lipids (GC/MS)	0.08	0.03	0.04	0.18			0.2
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF08LB08-0-8S30	H3-TF08LB09-0-8S30	H3-TF09BB01-0-8S30	H3-TF09LB11-0-8S30	H3-TF09LB12-0-8S30	H3-TF09LB15-0-8S30	H3-TF10BB02-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Brown Bullhead	Largemouth Bass	Largemouth Bass	Largemouth Bass	Brown Bullhead
Collection Date	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98
Fish Length (cm)	46.0	33.0	26	38	39.5	33	26
PCBs							
PCB, Total	8.55072	13.33649	10.26643	25.26079	151.09842	15.83615	12.78059
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.0000037 UJ		0.000004 UJ
1,2,3,4,6,7,8-HPCDF	0.0000033 U	0.0000033 U	0.0000031 J	0.0000042 J	0.00001 J		0.00001 J
1,2,3,4,7,8,9-HPCDF	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.000001 J		0.000004 UJ
1,2,3,4,7,8-HXCDD	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.0000037 UJ		0.000004 UJ
1,2,3,4,7,8-HXCDF	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.0000021 J		0.000004 UJ
1,2,3,6,7,8-HXCDD	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.0000037 UJ		0.000004 UJ
1,2,3,6,7,8-HXCDF	0.0000033 U	0.0000033 U	0.0000006 J	0.0000004 J	0.0000029 J		0.000004 UJ
1,2,3,7,8,9-HXCDD	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.0000037 UJ		0.000004 UJ
1,2,3,7,8,9-HXCDF	0.0000033 U	0.0000033 U	0.0000039 UJ	0.0000037 UJ	0.0000037 UJ		0.000004 UJ
1,2,3,7,8-PECDD	0.0000033 U	0.0000033 U	0.0000006 J	0.0000037 UJ	0.0000037 UJ		0.000004 UJ
1,2,3,7,8-PECDF	0.0000033 J	0.0000035	0.00004 J	0.00005 J	0.00017 J		0.00018 J
2,3,4,6,7,8-HXCDF	0.0000033 U	0.0000033 U	0.0000007 J	0.0000037 UJ	0.0000037 J		0.000004 UJ
2,3,4,7,8-PECDF	0.0000033 U	0.0000041	0.00001 J	0.0000086 J	0.00003 J		0.00003 J
2,3,7,8-TCDD	0.0000007 U	0.0000007 U	0.000001 J	0.0000007 UJ	0.0000023 J		0.0000008 UJ
2,3,7,8-TCDF	0.0000053	0.0000072	0.0000033 J	0.0000092 J	0.00002 J		0.00002 UJ
OCDD	0.0000066 U	0.0000067 U	0.0000006 J	0.0000075 UJ	0.0000034 J		0.0000011 J
OCDF	0.0000066 U	0.0000067 U	0.0000078 UJ	0.0000075 UJ	0.0000018 J		0.0000079 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.02763	0.0302	0.14655	0.19233	1.26764 J	0.06706 J	0.06911
PCB-114	0.0002 U	0.00019 U	0.00002 U	0.00001 U	0.00001 UJ	0.00002 UJ	0.00003 U
PCB-118	0.08461	0.21634	0.10919	0.2851	1.16337 J	0.16207 J	0.28191
PCB-126	0.00104	0.00189	0.00083	0.00103	0.00408 J	0.00048 J	0.00324
PCB-149/123	0.60554 J	0.9291 J	0.50001	1.00451	9.0001 J	0.86128 J	0.46769
PCB-156	0.05156	0.03502	0.04755	0.13678	0.28771 J	0.07623 J	0.01579
PCB-167	0.03052	0.05642	0.03107	0.11178	0.47161 J	0.05599 J	0.02203
PCB-169	0.00012 J	0.00016 J	0.00013	0.00017	0.00077 J	0.00003 J	0.00041
PCB-189	0.01016	0.01598	0.01009	0.03511	0.24279 J	0.02235 J	0.00577
PCB-201/157/173	0.02265	0.03548	0.01961	0.04328	0.40562 J	0.05325 J	0.01566
PCB-77	0.00085	0.00226	0.00057	0.00117	0.00404 J	0.00079 J	0.00187
PCB-81	0.0002 U	0.0002 J	0.00024	0.00038	0.00047 J	0.00016 J	0.00021
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01301	0.02107	0.03109	0.05207	0.38795 J	0.03517 J	0.01556
1,2,4,5-Tetrachlorobenzene	0.00413	0.00658	0.01727	0.01679	0.08871 J	0.0082 J	0.00308 J
4,4'-DDD	0.00327	0.00676	0.01135	0.01734	0.08588 J	0.00564 J	0.00744
4,4'-DDE	0.01041	0.02276	0.02143	0.03285	0.24603 J	0.00483 J	0.02684
4,4'-DDT	0.00037 J	0.00068 J	0.00041 J	0.00191 J	0.00194 UJ	0.00059 J	0.00316 U
Aldrin	0.00195 U	0.00188 U	0.00199 U	0.00194 U	0.00194 UJ	0.00197 UJ	0.00316 U
alpha-BHC	0.00195 U	0.00188 U	0.00199 U	0.00034 J	0.00194 UJ	0.00016 J	0.00316 U
alpha-Chlordane	0.00195 U	0.00188 U	0.00199 U	0.00194 U	0.00194 UJ	0.00197 UJ	0.00316 U
beta-BHC	0.00007 J	0.0001 J	0.00199 U	0.00194 U	0.0006 J	0.00004 J	0.00037 J
Chlorpyrifos	0.00009 J	0.00017 J	0.00108 J	0.0009 J	0.00185 J	0.00008 J	0.00316 U
cis-Nonachlor	0.01216	0.02022	0.01954	0.03214	0.33126 J	0.03191 J	0.02649
delta-BHC	0.00195 U	0.00188 U	0.00199 U	0.00482	0.00194 UJ	0.00197 UJ	0.00255 J
Dieldrin	0.0004 J	0.00072 J	0.00787	0.01968	0.00646 J	0.00051 J	0.00083 J
Endosulfan II	0.00269	0.00448	0.00342	0.01747	0.02828 J	0.00886 J	0.00756
Endrin	0.00195 U	0.00188 U	0.00199 U	0.00194 U	0.00194 UJ	0.00197 UJ	0.00316 U
gamma-BHC (Lindane)	0.00015 J	0.00025 J	0.00039 J	0.00061 J	0.0018 J	0.00015 J	0.00023 J
gamma-Chlordane	0.00195 U	0.00023 J	0.00137 J	0.00042 J	0.00271 J	0.00033 J	0.00316 U
Heptachlor	0.00195 U	0.00188 U	0.0003 J	0.00023 J	0.00194 UJ	0.00197 UJ	0.00316 U
Heptachlor epoxide	0.00195 U	0.00188 U	0.00139 J	0.00194 U	0.00194 UJ	0.00197 UJ	0.00316 U
Hexachlorobenzene	0.0006 J	0.00106 J	0.00117 J	0.00376	0.00711 J	0.00201 J	0.00316 U

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF08LB08-0-8S30	H3-TF08LB09-0-8S30	H3-TF09BB01-0-8S30	H3-TF09LB11-0-8S30	H3-TF09LB12-0-8S30	H3-TF09LB15-0-8S30	H3-TF10BB02-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Brown Bullhead	Largemouth Bass	Largemouth Bass	Largemouth Bass	Brown Bullhead
Collection Date	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98
Fish Length (cm)	46.0	33.0	26	38	39.5	33	26
Mirex	0.00195 U	0.00188 U	0.00199 U	0.00194 U	0.00194 UJ	0.00197 UJ	0.00316 U
o,p'-DDD	0.02397	0.04427	0.02576	0.061	0.2886 J	0.0084 J	0.03908
o,p'-DDE	0.00195 U	0.00188 U	0.00166 J	0.00096 J	0.00194 UJ	0.00197 UJ	0.00316 U
o,p'-DDT	0.02527	0.04794	0.02386	0.05583	0.08229 J	0.03133 J	0.04139
Oxychlordane	0.0016 J	0.00243	0.00199 U	0.00082 J	0.0135 J	0.00145 J	0.00284 J
Pentachloroanisole	0.00013 U	0.00021 J	0.0007 J	0.0011 J	0.00212 J	0.00017 J	0.00098 J
Pentachlorobenzene	0.00656	0.01034	0.01115	0.01927	0.19906 J	0.02822 J	0.00372
Toxaphene	0.01954 U	0.01878 U	0.0199 U	0.0195 U	0.0195 UJ	0.0198 UJ	0.0316 U
trans-Nonachlor	0.00083 J	0.00161 J	0.00234	0.0034	0.01078 J	0.00088 J	0.00023 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.4	0.8	2	2	7.6 J	4.3 J	3.9
Percent Lipids (GC/MS)	0.4	0.8	2 J	2 J	7.6 J		3.9 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF10BB03-0-8S30	H3-TF10LB16-0-8S30	H3-TF10LB17-0-8S30	H3-TF10LB17-1-8S30	H3-TF10LB19-0-8S30	H3-TF11BB01-0-8C19	H3-TF11BB02-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Brown Bullhead	Brown Bullhead
Collection Date	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98	10/20/98	10/20/98
Fish Length (cm)	20	42.5	37	37	31	30.4	33.4
PCBs							
PCB, Total	6.75996	39.3466	7.54906	15.97553	3.09625	1.22943	2.74634
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,4,6,7,8-HPCDF	0.0000047 J	0.0000068 J	0.0000035 UJ	0.0000029 J	0.0000013 J	0.0000018 J	0.0000042 J
1,2,3,4,7,8,9-HPCDF	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000004 J	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,4,7,8-HXCDD	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,4,7,8-HXCDF	0.0000037 UJ	0.0000018 J	0.0000035 UJ	0.0000008 J	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,6,7,8-HXCDD	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,6,7,8-HXCDF	0.0000037 UJ	0.0000005 J	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,7,8,9-HXCDD	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,7,8,9-HXCDF	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,7,8-PECDD	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000035 UJ	0.0000035 UJ	0.0000067 U	0.0000047 U
1,2,3,7,8-PECDF	0.00005 J	0.00008 J	0.00001 J	0.00003 J	0.00001 J	0.00001	0.00003
2,3,4,6,7,8-HXCDF	0.0000037 UJ	0.0000044 UJ	0.0000035 UJ	0.0000009 J	0.0000035 UJ	0.0000067 U	0.0000047 U
2,3,4,7,8-PECDF	0.00001 J	0.0000083 J	0.0000022 J	0.0000048 J	0.0000024 J	0.00001	0.00001
2,3,7,8-TCDD	0.0000012 J	0.0000009 UJ	0.0000007 UJ	0.0000007 UJ	0.0000007 UJ	0.0000013 U	0.0000009 U
2,3,7,8-TCDF	0.0000027 UJ	0.00001 J	0.0000066 J	0.0000084 J	0.0000043 J	0.0000047	0.000006
OCDD	0.0000073 UJ	0.0000089 UJ	0.0000003 J	0.0000071 UJ	0.0000071 UJ	0.00001 U	0.0000094 U
OCDF	0.0000073 UJ	0.0000089 UJ	0.000007 UJ	0.0000071 UJ	0.0000071 UJ	0.00001 U	0.0000094 U
Dioxin-Like PCB Congeners							
PCB-105	0.08153	0.22273 J	0.02342 J	0.20744	0.04357	0.00788	0.01106
PCB-114	0.00003 U	0.00001 UJ	0.00001 UJ	0.00002 U	0.00002 U	0.0003 U	0.00024 U
PCB-118	0.10236	0.74587 J	0.09882 J	0.24877	0.0413	0.02075	0.04021
PCB-126	0.00059	0.00191 J	0.0004 J	0.00114	0.0002	0.0011	0.00416
PCB-149/123	0.2584	2.05098 J	0.47352 J	0.58524	0.15905	0.06581	0.13033
PCB-156	0.01267	0.28741 J	0.04013 J	0.10712	0.01655	0.00498	0.01147
PCB-167	0.01736	0.18189 J	0.03464 J	0.06393	0.00896	0.00297	0.00885
PCB-169	0.00004 J	0.00035 J	0.00012 J	0.00012	0.00003 J	0.00003 J	0.00005 J
PCB-189	0.00611	0.06361 J	0.01086 J	0.01985	0.00248	0.00078	0.00262
PCB-201/157/173	0.01324	0.19313 J	0.01685 J	0.02841	0.00429	0.00242	0.00624
PCB-77	0.00049	0.00395 J	0.00102 J	0.00077	0.00035	0.00343	0.00921
PCB-81	0.00092	0.00087 J	0.00009 J	0.00002 U	0.00002 U	0.00094	0.00255
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01346	0.03048 J	0.01518 J	0.03174	0.01174	0.00061 U	0.00328
1,2,4,5-Tetrachlorobenzene	0.00272 J	0.01068 J	0.00416 J	0.00885	0.00271	0.00043 J	0.00031 J
4,4'-DDD	0.00439	0.03975 J	0.00504 J	0.00873	0.00145 J	0.0003 J	0.00126 J
4,4'-DDE	0.01397	0.07708 J	0.01522 J	0.03142	0.0045	0.00302 U	0.00146 J
4,4'-DDT	0.00328 U	0.00549 J	0.00054 J	0.00138 J	0.00197 U	0.00302 U	0.00242 U
Aldrin	0.00328 U	0.00195 UJ	0.0019 UJ	0.00197 U	0.00197 U	0.00302 U	0.00242 U
alpha-BHC	0.00025 J	0.0004 J	0.0019 UJ	0.00016 J	0.0001 J	0.00302 U	0.00242 U
alpha-Chlordane	0.00328 U	0.00195 UJ	0.0019 UJ	0.0014 J	0.00197 U	0.00302 U	0.00242 U
beta-BHC	0.00328 U	0.00195 UJ	0.0019 UJ	0.00197 U	0.00197 U	0.00302 U	0.00006 J
Chlorpyrifos	0.00328 U	0.00022 J	0.00005 J	0.00197 U	0.00047 J	0.00006 J	0.0001 J
cis-Nonachlor	0.01898	0.06507 J	0.01067 J	0.01841	0.00349	0.0026 J	0.00529
delta-BHC	0.00064 J	0.00195 UJ	0.0019 UJ	0.00243	0.00068 J	0.00302 U	0.00242 U
Dieldrin	0.0003 J		0.00066 J	0.0004 J	0.00235	0.00302 U	0.00242 U
Endosulfan II	0.00825	0.00195 UJ	0.0053 J	0.00945	0.00108 J	0.00302 U	0.00242 U
Endrin	0.00328 U	0.00195 UJ	0.0019 UJ	0.00197 U	0.00007 J	0.00302 U	0.00242 U
gamma-BHC (Lindane)	0.00328 U	0.00046 J	0.00022 UJ	0.0004 J	0.00014 J	0.00302 U	0.00242 U
gamma-Chlordane	0.00328 U	0.00168 J	0.00042 J	0.00025 J	0.00197 U	0.00302 U	0.00009 J
Heptachlor	0.00328 U	0.00195 UJ	0.0019 UJ	0.00024 J	0.00041 J	0.00302 U	0.00242 U
Heptachlor epoxide	0.00328 U	0.00195 UJ	0.00039 UJ	0.00219	0.00197 U	0.00302 U	0.00242 U
Hexachlorobenzene	0.00072 J	0.00214 J	0.00076 J	0.00147 J	0.00034 J	0.00302 U	0.00018 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF10BB03-0-8S30	H3-TF10LB16-0-8S30	H3-TF10LB17-0-8S30	H3-TF10LB17-1-8S30	H3-TF10LB19-0-8S30	H3-TF11BB01-0-8C19	H3-TF11BB02-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Brown Bullhead	Brown Bullhead
Collection Date	09/30/98	09/30/98	09/30/98	09/30/98	09/30/98	10/20/98	10/20/98
Fish Length (cm)	20	42.5	37	37	31	30.4	33.4
Mirex	0.00328 U	0.00195 UJ	0.0019 UJ	0.00197 U	0.000006 J	0.00302 U	0.00242 U
o,p'-DDD	0.03065	0.068 J	0.02319 J	0.04129	0.00891	0.00484	0.00898
o,p'-DDE	0.00328 U	0.00195 UJ	0.0019 UJ	0.00152 J	0.00159 J	0.00302 U	0.00242 U
o,p'-DDT	0.02941	0.15963 J	0.0244 J	0.04071	0.00631	0.00389	0.00818
Oxychlordane	0.00135 J	0.00868 J	0.00137 J	0.00197 U	0.00079 J	0.00017 J	0.00025 J
Pentachloroanisole	0.00089 J	0.00041 J	0.00023 J	0.00042 J	0.00017 J	0.00004 U	0.00007 J
Pentachlorobenzene	0.00758	0.01078 J	0.00657 J	0.01398	0.00439	0.00016 U	0.00133 J
Toxaphene	0.0329 U	0.0195 UJ	0.019 UJ	0.0198 U	0.0197 U	0.03024 U	0.02422 U
trans-Nonachlor	0.00328 U	0.00587 J	0.0017 J	0.00284	0.00051 J	0.00302 U	0.00038 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.5	1.8 J	0.5 J	1.3	0.4	0.02	0.08
Percent Lipids (GC/MS)	0.5 J	1.8 J	0.5 J	1.3 J	0.4 J	0.02	0.08
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11BB03-0-8C19	H3-TF11BB04-0-8C19	H3-TF11BB04-0-8S30	H3-TF11BB05-0-8C19	H3-TF11BB05-0-8S30	H3-TF11BB06-0-8C19	H3-TF11BB07-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/20/98	10/20/98	10/01/98	10/20/98	10/01/98	10/20/98	10/20/98
Fish Length (cm)	33.5	26.6	23.3	25.9	29.5	19.9	22.6
PCBs							
PCB, Total	6.28971	3.59268	4.79244	8.24526	20.27923	3.10894	3.03199
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,4,6,7,8-HPCDF	0.0000033 J	0.0000013 J	0.0000038 UJ	0.0000012 J	0.0000063 J		
1,2,3,4,7,8,9-HPCDF	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,4,7,8-HXCDD	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,4,7,8-HXCDF	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000018 J	0.0000046 UJ		
1,2,3,6,7,8-HXCDD	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,6,7,8-HXCDF	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,7,8,9-HXCDD	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,7,8,9-HXCDF	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,7,8-PECDD	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
1,2,3,7,8-PECDF	0.00002	0.0000097	0.00006 J	0.00001	0.00002 J		
2,3,4,6,7,8-HXCDF	0.0000048 U	0.0000049 U	0.0000038 UJ	0.0000048 U	0.0000046 UJ		
2,3,4,7,8-PECDF	0.00001	0.00001	0.00001 J	0.0000088	0.0000046 UJ		
2,3,7,8-TCDD	0.000001 U	0.000001 U	0.0000007 J	0.000001 U	0.0000009 UJ		
2,3,7,8-TCDF	0.0000053	0.0000049	0.0000008 UJ	0.0000036	0.0001 UJ		
OCDD	0.0000096 U	0.0000099 U	0.0000077 UJ	0.0000096 U	0.0000092 UJ		
OCDF	0.0000096 U	0.0000099 U	0.0000077 UJ	0.0000096 U	0.0000092 UJ		
Dioxin-Like PCB Congeners							
PCB-105	0.01833 J	0.01193	0.05079	0.02767	0.0833	0.01778	0.01068
PCB-114	0.00032 UJ	0.0003 U	0.00002 U	0.0003 U	0.00001 U	0.00034 U	0.00032 U
PCB-118	0.08725 J	0.05499	0.04498	0.09598	0.28316	0.04923	0.04455
PCB-126	0.01175 J	0.00417	0.0003	0.00094 J	0.00126	0.00436	0.00364
PCB-149/123	0.28822 J	0.17138	0.20904	0.45386	0.70009	0.15109	0.15327
PCB-156	0.02978 J	0.01767	0.00815	0.03877 J	0.02701	0.01226	0.01043
PCB-167	0.02349 J	0.01014	0.01046	0.02954	0.04602	0.00892	0.00971
PCB-169	0.00006 J	0.00002 J	0.00005 J	0.00046 U	0.00032	0.00008 J	0.00006 J
PCB-189	0.00666 J	0.00302	0.00342	0.00833	0.01138	0.0029	0.00292
PCB-201/157/173	0.01727 J	0.00852	0.00985	0.02508	0.02509	0.00803	0.00732
PCB-77	0.0259 J	0.01205	0.00018	0.00111 J	0.00027	0.01177	0.00994
PCB-81	0.00716 J	0.0028	0.00033	0.00078 J	0.00009	0.00342	0.00269
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00285 J	0.00957	0.01564	0.00921	0.02924	0.00321 J	0.00309 J
1,2,4,5-Tetrachlorobenzene	0.00036 J	0.00045 J	0.00278	0.00233 J	0.00571	0.0011 J	0.00105 J
4,4'-DDD	0.00289 J	0.0032	0.00358	0.00473	0.0111	0.00222 J	0.00196 J
4,4'-DDE	0.00532 J	0.00309	0.00927	0.00678	0.03728	0.00155 J	0.00318 U
4,4'-DDT	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00021 J	0.00339 U	0.00318 U
Aldrin	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00196 U	0.00339 U	0.00318 U
alpha-BHC	0.00324 UJ	0.00299 U	0.00061 J	0.00005 J	0.00034 J	0.00339 U	0.00318 U
alpha-Chlordane	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00111 J	0.00339 U	0.00318 U
beta-BHC	0.00004 UJ	0.00299 U	0.00248 U	0.00005 J	0.00196 U	0.00339 U	0.00318 U
Chlorpyrifos	0.0001 J	0.0002 J	0.00248 U	0.00023 J	0.00196 U	0.00009 J	0.00318 U
cis-Nonachlor	0.01349 J	0.00856	0.01424	0.02008	0.03902	0.00736	0.00726
delta-BHC	0.00324 UJ	0.00299 U	0.00137 J	0.00301 U	0.00167 J	0.00339 U	0.0002 J
Dieldrin	0.00037 J	0.00299 U	0.00034 J	0.0009 J	0.00035 J	0.00339 U	0.00318 U
Endosulfan II	0.00324 UJ	0.00299 U	0.00229 J	0.00301 U	0.00993	0.00339 U	0.00318 U
Endrin	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00196 U	0.00339 U	0.00318 U
gamma-BHC (Lindane)	0.00324 UJ	0.00005 J	0.00248 U	0.00004 J	0.00025 J	0.00001 J	0.00002 J
gamma-Chlordane	0.00026 J	0.00034 J	0.00248 U	0.00073 J	0.00124 J	0.00019 J	0.00031 J
Heptachlor	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00132 J	0.00339 U	0.00318 U
Heptachlor epoxide	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00196 U	0.00339 U	0.00318 U
Hexachlorobenzene	0.00025 J	0.00051 J	0.00041 J	0.00073 J	0.00111 J	0.00027 J	0.0003 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11BB03-0-8C19	H3-TF11BB04-0-8C19	H3-TF11BB04-0-8S30	H3-TF11BB05-0-8C19	H3-TF11BB05-0-8S30	H3-TF11BB06-0-8C19	H3-TF11BB07-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/20/98	10/20/98	10/01/98	10/20/98	10/01/98	10/20/98	10/20/98
Fish Length (cm)	33.5	26.6	23.3	25.9	29.5	19.9	22.6
Mirex	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00196 U	0.00339 U	0.00318 U
o,p'-DDD	0.01977 J	0.01361	0.01888	0.02909	0.05849	0.01214	0.01076
o,p'-DDE	0.00324 UJ	0.00299 U	0.00248 U	0.00301 U	0.00196 U	0.00339 U	0.00318 U
o,p'-DDT	0.02086 J	0.01222	0.01906	0.0261	0.06211	0.00978	0.00428
Oxychlordane	0.00054 J	0.00051 J	0.00068 J	0.00301 U	0.00273	0.0003 J	0.00043 J
Pentachloroanisole	0.00014 J	0.00027 J	0.00015 J	0.00034 J	0.0006 J	0.00014 J	0.00016 J
Pentachlorobenzene	0.00134 J	0.00427	0.00753	0.00506	0.01457	0.00172 J	0.00121 J
Toxaphene	0.03238 U	0.02985 U	0.0248 U	0.03012 U	0.0197 U	0.03386 U	0.03185 U
trans-Nonachlor	0.0009 J	0.00077 J	0.00012 J	0.00107 J	0.00274	0.00019 J	0.00069 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.07	0.25	1.9	0.6	1.6	0.11	0.19
Percent Lipids (GC/MS)	0.07	0.25	1.9 J	0.59	1.6 J		
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11BB07-0-8S30	H3-TF11BB08-0-8C20	H3-TF11BB09-0-8C20	H3-TF11BB10-0-8C20	H3-TF11BB11-0-8C20	H3-TF11LB22-0-8S30	H3-TF11LB23-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Largemouth Bass	Largemouth Bass
Collection Date	09/30/98	10/20/98	10/20/98	10/20/98	10/20/98	10/01/98	10/01/98
Fish Length (cm)	30.9	23.5	26.1	27	27.6	41.5	34.5
PCBs							
PCB, Total	9.09184	0.92827	2.30822	0.40645	2.72078	4.3449	5.4767
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,4,6,7,8-HPCDF	0.0000091	0.0000047 U	0.0000068 U	0.0000048 U	0.0000019 J	0.00001 J	
1,2,3,4,7,8,9-HPCDF	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,4,7,8-HXCDD	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,4,7,8-HXCDF	0.0000049 U	0.0000018 J	0.0000068 U	0.0000048 U	0.0000029 J	0.0000036 UJ	
1,2,3,6,7,8-HXCDD	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,6,7,8-HXCDF	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,7,8,9-HXCDD	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,7,8,9-HXCDF	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,7,8-PECDD	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
1,2,3,7,8-PECDF	0.0000049 U	0.0000085	0.0000044 J	0.0000039 J	0.00001	0.00015 J	
2,3,4,6,7,8-HXCDF	0.0000049 U	0.0000047 U	0.0000068 U	0.0000048 U	0.0000049 U	0.0000036 UJ	
2,3,4,7,8-PECDF	0.00001	0.0000083	0.0000095	0.0000059	0.00001	0.0000028 J	
2,3,7,8-TCDD	0.000001 U	0.0000009 U	0.0000014 U	0.000001 U	0.000001 U	0.0000007 UJ	
2,3,7,8-TCDF	0.00001	0.0000039	0.0000046	0.0000034	0.0000052	0.0000023 UJ	
OCDD	0.0000097 U	0.0000032 J	0.00001 U	0.0000097 U	0.0000099 U	0.0000035 J	
OCDF	0.0000097 U	0.0000093 U	0.00001 U	0.0000097 U	0.0000099 U	0.0000032 J	
Dioxin-Like PCB Congeners							
PCB-105	0.0249 J	0.0054	0.00508	0.002	0.01122	0.03159	0.01557 J
PCB-114	0.00022 U	0.00028 U	0.00026 U	0.00033 U	0.00033 U	0.00001 U	0.00001 UJ
PCB-118	0.14647 J	0.01591	0.03377	0.00569	0.03417	0.03408	0.04871 J
PCB-126	0.00926 J	0.00103	0.00389	0.00079	0.00339	0.00033	0.00019 J
PCB-149/123	0.44791 J	0.05005	0.10387	0.0184	0.14357	0.16128	0.431 J
PCB-156	0.03918 J	0.00349	0.01362	0.00193	0.00993	0.00961	0.0176 J
PCB-167	0.03678 J	0.00264	0.00946	0.00135	0.00651	0.0125	0.01868 J
PCB-169	0.00011 J	0.00028 U	0.00005 J	0.00003 J	0.00004 J	0.00007	0.00008 J
PCB-189	0.01006 J	0.00071	0.0029	0.00033 U	0.00216	0.00424	0.00598 J
PCB-201/157/173	0.0269 J	0.00233	0.00724	0.00131	0.00623	0.0077	0.0088 J
PCB-77	0.02779 J	0.00278	0.00869	0.00098	0.00863	0.00024	0.00021 J
PCB-81	0.007 J	0.00077	0.00235	0.00034	0.00248	0.00023	0.00024 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.02118	0.00168 J	0.00419	0.00075 UJ	0.00316	0.00736	0.01533 J
1,2,4,5-Tetrachlorobenzene	0.00673	0.00076 J	0.00146 J	0.00006 J	0.00085 J	0.00181 J	0.00495 J
4,4'-DDD	0.00407	0.00056 J	0.00176 J	0.00329 UJ	0.00161 J	0.00247	0.00214 J
4,4'-DDE	0.00697	0.00073 J	0.00928	0.00036 J	0.00152 J	0.00835	0.00582 J
4,4'-DDT	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
Aldrin	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
alpha-BHC	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
alpha-Chlordane	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
beta-BHC	0.00004 U	0.00283 U	0.00257 U	0.00001 J	0.00002 J	0.00191 U	0.0019 UJ
Chlorpyrifos	0.00012 U	0.00283 U	0.00257 U	0.00006 J	0.00003 U	0.00191 U	0.00006 J
cis-Nonachlor	0.01907	0.00221 J	0.00386	0.00066 J	0.00585	0.00828	0.00712 J
delta-BHC	0.00006 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00044 J	0.0019 UJ
Dieldrin	0.00101	0.00283 U	0.00016 J	0.00005 J	0.00326 U	0.00005 J	0.00053 J
Endosulfan II	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00154 J	0.00449 J
Endrin	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
gamma-BHC (Lindane)	0.00014	0.00283 U	0.00257 U	0.00329 UJ	0.00001 J	0.00191 U	0.00025 J
gamma-Chlordane	0.00072	0.00283 U	0.00257 U	0.00329 UJ	0.00021 J	0.00191 U	0.0019 UJ
Heptachlor	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
Heptachlor epoxide	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
Hexachlorobenzene	0.00075	0.00009 J	0.0003 J	0.00002 J	0.00015 J	0.00028 J	0.00104 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11BB07-0-8S30	H3-TF11BB08-0-8C20	H3-TF11BB09-0-8C20	H3-TF11BB10-0-8C20	H3-TF11BB11-0-8C20	H3-TF11LB22-0-8S30	H3-TF11LB23-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Largemouth Bass	Largemouth Bass
Collection Date	09/30/98	10/20/98	10/20/98	10/20/98	10/20/98	10/01/98	10/01/98
Fish Length (cm)	30.9	23.5	26.1	27	27.6	41.5	34.5
Mirex	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
o,p'-DDD	0.02705	0.00341	0.00607	0.00146 J	0.00908	0.01718	0.01189 J
o,p'-DDE	0.00223 U	0.00283 U	0.00257 U	0.00329 UJ	0.00326 U	0.00191 U	0.0019 UJ
o,p'-DDT	0.02811	0.00125 J	0.00705	0.00111 J	0.00788	0.01838	0.01548 J
Oxychlordane	0.00223 U	0.00032 J	0.00031 J	0.00329 UJ	0.00024 J	0.00055 J	0.00073 J
Pentachloroanisole	0.00047	0.00006 J	0.0001 J	0.00003 UJ	0.0001 J	0.00191 U	0.00016 J
Pentachlorobenzene	0.00794	0.00049 U	0.00437	0.00014 UJ	0.0015 J	0.00322	0.0077 J
Toxaphene	0.02233 U	0.02828 U	0.02569 U	0.03286 U	0.03259 U	0.0192 U	0.0191 UJ
trans-Nonachlor	0.00108	0.00001 J	0.00257 U	0.00329 UJ	0.00038 J	0.0003 J	0.00105 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1.5	0.03	0.09	0.03	0.04	0.5	0.5 J
Percent Lipids (GC/MS)	1.5	0.03	0.09	0.03	0.04	0.5 J	
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11LB24-0-8S30	H4-TFWPBB01-0-8C21	H4-TFWPBB01-0-8S30	H4-TFWPBB01-1-8C21	H4-TFWPBB02-0-8C01	H4-TFWPBB02-0-8C21	H4-TFWPBB03-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98
Fish Length (cm)	37	30	30.0	30	29.5	27	26
PCBs							
PCB, Total	82.65609	11.76548	44.97181	19.64147	27.23799	19.60534	20.30066
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,4,6,7,8-HPCDF		0.0000011 J	0.00011	0.0000012 J		0.00000704 U	0.00002 J
1,2,3,4,7,8,9-HPCDF		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,4,7,8-HXCDD		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,4,7,8-HXCDF		0.0000018 J	0.0000097 U	0.0000034 J		0.000003 J	0.0000049 UJ
1,2,3,6,7,8-HXCDD		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,6,7,8-HXCDF		0.00000445 U	0.0000097 U	0.0000019 J		0.0000018 J	0.0000049 UJ
1,2,3,7,8,9-HXCDD		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,7,8,9-HXCDF		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,7,8-PECDD		0.00000445 U	0.0000097 U	0.00000693 U		0.00000704 U	0.0000049 UJ
1,2,3,7,8-PECDF		0.00001	0.0004	0.00001		0.00001	0.0002 J
2,3,4,6,7,8-HXCDF		0.00000445 U	0.0000097 U	0.0000015 J		0.0000012 J	0.0000049 UJ
2,3,4,7,8-PECDF		0.00001	0.00003	0.00003		0.00002	0.00004 J
2,3,7,8-TCDD		0.00000089 U	0.0000019 U	0.0000015		0.00000141 U	0.000001 UJ
2,3,7,8-TCDF		0.0000084	0.00004	0.00001		0.00001	0.0000051 J
OCDD		0.0000089 U	0.00001 U	0.00001 U		0.00001 U	0.0000016 J
OCDF		0.0000089 U	0.00001 U	0.0000008 J		0.00001 U	0.0000099 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.44952 J	0.03597	0.09533 J	0.07014	0.49125	0.05517	0.36613
PCB-114	0.00001 UJ	0.00025 U	0.00022 U	0.00028 U	0.00002 U	0.00027 U	0.00002 U
PCB-118	1.29308 J	0.20171	0.60315 J	0.33632	0.47371	0.31399	0.31371
PCB-126	0.00444 J	0.00104 J	0.03477 J	0.00185 J	0.00233	0.00127 J	0.00151
PCB-149/123	2.39336 J	0.50532	1.96284 J	0.82474	1.94907	0.92276	1.19665
PCB-156	0.39469 J	0.07122 J	0.00022 U	0.09367 J	0.13237	0.09144 J	0.09208
PCB-167	0.38979 J	0.041	0.17825 J	0.07966	0.08773	0.08613	0.07854
PCB-169	0.00144 J	0.00017 U	0.00078 J	0.00057 U	0.00034 J	0.0002 U	0.00039
PCB-189	0.11607 J	0.0099	0.04823 J	0.018	0.02742 J	0.01872	0.0262
PCB-201/157/173	0.17317 J	0.03387	0.11595 J	0.07197	0.055 J	0.07263	0.0449
PCB-77	0.00341 J	0.00079 J	0.11587 J	0.00106 J	0.00171	0.0009 J	0.0006
PCB-81	0.00035 J	0.00025 U	0.02162 J	0.00028 U	0.00015 J	0.00001 J	0.00004 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.16763 J	0.01305	0.01825	0.02107	0.04922 J	0.02122	0.01333
1,2,4,5-Tetrachlorobenzene	0.04639 J	0.00491	0.0085	0.00568	0.01733 J	0.00566	0.0029
4,4'-DDD	0.05113 J	0.00677	0.02392	0.01161	0.01686	0.01167	0.00432
4,4'-DDE	0.20381 J	0.0231	0.00224 U	0.03944	0.05221 J	0.0358	0.03809
4,4'-DDT	0.0058 J	0.00248 U	0.00224 U	0.00279 U	0.0005 J	0.0027 U	0.00103 J
Aldrin	0.00189 UJ	0.00248 U	0.00224 U	0.00059 J	0.00052 J	0.0027 U	0.00046 J
alpha-BHC	0.00189 UJ	0.00007 J	0.00224 U	0.00013 J	0.0001 J	0.00006 J	0.00006 U
alpha-Chlordane	0.00189 UJ	0.00248 U	0.00224 U	0.00279 U	0.00283	0.0027 U	0.00147 J
beta-BHC	0.00034 J	0.00004 J	0.00007 U	0.00008 J	0.00065 J	0.00009 J	0.00032 J
Chlorpyrifos	0.00219 J	0.00033 J	0.00025 U	0.00038 J	0.00016 J	0.00017 J	0.00198 U
cis-Nonachlor	0.09353 J	0.02585	0.07561	0.04381	0.05856 J	0.04717	0.03409
delta-BHC	0.00189 UJ	0.00248 U	0.00224 U	0.00279 U	0.00423 J	0.0027 U	0.00321
Dieldrin	0.00196 J	0.00221 J	0.00391	0.00303	0.00292 J	0.00265 J	0.00071 J
Endosulfan II	0.02046 J	0.00321	0.00224 U	0.0063	0.03934 J	0.00888	0.00586
Endrin	0.00189 UJ	0.00248 U	0.00224 U	0.00005 J	0.00198 U	0.0027 U	0.00198 U
gamma-BHC (Lindane)	0.00197 J	0.0001 J	0.00033	0.00016 J	0.00067 J	0.00015 J	0.00034 J
gamma-Chlordane	0.00158 J	0.00075 J	0.00293	0.00156 J	0.00302	0.00153 J	0.00107 J
Heptachlor	0.00189 UJ	0.00002 J	0.00224 U	0.00279 U	0.00198 U	0.0027 U	0.00012 J
Heptachlor epoxide	0.00189 UJ	0.00248 U	0.00224 U	0.00279 U	0.00146 J	0.0027 U	0.00119 J
Hexachlorobenzene	0.00579 J	0.00064 J	0.00221	0.00113 J	0.00221	0.00101 J	0.00113 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11LB24-0-8S30	H4-TFWPBB01-0-8C21	H4-TFWPBB01-0-8S30	H4-TFWPBB01-1-8C21	H4-TFWPBB02-0-8C01	H4-TFWPBB02-0-8C21	H4-TFWPBB03-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98
Fish Length (cm)	37	30	30.0	30	29.5	27	26
Mirex	0.0011 J	0.00248 U	0.00224 U	0.00279 U	0.00198 U	0.0027 U	0.00198 U
o,p'-DDD	0.28802 J	0.04521	0.12608	0.0778	0.13311 J	0.07626	0.05861
o,p'-DDE	0.00189 UJ	0.00248 U	0.00224 U	0.00279 U	0.00097 J	0.0027 U	0.00164 J
o,p'-DDT	0.35911 J	0.04258	0.13802	0.07247	0.07366 J	0.07734	0.05071
Oxychlordane	0.01649 J	0.00248 U	0.00224 U	0.00279 U	0.00555 J	0.0027 U	0.00548
Pentachloroanisole	0.00187 J	0.00048 J	0.00074	0.00081 J	0.00144 J	0.0007 J	0.0006 J
Pentachlorobenzene	0.07279 J	0.0062	0.01174	0.00998	0.01955 J	0.00951	0.00689
Toxaphene	0.019 UJ	0.02481 U	0.02235 U	0.02786 U	0.0198 U	0.02703 U	0.0199 U
trans-Nonachlor	0.00858 J	0.00127 J	0.00431	0.0023 J	0.00364	0.00212 J	0.00192 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	7.2 J	1	2.9	1.8	2.9	1.6	1.2
Percent Lipids (GC/MS)		1.03	2.9	1.78		1.59	1.2 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPBB03-0-8C21	H4-TFWPBB04-0-8C01	H4-TFWPBB04-0-8C21	H4-TFWPBB05-0-8C01	H4-TFWPBB05-0-8C21	H4-TFWPBB06-0-8C01	H4-TFWPBB06-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98
Fish Length (cm)	30.5	27	28	27.4	25	25.7	27
PCBs							
PCB, Total	9.47491	18.67837	16.98332	18.28808	6.18432	14.0896	19.97692
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.00001 U		0.0000013 J	0.0000045 UJ	0.00000906 U		
1,2,3,4,6,7,8-HPCDF	0.000002 J		0.0000024 J	0.0000045 UJ	0.0000008 J		
1,2,3,4,7,8,9-HPCDF	0.00001 U		0.00000711 U	0.0000045 UJ	0.00000906 U		
1,2,3,4,7,8-HXCDD	0.00001 U		0.00000711 U	0.0000045 UJ	0.00000906 U		
1,2,3,4,7,8-HXCDF	0.00001 U		0.0000059 J	0.0000045 UJ	0.0000017 J		
1,2,3,6,7,8-HXCDD	0.00001 U		0.0000019 J	0.0000045 UJ	0.00000906 U		
1,2,3,6,7,8-HXCDF	0.00001 U		0.000003 J	0.0000045 UJ	0.00000906 U		
1,2,3,7,8,9-HXCDD	0.00001 U		0.00000711 U	0.0000045 UJ	0.00000906 U		
1,2,3,7,8,9-HXCDF	0.00001 U		0.00000711 U	0.0000045 UJ	0.00000906 U		
1,2,3,7,8-PECDD	0.00001 U		0.0000019 J	0.0000045 UJ	0.00000906 U		
1,2,3,7,8-PECDF	0.00001		0.00002	0.00005 J	0.0000076 J		
2,3,4,6,7,8-HXCDF	0.00001 U		0.0000023 J	0.0000045 UJ	0.00000906 U		
2,3,4,7,8-PECDF	0.00001		0.00004	0.00002 J	0.00001		
2,3,7,8-TCDD	0.00000238 U		0.00000142 U	0.0000009 UJ	0.00000181 U		
2,3,7,8-TCDF	0.00003		0.00001	0.0000009 UJ	0.0000091		
OCDD	0.00002 U		0.00001 U	0.0000008 J	0.00001 U		
OCDF	0.00002 U		0.00001 U	0.000009 UJ	0.00001 U		
Dioxin-Like PCB Congeners							
PCB-105	0.05084	0.3736	0.06054	0.43439	0.01415	0.32807	0.03963
PCB-114	0.0002 U	0.00002 U	0.00026 U	0.00002 U	0.00028 U	0.00002 U	0.00027 U
PCB-118	0.16466	0.27859	0.28107	0.33508	0.11793	0.26554	0.29387
PCB-126	0.00117	0.0014	0.00202 J	0.00259	0.00097 J	0.00121	0.00157 J
PCB-149/123	0.34886	1.34305	0.78059	1.2228	0.31455	0.91781	1.00499
PCB-156	0.0002 U	0.08137	0.07144 J	0.10585	0.02626 J	0.08298	0.05516 J
PCB-167	0.04426	0.07745	0.07672	0.06954	0.02107	0.06413	0.09169
PCB-169	0.00022 J	0.00028	0.00036 U	0.00051	0.0004 U	0.00023	0.00057 U
PCB-189	0.01452	0.02142	0.01748	0.02291	0.00507	0.01811	0.02129
PCB-201/157/173	0.02895 J	0.03741	0.06146	0.03529	0.01484	0.02561	0.07167
PCB-77	0.00094	0.001	0.00129 J	0.00151	0.00063 J	0.00103	0.00134 J
PCB-81	0.0001 J	0.00016	0.00012 J	0.00015	0.000009 J	0.00008	0.00011 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00392	0.02125	0.01967	0.01061	0.00723	0.00612	0.02029
1,2,4,5-Tetrachlorobenzene	0.00134 U	0.00592	0.00575	0.00446	0.00429	0.00249	0.00463
4,4'-DDD	0.02812 J	0.00721	0.01062	0.00713	0.00288	0.00564	0.01392
4,4'-DDE	0.02428 J	0.03408	0.0348	0.04813	0.01325	0.03679	0.0223
4,4'-DDT	0.00195 U	0.00061 J	0.00258 U	0.00044 J	0.00275 U	0.00041 J	0.00272 U
Aldrin	0.00195 U	0.00198 U	0.00258 U	0.00199 U	0.00023 J	0.00198 U	0.00272 U
alpha-BHC	0.0003 J	0.0001 J	0.00008 J	0.00007 U	0.00003 J	0.00008 J	0.0001 J
alpha-Chlordane	0.0032	0.00196 J	0.00258 U	0.00136 J	0.00275 U	0.00156 J	0.00272 U
beta-BHC	0.00195 U	0.00198 U	0.00006 J	0.00043 J	0.00006 J	0.00011 J	0.00007 J
Chlorpyrifos	0.00195 U	0.00011 J	0.00026 J	0.00009 J	0.00023 J	0.00016 J	0.0003 J
cis-Nonachlor	0.00195 U	0.04313	0.0394	0.03809	0.01383	0.03276	0.04364
delta-BHC	0.00195 U	0.00181 J	0.00258 U	0.00133 J	0.00275 U	0.001 J	0.00272 U
Dieldrin	0.00962 J	0.00321	0.00251 J	0.00304	0.00106 J	0.00288	0.00259 J
Endosulfan II	0.02261 J	0.01479	0.0072	0.01445	0.00141 J	0.01275	0.0064
Endrin	0.00195 U	0.00198 U	0.00003 J	0.00114 J	0.00275 U	0.00198 U	0.0001 J
gamma-BHC (Lindane)	0.00002 J	0.00032 J	0.00012 J	0.00037 J	0.00008 J	0.00022 J	0.00014 J
gamma-Chlordane	0.00037 J	0.00153 J	0.00089 J	0.00127 J	0.00042 J	0.00122 J	0.0019 J
Heptachlor	0.00195 U	0.00009 J	0.00258 U	0.00009 J	0.00009 J	0.00007 J	0.00272 U
Heptachlor epoxide	0.00195 U	0.0008 J	0.00258 U	0.00119 J	0.00275 U	0.00094 J	0.00272 U
Hexachlorobenzene	0.00019 U	0.00164 J	0.00109 J	0.00108 J	0.00028 J	0.00137 J	0.00177 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPBB03-0-8C21	H4-TFWPBB04-0-8C01	H4-TFWPBB04-0-8C21	H4-TFWPBB05-0-8C01	H4-TFWPBB05-0-8C21	H4-TFWPBB06-0-8C01	H4-TFWPBB06-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98
Fish Length (cm)	30.5	27	28	27.4	25	25.7	27
Mirex	0.00195 U	0.00198 U	0.00258 U	0.00199 U	0.00275 U	0.00198 U	0.00272 U
o,p'-DDD	0.03372 J	0.05806	0.06352	0.05244	0.02149	0.04648	0.06274
o,p'-DDE	0.00195 U	0.00287	0.00258 U	0.00308	0.00275 U	0.00244	0.00272 U
o,p'-DDT	0.03201 J	0.05334	0.0645	0.05175	0.02116	0.03944	0.06491
Oxychlordane	0.00195 U	0.00375	0.00258 U	0.00459	0.00275 U	0.0053	0.00272 U
Pentachloroanisole	0.00024 J	0.00096 J	0.00064 J	0.00053 J	0.00028 J	0.0006 J	0.00096 J
Pentachlorobenzene	0.00152 J	0.01002	0.00945	0.00523	0.00228 J	0.00375	0.01783
Toxaphene	0.01954 U	0.0198 U	0.02577 U	0.0199 U	0.02755 U	0.0199 U	0.02725 U
trans-Nonachlor	0.00195 U	0.00247	0.00195 J	0.00134 J	0.00086 J	0.00187 J	0.00254 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.6	1.5	1.3	2.2	0.7	1.6	2.1
Percent Lipids (GC/MS)	0.6		1.34	2.2 J	0.71		
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPBB07-0-8C01	H4-TFWPBB07-0-8C21	H4-TFWPBB08-0-8C01	H4-TFWPBB08-0-8C21	H4-TFWPBB09-0-8C01	H4-TFWPBB09-0-8C21	H4-TFWPBB10-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98
Fish Length (cm)	23.0	26	25.0	27	25.0	28.1	30
PCBs							
PCB, Total	9.98464	7.83601	13.18094	5.21935	14.25138	12.61219	23.58088
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000049 UJ	0.00000978 U	0.0000008 J				0.0000048 UJ
1,2,3,4,6,7,8-HPCDF	0.0000066 J	0.0000017 J	0.0000036 J				0.0000053 J
1,2,3,4,7,8,9-HPCDF	0.0000049 UJ	0.00000978 U	0.0000049 UJ				0.0000002 J
1,2,3,4,7,8-HXCDD	0.0000049 UJ	0.00000978 U	0.0000049 UJ				0.0000048 UJ
1,2,3,4,7,8-HXCDF	0.0000049 UJ	0.0000031 J	0.0000047 J				0.0000048 UJ
1,2,3,6,7,8-HXCDD	0.0000049 UJ	0.00000978 U	0.000001 J				0.0000048 UJ
1,2,3,6,7,8-HXCDF	0.0000011 J	0.00000978 U	0.000001 J				0.0000009 J
1,2,3,7,8,9-HXCDD	0.0000049 UJ	0.00000978 U	0.0000003 J				0.0000048 UJ
1,2,3,7,8,9-HXCDF	0.0000049 UJ	0.00000978 U	0.0000049 UJ				0.0000048 UJ
1,2,3,7,8-PECDD	0.0000049 UJ	0.00000978 U	0.0000049 UJ				0.0000048 UJ
1,2,3,7,8-PECDF	0.00006 J	0.00001	0.00003 J				0.00006 J
2,3,4,6,7,8-HXCDF	0.0000049 UJ	0.00000978 U	0.000001 J				0.000001 J
2,3,4,7,8-PECDF	0.00001 J	0.00002	0.00002 J				0.00002 J
2,3,7,8-TCDD	0.000001 UJ	0.00000196 U	0.0000006 J				0.000001 UJ
2,3,7,8-TCDF	0.00001 J	0.00001	0.00001 J				0.00001 J
OCDD	0.0000097 UJ	0.00001 U	0.0000098 UJ				0.0000017 J
OCDF	0.0000097 UJ	0.00001 U	0.0000098 UJ				0.0000097 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.10949	0.01471	0.15903	0.01146	0.10449	0.03376	0.23272
PCB-114	0.00001 U	0.00027 U	0.00001 U	0.00024 U	0.00001 U	0.0002 U	0.00001 U
PCB-118	0.18425	0.12316	0.21538	0.08235	0.27839	0.19997	0.36137
PCB-126	0.00129	0.00086 J	0.0015	0.0007 J	0.00279	0.00107 J	0.00308
PCB-149/123	0.35613	0.36094	0.5261	0.27444	0.53676	0.53126	0.78629
PCB-156	0.04189	0.03047 J	0.05453	0.02114 J	0.038	0.05393 J	0.07931
PCB-167	0.04773	0.026	0.07099	0.01566	0.07332	0.06114	0.12138
PCB-169	0.0003	0.00031 U	0.00025	0.0001 U	0.00056	0.00026 U	0.0007
PCB-189	0.01334	0.00671	0.01826	0.00373	0.0208	0.01229	0.03301
PCB-201/157/173	0.02151	0.01911	0.03155	0.01189	0.03085	0.04398	0.05536
PCB-77	0.00117	0.00066 J	0.00058	0.00049 J	0.00093	0.00059 J	0.00167
PCB-81	0.00019	0.00003 J	0.00005 J	0.00002 J	0.00013	0.00004 J	0.00012
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00953	0.01065	0.00718	0.00557	0.01171	0.00248	0.00507
1,2,4,5-Tetrachlorobenzene	0.00276	0.00426	0.00257	0.001 J	0.00428	0.00045 J	0.00183 J
4,4'-DDD	0.00958	0.00361	0.01196	0.00203 J	0.0111	0.003	0.01485
4,4'-DDE	0.02719	0.01103	0.0339	0.00783	0.04622	0.02271	0.06352
4,4'-DDT	0.00198 U	0.00272 U	0.00198 U	0.00239 U	0.00198 U	0.002 U	0.00197 U
Aldrin	0.00198 U	0.00272 U	0.00198 U	0.00239 U	0.00028 J	0.002 U	0.00197 U
alpha-BHC	0.00014 J	0.00006 J	0.00017 J	0.00007 J	0.00013 J	0.00003 J	0.00011 J
alpha-Chlordane	0.00102 J	0.00083 J	0.00143 J	0.00239 U	0.00121 J	0.002 U	0.00197 U
beta-BHC	0.00198 U	0.00005 J	0.00198 U	0.00005 J	0.00198 U	0.002 U	0.00197 U
Chlorpyrifos	0.00006 J	0.00018 J	0.00009 J	0.00015 J	0.00004 J	0.00032 J	0.00002 J
cis-Nonachlor	0.02196	0.01653	0.03022	0.01139	0.03028	0.01974	0.03573
delta-BHC	0.00198 U	0.00272 U	0.00198 U	0.00239 U	0.00198 U	0.00014 J	0.00197 U
Dieldrin	0.00078 J	0.00067 J	0.00078 J	0.00073 J	0.0005 J	0.00075 J	0.00174 J
Endosulfan II	0.00645	0.00219 J	0.00636	0.00239 U	0.00949	0.002 U	0.01502
Endrin	0.00007 J	0.00272 U	0.00198 U	0.00239 U	0.00008 J	0.002 U	0.00197 U
gamma-BHC (Lindane)	0.00019 J	0.00007 J	0.00017 J	0.00004 J	0.00029 J	0.002 U	0.00012 J
gamma-Chlordane	0.00059 J	0.00072 J	0.00081 J	0.0004 J	0.00064 J	0.002 U	0.00064 J
Heptachlor	0.00198 U	0.00272 U	0.00021 J	0.00003 J	0.00015 J	0.00004 J	0.00197 U
Heptachlor epoxide	0.00198 U	0.00272 U	0.00198 U	0.00239 U	0.00198 U	0.002 U	0.00197 U
Hexachlorobenzene	0.00066 J	0.00056 J	0.00097 J	0.0002 J	0.00092 J	0.00044 J	0.00052 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPBB07-0-8C01	H4-TFWPBB07-0-8C21	H4-TFWPBB08-0-8C01	H4-TFWPBB08-0-8C21	H4-TFWPBB09-0-8C01	H4-TFWPBB09-0-8C21	H4-TFWPBB10-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead
Collection Date	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98	10/21/98	10/01/98
Fish Length (cm)	23.0	26	25.0	27	25.0	28.1	30
Mirex	0.00198 U	0.00272 U	0.00198 U	0.00239 U	0.00198 U	0.002 U	0.00197 U
o,p'-DDD	0.03317	0.02703	0.03842	0.01735	0.0411	0.04369	0.05454
o,p'-DDE	0.00198 U	0.00272 U	0.00198 U	0.00239 U	0.00198 U	0.002 U	0.00197 U
o,p'-DDT	0.02743	0.02548	0.03666	0.01646	0.03979	0.04335	0.05371
Oxychlordane	0.00358	0.00272 U	0.00324	0.00239 U	0.0041	0.002 U	0.00544
Pentachloroanisole	0.0004 J	0.00034 J	0.0006 J	0.00021 J	0.0005 J	0.00015 J	0.00023 J
Pentachlorobenzene	0.00339	0.00568	0.00133 J	0.00182 J	0.00472	0.00104 J	0.00221
Toxaphene	0.0198 U	0.02717 U	0.0198 U	0.02387 U	0.0198 U	0.02 U	0.0198 U
trans-Nonachlor	0.00107 J	0.00108 J	0.00153 J	0.00046 J	0.00111 J	0.00075 J	0.00145 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1.1	1	1.2	0.7	2	0.3	1.9
Percent Lipids (GC/MS)	1.1 J	0.99	1.2 J				1.9 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPBB11-0-8C01	H4-TFWPBB12-0-8C01	H4-TFWPBB13-0-8C01	H4-TFWPBB14-0-8C01	H4-TFWPBB15-0-8C01	H4-TFWPBB16-0-8C01	H4-TFWPLB01-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Largemouth Bass
Collection Date	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98
Fish Length (cm)	29.4	30	27.4	29.0	30.2	26	33.0
PCBs							
PCB, Total	11.37169	90.21707	7.34771	8.4675	22.29519	6.57099	7.24572
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000008 J		0.0000004 J		0.0000004 J		0.0000031 U
1,2,3,4,6,7,8-HPCDF	0.00001 J		0.0000047 J		0.0000027 J		0.00001
1,2,3,4,7,8,9-HPCDF	0.0000006 J		0.0000003 J		0.0000003 J		0.0000031 U
1,2,3,4,7,8-HXCDD	0.0000006 J		0.0000048 UJ		0.0000002 J		0.0000031 U
1,2,3,4,7,8-HXCDF	0.0000048 UJ		0.0000048 UJ		0.0000048 UJ		0.0000031 U
1,2,3,6,7,8-HXCDD	0.0000004 J		0.0000048 UJ		0.0000002 J		0.0000031 U
1,2,3,6,7,8-HXCDF	0.0000048 UJ		0.0000006 J		0.0000006 J		0.0000031 U
1,2,3,7,8,9-HXCDD	0.0000004 J		0.0000048 UJ		0.0000048 UJ		0.0000031 U
1,2,3,7,8,9-HXCDF	0.0000004 J		0.0000004 J		0.0000048 UJ		0.0000031 U
1,2,3,7,8-PECDD	0.0000048 UJ		0.0000048 UJ		0.0000048 UJ		0.0000031 U
1,2,3,7,8-PECDF	0.00007 J		0.00003 J		0.00002 J		0.00003
2,3,4,6,7,8-HXCDF	0.0000027 J		0.0000048 UJ		0.0000014 J		0.0000031 U
2,3,4,7,8-PECDF	0.00001 J		0.00001 J		0.00001 J		0.0000054
2,3,7,8-TCDD	0.0000005 J		0.0000007 J		0.0000004 J		0.0000006 U
2,3,7,8-TCDF	0.00001 J		0.00001 J		0.00001 J		0.00001
OCDD	0.0000024 J		0.0000015 J		0.0000009 J		0.0000063 U
OCDF	0.0000014 J		0.0000008 J		0.0000007 J		0.0000063 U
Dioxin-Like PCB Congeners							
PCB-105	0.06355	0.66521	0.06172	0.06971	0.18038	0.0483 J	0.02174 J
PCB-114	0.00002 U	0.00001 U	0.00001 U	0.00002 U	0.00001 U	0.00004 UJ	0.0002 U
PCB-118	0.14905	1.15176	0.13861	0.12761	0.28596	0.07255 J	0.15774 J
PCB-126	0.00111	0.00839	0.00108	0.00108	0.0013	0.00108 J	0.00843 J
PCB-149/123	0.29517	3.53195	0.23537	0.32488	0.84742	0.29213 J	0.30101 J
PCB-156	0.07698	0.23243	0.03238	0.0279	0.07871	0.01392 J	0.03203 J
PCB-167	0.07643	0.35534	0.04196	0.03308	0.07686	0.02327 J	0.02724 J
PCB-169	0.00027	0.00205	0.00024	0.00016	0.00031	0.0001 J	0.00012 J
PCB-189	0.02066	0.12636	0.01132	0.01028	0.02216	0.00822 J	0.00641 J
PCB-201/157/173	0.03612	0.20299	0.02002	0.0194	0.04041	0.01502 J	0.01696 J
PCB-77	0.00049	0.0041	0.00048	0.00054	0.00062	0.00055 J	0.02465 J
PCB-81	0.00005 J	0.00043	0.00001 J	0.00005 J	0.00008	0.00018 J	0.0059 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00232	0.03742	0.00331	0.01288	0.02132	0.00941 J	0.00488
1,2,4,5-Tetrachlorobenzene	0.00082 J	0.00953	0.00187 J	0.00451	0.00628	0.00144 J	0.00331
4,4'-DDD	0.0054	0.05186	0.00225	0.00833	0.01319	0.00384 J	0.00362
4,4'-DDE	0.02149	0.22957	0.02066	0.02045	0.03104	0.02037 J	0.01853
4,4'-DDT	0.00199 U	0.00292	0.00026 J	0.00035 J	0.00051 J	0.00492 UJ	0.00202 U
Aldrin	0.00199 U	0.00198 U	0.00198 U	0.00199 U	0.00199 U	0.00492 UJ	0.00202 U
alpha-BHC	0.00011 J	0.00005 J	0.00016 J	0.00016 J	0.00012 J	0.00492 UJ	0.00202 U
alpha-Chlordane	0.00199 U	0.00443	0.0005 J	0.00154 J	0.00213	0.00049 J	0.00202 U
beta-BHC	0.00199 U	0.00198 U	0.00198 U	0.00199 U	0.00199 U	0.00492 UJ	0.00002 U
Chlorpyrifos	0.00199 U	0.00038 J	0.00198 U	0.00008 J	0.0001 J	0.00492 UJ	0.00013 U
cis-Nonachlor	0.01163	0.20578	0.011	0.01837	0.03418	0.00492 UJ	0.01332
delta-BHC	0.00199 U	0.00198 U	0.00198 U	0.00199 U	0.00199 U	0.00011 J	0.00202 U
Dieldrin	0.00077 J	0.00362	0.00052 J	0.00092 J	0.00097 J	0.0006 J	0.00105
Endosulfan II	0.00763	0.03436	0.00809	0.00757	0.00802	0.00431 J	0.00202 U
Endrin	0.00199 U	0.00019 J	0.00198 U	0.00199 U	0.00199 U	0.00492 UJ	0.00202 U
gamma-BHC (Lindane)	0.00004 J	0.00049 J	0.00006 J	0.00017 J	0.00021 J	0.00007 J	0.00008
gamma-Chlordane	0.00009 J	0.00367	0.00017 J	0.00075 J	0.00141 J	0.00028 J	0.00013
Heptachlor	0.00199 U	0.00043 J	0.00011 J	0.00008 J	0.00015 J	0.00492 UJ	0.00202 U
Heptachlor epoxide	0.00199 U	0.01337	0.00198 U	0.00199 U	0.00199 U	0.00153 J	0.00202 U
Hexachlorobenzene	0.00021 J	0.00303	0.00054 J	0.00063 J	0.00138 J	0.0003 J	0.0002

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPBB11-0-8C01	H4-TFWPBB12-0-8C01	H4-TFWPBB13-0-8C01	H4-TFWPBB14-0-8C01	H4-TFWPBB15-0-8C01	H4-TFWPBB16-0-8C01	H4-TFWPLB01-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Brown Bullhead	Largemouth Bass
Collection Date	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98
Fish Length (cm)	29.4	30	27.4	29.0	30.2	26	33.0
Mirex	0.00199 U	0.00198 U	0.00198 U	0.00199 U	0.00199 U	0.00492 UJ	0.00202 U
o,p'-DDD	0.02678	0.29004	0.02176	0.02703	0.04463	0.02297 J	0.0309
o,p'-DDE	0.00199 U	0.00198 U	0.00198 U	0.00199 U	0.00199 U	0.00492 UJ	0.00202 U
o,p'-DDT	0.02696	0.38017	0.00579	0.021	0.04006	0.02996 J	0.02228
Oxychlordane	0.00124 J	0.00198 U	0.00152 J	0.00273	0.00418	0.00492 UJ	0.00202 U
Pentachloroanisole	0.00019 J	0.0014 J	0.00014 J	0.00042 J	0.00066 J	0.00019 J	0.00008 U
Pentachlorobenzene	0.00104 J	0.01634	0.00165 J	0.00458	0.01071	0.00392 J	0.0016
Toxaphene	0.02 U	0.0199 U	0.0199 U	0.02 U	0.0199 U	0.0493 UJ	0.02016 U
trans-Nonachlor	0.00035 J	0.00846	0.0006 J	0.00128 J	0.00237	0.00139 J	0.00076
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.3	1.9	0.5	1	1	0.4 J	0.9
Percent Lipids (GC/MS)	0.3 J		0.5 J		1 J		0.9
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPLB01-0-9Y13	H4-TFWPLB01-1-8S30	H4-TFWPLB02-0-9Y13	H4-TFWPLB03-0-8S30	H4-TFWPLB03-0-9Y13	H4-TFWPLB03-1-9Y13	H4-TFWPLB04-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	05/13/99	10/01/98	05/13/99	10/01/98	05/13/99	05/13/99	10/01/98
Fish Length (cm)	32	33.0	31.5	33.0	34.4	34.4	33.0
PCBs							
PCB, Total		6.28766		6.11945			10.73934
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD		0.0000033 U		0.0000033 U			
1,2,3,4,6,7,8-HPCDF		0.0000065		0.00001			
1,2,3,4,7,8,9-HPCDF		0.0000033 U		0.0000033 U			
1,2,3,4,7,8-HXCDD		0.0000033 U		0.0000033 U			
1,2,3,4,7,8-HXCDF		0.0000033 U		0.0000033 U			
1,2,3,6,7,8-HXCDD		0.0000033 U		0.0000033 U			
1,2,3,6,7,8-HXCDF		0.0000033 U		0.0000033 U			
1,2,3,7,8,9-HXCDD		0.0000033 U		0.0000033 U			
1,2,3,7,8,9-HXCDF		0.0000033 U		0.0000033 U			
1,2,3,7,8-PECDD		0.0000033 U		0.0000033 U			
1,2,3,7,8-PECDF		0.00003		0.00006			
2,3,4,6,7,8-HXCDF		0.0000033 U		0.0000033 U			
2,3,4,7,8-PECDF		0.0000033 U		0.0000042			
2,3,7,8-TCDD		0.0000007 U		0.0000007 U			
2,3,7,8-TCDF		0.00001		0.00001			
OCDD		0.0000066 U		0.0000066 U			
OCDF		0.0000066 U		0.0000066 U			
Dioxin-Like PCB Congeners							
PCB-105		0.03017		0.01773			0.03288 J
PCB-114		0.00023 U		0.00019 U			0.00019 U
PCB-118		0.13502		0.13323			0.13593 J
PCB-126		0.00599		0.00667			0.00048 J
PCB-149/123		0.26575		0.28776			0.84699 J
PCB-156		0.02953		0.03963			0.09843 J
PCB-167		0.02182		0.02964			0.05194 J
PCB-169		0.00002 J		0.0001 J			0.00017 J
PCB-189		0.00469		0.00662			0.01996 J
PCB-201/157/173		0.01448		0.01625			0.03374 J
PCB-77		0.01767		0.01695			0.00095 J
PCB-81		0.00378		0.00371			0.00012 J
Pesticides							
1,2,3,4-Tetrachlorobenzene		0.00443		0.00252			0.0193 J
1,2,4,5-Tetrachlorobenzene		0.00227 U		0.00217			0.0045
4,4'-DDD		0.00271		0.0027			0.00617
4,4'-DDE		0.01432		0.01592			0.00545
4,4'-DDT		0.00227 U		0.0019 U			0.00054
Aldrin		0.00227 U		0.0019 U			0.00191 U
alpha-BHC		0.00227 U		0.0019 U			0.00191 U
alpha-Chlordane		0.00227 U		0.0019 U			0.00131
beta-BHC		0.00227 U		0.00003 U			0.00002 J
Chlorpyrifos		0.00021 U		0.00005 U			0.00006 U
cis-Nonachlor		0.01182		0.0102			0.02296 J
delta-BHC		0.00227 U		0.000003 U			0.00191 U
Dieldrin		0.00119		0.0007			0.00191 U
Endosulfan II		0.00227 U		0.0019 U			0.00191 U
Endrin		0.00227 U		0.0019 U			0.00191 U
gamma-BHC (Lindane)		0.00013		0.00008			0.00006 U
gamma-Chlordane		0.00227 U		0.0019 U			0.00191 U
Heptachlor		0.00227 U		0.0019 U			0.00191 U
Heptachlor epoxide		0.00227 U		0.0019 U			0.00191 U
Hexachlorobenzene		0.00023		0.00014			0.00059

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPLB01-0-9Y13	H4-TFWPLB01-1-8S30	H4-TFWPLB02-0-9Y13	H4-TFWPLB03-0-8S30	H4-TFWPLB03-0-9Y13	H4-TFWPLB03-1-9Y13	H4-TFWPLB04-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	05/13/99	10/01/98	05/13/99	10/01/98	05/13/99	05/13/99	10/01/98
Fish Length (cm)	32	33.0	31.5	33.0	34.4	34.4	33.0
Mirex		0.00227 U		0.0019 U			0.00191 U
o,p'-DDD		0.02783		0.02236			0.02156 J
o,p'-DDE		0.00227 U		0.0019 U			0.00191 U
o,p'-DDT		0.02328		0.02514			0.03459 J
Oxychlordane		0.00227 U		0.0019 U			0.00191 U
Pentachloroanisole		0.00008 U		0.00007 U			0.00008 U
Pentachlorobenzene		0.00116		0.00092			0.00822 J
Toxaphene		0.02265 U		0.01902 U			0.01907 U
trans-Nonachlor		0.0007		0.0005			0.00082
Metals							
Lead	0.14 U		0.14 U		0.19 U	0.08 J	
Mercury	0.36		0.33		0.37	0.46 J	
Lipids							
Percent Lipids (GC)		0.6		0.7			0.3
Percent Lipids (GC/MS)		0.6		0.7			
Percent Lipids (Other)	0.1 U		0.1 U		0.3	0.1 U	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPLB04-0-9Y13	H4-TFWPLB05-0-9Y13	H4-TFWPLB06-0-8C01	H4-TFWPLB06-0-9Y13	H4-TFWPLB07-0-8C01	H4-TFWPLB11-0-8C01	H4-TFWPLB12-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	05/13/99	05/13/99	10/01/98	05/13/99	10/01/98	10/01/98	10/01/98
Fish Length (cm)	33	35.5	33.0	31.5	38.0	35.5	33.5
PCBs							
PCB, Total			3.55948		2.43179	5.53611	6.28418
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD			0.0000097 U		0.0000033 U		
1,2,3,4,6,7,8-HPCDF			0.0000091 J		0.0000017 J		
1,2,3,4,7,8,9-HPCDF			0.0000097 U		0.0000033 U		
1,2,3,4,7,8-HXCDD			0.0000097 U		0.0000033 U		
1,2,3,4,7,8-HXCDF			0.0000097 U		0.0000033 U		
1,2,3,6,7,8-HXCDD			0.0000097 U		0.0000033 U		
1,2,3,6,7,8-HXCDF			0.0000097 U		0.0000033 U		
1,2,3,7,8,9-HXCDD			0.0000097 U		0.0000033 U		
1,2,3,7,8,9-HXCDF			0.0000097 U		0.0000033 U		
1,2,3,7,8-PECDD			0.0000097 U		0.0000033 U		
1,2,3,7,8-PECDF			0.00002		0.00001		
2,3,4,6,7,8-HXCDF			0.0000097 U		0.0000033 U		
2,3,4,7,8-PECDF			0.0000098		0.0000039		
2,3,7,8-TCDD			0.0000019 U		0.0000007 U		
2,3,7,8-TCDF			0.00003		0.00001		
OCDD			0.00002		0.0000066 U		
OCDF			0.00001 J		0.0000066 U		
Dioxin-Like PCB Congeners							
PCB-105			0.01846 J		0.0071	0.04007	0.05175
PCB-114			0.0002 U		0.0002 U	0.00002 U	0.00002 U
PCB-118			0.05985 J		0.03777 J	0.12551	0.11383
PCB-126			0.00648 J		0.00033 J	0.00066	0.00046
PCB-149/123			0.14781 J		0.14659	0.33526	0.43787
PCB-156			0.02519 J		0.0116	0.03167	0.04626
PCB-167			0.01705 J		0.00811	0.02484	0.02639
PCB-169			0.00007 J		0.00006 J	0.00006 J	0.00006 U
PCB-189			0.0047 J		0.00227	0.00533	0.00728
PCB-201/157/173			0.01157 J		0.00519 J	0.00923	0.01104
PCB-77			0.01648 J		0.00046	0.00082	0.0004
PCB-81			0.0044 J		0.0002 U	0.00001 J	0.00002 J
Pesticides							
1,2,3,4-Tetrachlorobenzene			0.0052		0.0037	0.00432	0.00575
1,2,4,5-Tetrachlorobenzene			0.00293		0.00106 U	0.00051 J	0.00105 J
4,4'-DDD			0.00182		0.0008	0.0023	0.00187 J
4,4'-DDE			0.01623		0.00491 J	0.01132	0.01067
4,4'-DDT			0.00198 U		0.00196 U	0.00019 J	0.0002 J
Aldrin			0.00198 U		0.00196 U	0.00018 J	0.00197 U
alpha-BHC			0.00198 U		0.00001 J	0.00004 J	0.00009 J
alpha-Chlordane			0.00198 U		0.00196 U	0.00195 U	0.00049 J
beta-BHC			0.00004 U		0.00196 U	0.00001 J	0.00197 U
Chlorpyrifos			0.00012 U		0.00196 U	0.00013 J	0.00004 J
cis-Nonachlor			0.00788		0.00361	0.00766	0.00839
delta-BHC			0.00198 U		0.00196 U	0.00002 J	0.00072 J
Dieldrin			0.00048 J		0.00019	0.00035 J	0.00079 J
Endosulfan II			0.00198 U		0.00077 J	0.00345	0.0048
Endrin			0.00198 U		0.00196 U	0.00195 U	0.00197 U
gamma-BHC (Lindane)			0.00019		0.00006 J	0.00006 J	0.00008 J
gamma-Chlordane			0.00198 U		0.00011 J	0.00195 U	0.00197 U
Heptachlor			0.00198 U		0.00196 U	0.00003 J	0.00006 J
Heptachlor epoxide			0.00198 U		0.00196 U	0.00195 U	0.00004 J
Hexachlorobenzene			0.00036		0.00011 J	0.00017 J	0.00054 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPLB04-0-9Y13	H4-TFWPLB05-0-9Y13	H4-TFWPLB06-0-8C01	H4-TFWPLB06-0-9Y13	H4-TFWPLB07-0-8C01	H4-TFWPLB11-0-8C01	H4-TFWPLB12-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	05/13/99	05/13/99	10/01/98	05/13/99	10/01/98	10/01/98	10/01/98
Fish Length (cm)	33	35.5	33.0	31.5	38.0	35.5	33.5
Mirex			0.00198 U		0.00196 U	0.00195 U	0.00197 U
o,p'-DDD			0.01609		0.0094 J	0.02154	0.02247
o,p'-DDE			0.00198 U		0.00196 U	0.00195 U	0.00085 J
o,p'-DDT			0.01652		0.00867 J	0.02136	0.01871
Oxychlordane			0.00198 U		0.00084	0.00109 J	0.00102 J
Pentachloroanisole			0.00009 U		0.00005 J	0.00001 J	0.00017 J
Pentachlorobenzene			0.00195		0.00114	0.00149 J	0.00266
Toxaphene			0.0198 U		0.01959 U	0.0196 U	0.0197 U
trans-Nonachlor			0.00104		0.00124	0.00043 J	0.00077 J
Metals							
Lead	0.15 UJ	0.08 J		0.08 UJ			
Mercury	0.46	0.72		0.48 J			
Lipids							
Percent Lipids (GC)			0.5		0.3	0.2	0.3
Percent Lipids (GC/MS)			0.5		0.3		
Percent Lipids (Other)	0.2	0.1 U		0.1			

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPLB13-0-8C01	H4-TFWPLB14-0-8C01	H4-TFWPLB15-0-8C01	H4-TFWPLB17-0-8C01	H4-TFWPLB21-0-8C01	H4-TFWPLB22-0-8C01	H4-TFWPLB23-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98
Fish Length (cm)	38	37	40	35.5	34	31.4	32.7
PCBs							
PCB, Total	9.98139	5.15863	4.8221	11.47063	3.71419	9.20097	11.36232
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,4,6,7,8-HPCDF		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000003 UJ	0.0000021 J	0.0000019 J
1,2,3,4,7,8,9-HPCDF		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,4,7,8-HXCDD		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,4,7,8-HXCDF		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,6,7,8-HXCDD		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,6,7,8-HXCDF		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,7,8,9-HXCDD		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,7,8,9-HXCDF		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,7,8-PECDD		0.0000049 UJ	0.000005 UJ	0.0000044 UJ	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
1,2,3,7,8-PECDF		0.00001 J	0.00001 J	0.0000008 UJ	0.0000004 UJ	0.00001 J	0.00001 J
2,3,4,6,7,8-HXCDF		0.0000049 UJ	0.000005 UJ	0.0000005 J	0.0000047 UJ	0.0000049 UJ	0.0000049 UJ
2,3,4,7,8-PECDF		0.0000049 UJ	0.0000012 J	0.0000011 UJ	0.0000009 UJ	0.0000019 J	0.0000055 J
2,3,7,8-TCDD		0.000001 UJ	0.000001 UJ	0.0000009 UJ	0.0000009 UJ	0.000001 UJ	0.000001 UJ
2,3,7,8-TCDF		0.000001 UJ	0.0000019 J	0.0000016 UJ	0.0000013 UJ	0.0000019 J	0.00001 J
OCDD		0.0000097 UJ	0.0000099 UJ	0.0000089 UJ	0.0000093 UJ	0.0000098 UJ	0.0000098 UJ
OCDF		0.0000013 J	0.0000099 UJ	0.0000089 UJ	0.0000093 UJ	0.0000098 UJ	0.0000098 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.07021	0.06453	0.0406	0.0526	0.02586	0.06374	0.0306
PCB-114	0.00002 U	0.00002 U	0.00002 U	0.00001 U	0.00001 U	0.00002 U	0.00001 U
PCB-118	0.15366	0.07025	0.06197	0.13767	0.03955	0.17337	0.15892
PCB-126	0.00064	0.00043	0.00031	0.00075	0.00036	0.00088	0.001
PCB-149/123	0.63576	0.32425	0.34329	0.71885	0.23505	0.62173	0.45508
PCB-156	0.05387	0.01515	0.03048	0.07106	0.0081	0.04257	0.05242
PCB-167	0.04806	0.01601	0.01701	0.045	0.011	0.03399	0.0636
PCB-169	0.00008 U	0.00006 J	0.00006 U	0.00014	0.00006 J	0.00012 U	0.00012
PCB-189	0.0125	0.00418	0.00519	0.01733	0.0036	0.00879	0.01564
PCB-201/157/173	0.01874	0.00808	0.00915	0.02923	0.00723	0.01374	0.02389
PCB-77	0.00057	0.00033	0.0004	0.00088	0.00027	0.00086	0.00062
PCB-81	0.00004 J	0.00012	0.00009	0.0002	0.00001 U	0.00007	0.00004 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00415	0.00394	0.00771	0.02649	0.0083	0.01294	0.00753
1,2,4,5-Tetrachlorobenzene	0.00088 J	0.00134 J	0.00179 J	0.00557	0.00151 J	0.00301	0.00211
4,4'-DDD	0.00284	0.00341	0.00174 J	0.00323	0.00111 J	0.00246	0.00561
4,4'-DDE	0.01979	0.01187	0.00887	0.00671	0.00679	0.01551	0.02634
4,4'-DDT	0.00062 J	0.00008 J	0.00055 J	0.0004 J	0.00017 J	0.00095 J	0.00045 J
Aldrin	0.00041 J	0.00197 U	0.00042 J	0.00192 U	0.00194 U	0.00066 J	0.00198 U
alpha-BHC	0.00009 J	0.00197 U	0.00009 J	0.00005 J	0.00002 J	0.0001 J	0.0001 J
alpha-Chlordane	0.00085 J	0.00197 U	0.00068 J	0.00192 U	0.0002 J	0.00096 J	0.00198 U
beta-BHC	0.00197 U	0.00197 U	0.00012 J	0.00192 U	0.00194 U	0.00196 U	0.00198 U
Chlorpyrifos	0.00004 J	0.00197 U	0.00199 U	0.00005 J	0.00194 U	0.00011 J	0.00025 J
cis-Nonachlor	0.0121	0.00724	0.00818	0.01951	0.00844	0.01528	0.01973
delta-BHC	0.00073 J	0.00197 U	0.00119 J	0.00184 J	0.00103 J	0.00193 J	0.00198 U
Dieldrin	0.00111 J	0.00197 U	0.00066 J	0.00063 J	0.00058 J	0.00118 J	0.00066 J
Endosulfan II	0.00197 U	0.00197 U	0.00303	0.0075	0.00217	0.00618	0.00198 U
Endrin	0.00197 U	0.00197 U	0.00199 U	0.00192 U	0.00194 U	0.00196 U	0.00198 U
gamma-BHC (Lindane)	0.00007 J	0.00004 J	0.00014 J	0.00006 J	0.00008 J	0.00016 J	0.00008 J
gamma-Chlordane	0.00197 U	0.00197 U	0.00199 U	0.00008 J	0.00007 J	0.00196 U	0.00198 U
Heptachlor	0.00006 J	0.00197 U	0.00005 J	0.00192 U	0.00194 U	0.00008 J	0.00198 U
Heptachlor epoxide	0.00018 J	0.00167 J	0.00021 J	0.00084 J	0.00062 J	0.00038 J	0.00024 J
Hexachlorobenzene	0.00039 J	0.00016 J	0.00061 J	0.00109 J	0.00047 J	0.00092 J	0.00072 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPLB13-0-8C01	H4-TFWPLB14-0-8C01	H4-TFWPLB15-0-8C01	H4-TFWPLB17-0-8C01	H4-TFWPLB21-0-8C01	H4-TFWPLB22-0-8C01	H4-TFWPLB23-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass	Largemouth Bass
Collection Date	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98	10/01/98
Fish Length (cm)	38	37	40	35.5	34	31.4	32.7
Mirex	0.00197 U	0.00197 U	0.00199 U	0.00004 J	0.00014 J	0.00196 U	0.00198 U
o,p'-DDD	0.03271	0.0182	0.01457	0.00909	0.01242	0.02979	0.04118
o,p'-DDE	0.00082 J	0.00197 U	0.00108 J	0.00192 U	0.00194 U	0.00128 J	0.00075 J
o,p'-DDT	0.02752	0.01752	0.01383	0.0248	0.0133	0.02478	0.03381
Oxychlordane	0.00164 J	0.00035 J	0.00137 J	0.00029 J	0.00011 J	0.00237	0.00243
Pentachloroanisole	0.00016 J	0.00014 J	0.00021 J	0.00014 J	0.00017 J	0.00031 J	0.00017 J
Pentachlorobenzene	0.00242	0.00112 J	0.00514	0.01762	0.0043	0.00685	0.0034
Toxaphene	0.0197 U	0.0197 U	0.0199 U	0.0193 U	0.0194 U	0.0196 U	0.0198 U
trans-Nonachlor	0.00107 J	0.00022 J	0.0006 J	0.00043 J	0.00044 J	0.00115 J	0.00172 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.3	0.2	0.2	0.3	0.2	0.3	0.3
Percent Lipids (GC/MS)		0.2 J	0.2 J	0.3 J	0.2 J	0.3 J	0.3 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03BG01-0-8C20	H3-TF03PS01-0-8C02	H3-TF03YP01-0-8C02	H3-TF03YP01-0-8C19	H3-TF03YP01-1-8C19	H3-TF03YP02-0-8C02	H3-TF03YP02-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Bluegill	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/21/1998	10/3/1998	10/2/1998	10/19/1998	10/19/1998	10/3/1998	10/19/1998
Fish Length (cm)	16.5	16.3	29.4	24.5	24.5	28	24.5
PCBs							
PCB, Total	5.46542	7.27664	50.25485	4.38698	1.30028	16.93319	0.78561
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000018 J	0.0000044 U
1,2,3,4,6,7,8-HPCDF	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,4,7,8,9-HPCDF	0.0000009 J	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,4,7,8-HXCDD	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,4,7,8-HXCDF	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,6,7,8-HXCDD	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,6,7,8-HXCDF	0.000005 U	0.0000082 U	0.0000007 J	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,7,8,9-HXCDD	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,7,8,9-HXCDF	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,7,8-PECDD	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
1,2,3,7,8-PECDF	0.0000076	0.00001 U	0.00004 U	0.0000089 U	0.0000023 J	0.00002 UJ	0.0000013 J
2,3,4,6,7,8-HXCDF	0.000005 U	0.0000082 U	0.000005 U	0.0000089 U	0.0000064 U	0.0000049 UJ	0.0000044 U
2,3,4,7,8-PECDF	0.0000014 J	0.0000052 U	0.0000064 U	0.0000089 U	0.0000023 J	0.000003 UJ	0.0000014 J
2,3,7,8-TCDD	0.000001 U	0.0000016 U	0.000001 U	0.0000018 U	0.0000013 U	0.000001 UJ	0.00000088 U
2,3,7,8-TCDF	0.0000036	0.00002 U	0.00001 U	0.0000079	0.0000085	0.000001 UJ	0.000004
OCDD	0.0000099 U	0.00001 U	0.0000099 U	0.00001 U	0.00001 U	0.0000099 UJ	0.0000088 U
OCDF	0.0000099 U	0.000001 J	0.0000099 U	0.00001 U	0.00001 U	0.0000099 UJ	0.0000088 U
Dioxin-Like PCB Congeners							
PCB-105	0.04799	0.06878	0.2891 J	0.01917 J	0.00534	0.19953 J	0.00526
PCB-114	0.00032 U	0.00002 U	0.00002 U	0.00032 UJ	0.00031 U	0.00001 UJ	0.00038 U
PCB-118	0.16716	0.1664	0.54635 J	0.05694 J	0.01688	0.19464 J	0.01684
PCB-126	0.00783	0.00065	0.00436 J	0.00499 J	0.00229	0.00041 J	0.0005 J
PCB-149/123	0.20532	0.30782	3.24016 J	0.24318 J	0.07211	0.88614 J	0.03448
PCB-156	0.03907	0.11214	0.50019 J	0.03129 J	0.00633	0.08801 J	0.0038 J
PCB-167	0.01528	0.0271	0.21905 J	0.012 J	0.00319	0.04967 J	0.00205
PCB-169	0.00001 J	0.00006 J	0.00021 J	0.000009 J	0.00009 J	0.00007 J	0.00005 J
PCB-189	0.00446	0.01074	0.05914 J	0.00492 J	0.00115	0.02461 J	0.00067
PCB-201/157/173	0.01545	0.01871	0.14493 J	0.0132 J	0.00352	0.04976 J	0.00186
PCB-77	0.03635	0.00117	0.00394 J	0.01021 J	0.00473	0.00042 J	0.00065 J
PCB-81	0.01001	0.00006 J	0.00077 J	0.00326 J	0.00163	0.00008 J	0.00011 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00585	0.07335	0.02219	0.01682	0.00653	0.03143 J	0.00779
1,2,4,5-Tetrachlorobenzene	0.0016 J	0.0167	0.00736	0.00328	0.00035 J	0.00495 J	0.00383 J
4,4'-DDD	0.00819	0.0075	0.01649	0.00211 J	0.00026 J	0.00687 J	0.00106 J
4,4'-DDE	0.00504	0.01196	0.03063	0.00317 U	0.00315 U	0.01274 J	0.00234 J
4,4'-DDT	0.00094 J	0.00187 J	0.00265	0.00317 U	0.00315 U	0.0013 J	0.00027 J
Aldrin	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00024 J	0.00006 J
alpha-BHC	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00195 UJ	0.00003 J
alpha-Chlordane	0.00318 U	0.00095 J	0.00213	0.00084 J	0.00315 U	0.00195 UJ	0.00004 J
beta-BHC	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00195 UJ	0.00384 U
Chlorpyrifos	0.00002 U	0.00022 U	0.0002 U	0.00317 U	0.00315 U	0.00195 UJ	0.00022 J
cis-Nonachlor	0.01339	0.01108	0.07571	0.01208	0.00322	0.03757 J	0.00154 J
delta-BHC	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00658 J	0.00384 U
Dieldrin	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.01056 J	0.00006 J
Endosulfan II	0.00318 U	0.00724	0.02332	0.00317 U	0.00315 U	0.00954 J	0.00039 J
Endrin	0.00318 U	0.00004 J	0.00027 J	0.00317 U	0.00315 U	0.00195 UJ	0.00384 U
gamma-BHC (Lindane)	0.00318 U	0.00003 J	0.00198 U	0.00317 U	0.00315 U	0.000007 J	0.00384 U
gamma-Chlordane	0.00318 U	0.00007 J	0.00003 J	0.00317 U	0.00315 U	0.00195 UJ	0.00006 J
Heptachlor	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00016 J	0.00384 U
Heptachlor epoxide	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00195 UJ	0.00384 U
Hexachlorobenzene	0.00036 J	0.00233	0.00186 U	0.00061 J	0.00015 J	0.00109 J	0.00026 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03BG01-0-8C20	H3-TF03PS01-0-8C02	H3-TF03YP01-0-8C02	H3-TF03YP01-0-8C19	H3-TF03YP01-1-8C19	H3-TF03YP02-0-8C02	H3-TF03YP02-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Bluegill	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/21/1998	10/3/1998	10/2/1998	10/19/1998	10/19/1998	10/3/1998	10/19/1998
Fish Length (cm)	16.5	16.3	29.4	24.5	24.5	28	24.5
Mirex	0.00318 U	0.00002 J	0.00198 U	0.00317 U	0.00315 U	0.00195 UJ	0.00384 U
o,p'-DDD	0.02135	0.01215	0.09858	0.00602	0.00171 J	0.02916 J	0.00215 J
o,p'-DDE	0.00318 U	0.00199 U	0.00198 U	0.00317 U	0.00315 U	0.00214 J	0.00384 U
o,p'-DDT	0.02001	0.02327	0.17471	0.0101	0.00252 J	0.04202 J	0.00211 J
Oxychlordane	0.00374	0.00199 U	0.00198 U	0.00027 J	0.00006 J	0.00195 UJ	0.00384 U
Pentachloroanisole	0.00009 J	0.00081 J	0.00066 J	0.00009 J	0.00006 J	0.0004 J	0.0003 J
Pentachlorobenzene	0.00345	0.03224	0.01629	0.00868	0.00304 J	0.0162 J	0.00189 J
Toxaphene	0.03176 U	0.02 U	0.0199 U	0.03167 U	0.03148 U	0.0196 UJ	0.03843 U
trans-Nonachlor	0.00073 J	0.00184 J	0.00191 J	0.00317 U	0.00315 U	0.0016 J	0.00031 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.15	1.1	1.3	0.1	0.05	0.8 J	0.5
Percent Lipids (GC/MS)	0.15	1.1	1.3	0.1	0.05	0.8 J	0.51
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP03-0-8C02	H3-TF03YP03-1-8C02	H3-TF03YP04-0-8C02	H3-TF03YP05-0-8C02	H3-TF03YP06-0-8C02	H3-TF03YP07-0-8C02	H3-TF03YP08-0-8C02
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998
Fish Length (cm)	27.2	27.2	25	22.5	24.8	26.2	25.5
PCBs							
PCB, Total	9.53842	8.20793	4.80535	11.3869	4.9741	8.15478	6.66622
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000049 UJ	0.0000046 UJ	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,4,6,7,8-HPCDF	0.0000055 J	0.0000083 J	0.000007 UJ			0.0000073 J	0.0000058 J
1,2,3,4,7,8,9-HPCDF	0.0000049 UJ	0.0000011 J	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,4,7,8-HXCDD	0.0000049 UJ	0.0000046 UJ	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,4,7,8-HXCDF	0.0000049 UJ	0.0000006 J	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,6,7,8-HXCDD	0.0000049 UJ	0.0000046 UJ	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,6,7,8-HXCDF	0.0000049 UJ	0.0000007 J	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,7,8,9-HXCDD	0.0000049 UJ	0.0000046 UJ	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,7,8,9-HXCDF	0.0000049 UJ	0.0000005 J	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,7,8-PECDD	0.0000049 UJ	0.0000046 UJ	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
1,2,3,7,8-PECDF	0.00002 UJ	0.00002 J	0.00001 UJ			0.00004 UJ	0.00003 UJ
2,3,4,6,7,8-HXCDF	0.0000049 UJ	0.0000013 J	0.000007 UJ			0.0000039 UJ	0.0000046 UJ
2,3,4,7,8-PECDF	0.0000013 UJ	0.0000015 J	0.0000019 UJ			0.0000039 UJ	0.0000046 UJ
2,3,7,8-TCDD	0.000001 UJ	0.0000002 J	0.0000014 UJ			0.0000008 UJ	0.0000009 UJ
2,3,7,8-TCDF	0.0000038 J	0.0000031 J	0.0000034 J			0.0000055 J	0.000004 J
OCDD	0.0000098 UJ	0.000004 J	0.0000017 J			0.0000078 UJ	0.0000091 UJ
OCDF	0.0000098 UJ	0.000004 J	0.00001 UJ			0.0000078 UJ	0.0000091 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.11792 J	0.10732 J	0.07457 J	0.16389 J	0.06852 J	0.1073 J	0.085 J
PCB-114	0.00002 UJ	0.00002 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ
PCB-118	0.10244 J	0.08989 J	0.06219 J	0.12842 J	0.05621 J	0.07721 J	0.05659 J
PCB-126	0.0002 J	0.00021 J	0.00024 J	0.00028 J	0.00017 J	0.00015 J	0.00018 J
PCB-149/123	0.57991 J	0.48809 J	0.28405 J	0.66584 J	0.30375 J	0.51855 J	0.42126 J
PCB-156	0.07361 J	0.05183 J	0.02515 J	0.07245 J	0.01975 J	0.03855 J	0.03004 J
PCB-167	0.03125 J	0.03327 J	0.01203 J	0.0311 J	0.01192 J	0.02578 J	0.0207 J
PCB-169	0.00002 UJ	0.00003 J	0.00002 J	0.00002 J	0.00003 J	0.00001 J	0.00002 J
PCB-189	0.0133 J	0.01548 J	0.00431 J	0.01096 J	0.00411 J	0.01004 J	0.00821 J
PCB-201/157/173	0.02948 J	0.02999 J	0.00985 J	0.02809 J	0.00904 J	0.02285 J	0.01646 J
PCB-77	0.00039 J	0.00021 J	0.00021 J	0.00035 J	0.00036 J	0.00055 J	0.00043 J
PCB-81	0.00002 UJ	0.00001 J	0.00001 UJ	0.00001 UJ	0.0001 J	0.00005 J	0.00001 UJ
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.02725 J	0.02604 J	0.02372 J	0.02004 J	0.02656 J	0.0324 J	0.02539 J
1,2,4,5-Tetrachlorobenzene	0.00471 J	0.00474 J	0.00539 J	0.00438 J	0.00479 J	0.00562 J	0.00471 J
4,4'-DDD	0.00675 J	0.00495 J	0.00345 J	0.0066 J	0.00317 J	0.00458 J	0.00454 J
4,4'-DDE	0.00768 J	0.00798 J	0.00507 J	0.0122 J	0.00476 J	0.0064 J	0.00939 J
4,4'-DDT	0.00084 J	0.00079 J	0.0008 J	0.00073 J	0.00056 J	0.00096 J	0.00099 J
Aldrin	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
alpha-BHC	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
alpha-Chlordane	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
beta-BHC	0.00199 UJ	0.0003 J	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
Chlorpyrifos	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
cis-Nonachlor	0.02556 J	0.02539 J	0.01014 J	0.02594 J	0.01003 J	0.02198 J	0.01607 J
delta-BHC	0.00539 J	0.00527 J	0.00425 J	0.00714 J	0.00518 J	0.00643 J	0.00617 J
Dieldrin	0.00724 J	0.00698 J	0.00419 J	0.00967 J	0.00429 J	0.00721 J	0.00636 J
Endosulfan II	0.01334 J	0.01042 J	0.00799 J	0.0109 J	0.0059 J	0.01304 J	0.00634 J
Endrin	0.00002 J	0.00009 J	0.00008 J	0.00196 UJ	0.00008 J	0.00199 UJ	0.00197 UJ
gamma-BHC (Lindane)	0.00199 UJ	0.00001 J	0.00194 UJ	0.00003 J	0.00001 J	0.00199 UJ	0.000006 J
gamma-Chlordane	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
Heptachlor	0.00038 J	0.00014 J	0.00029 J	0.00042 J	0.00042 J	0.00044 J	0.00032 J
Heptachlor epoxide	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
Hexachlorobenzene	0.00081 J	0.00088 J	0.00075 J	0.0012 J	0.00075 J	0.00091 J	0.00088 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP03-0-8C02	H3-TF03YP03-1-8C02	H3-TF03YP04-0-8C02	H3-TF03YP05-0-8C02	H3-TF03YP06-0-8C02	H3-TF03YP07-0-8C02	H3-TF03YP08-0-8C02
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998
Fish Length (cm)	27.2	27.2	25	22.5	24.8	26.2	25.5
Mirex	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
o,p'-DDD	0.02021 J	0.01764 J	0.01251 J	0.02717 J	0.01189 J	0.01811 J	0.01765 J
o,p'-DDE	0.00202 J	0.0021 J	0.0014 J	0.0035 J	0.00126 J	0.00184 J	0.00149 J
o,p'-DDT	0.02797 J	0.02743 J	0.01281 J	0.0328 J	0.01264 J	0.02391 J	0.02146 J
Oxychlordane	0.00199 UJ	0.002 UJ	0.00194 UJ	0.00196 UJ	0.00193 UJ	0.00199 UJ	0.00197 UJ
Pentachloroanisole	0.00027 J	0.00073 J	0.00034 J	0.00032 J	0.00036 J	0.00039 J	0.00049 J
Pentachlorobenzene	0.01407 J	0.01429 J	0.01204 J	0.01357 J	0.01296 J	0.01535 J	0.01334 J
Toxaphene	0.02 UJ	0.02 UJ	0.0195 UJ	0.0197 UJ	0.0193 UJ	0.0199 UJ	0.0198 UJ
trans-Nonachlor	0.00138 J	0.00069 J	0.0008 J	0.00135 J	0.00098 J	0.00115 J	0.00094 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.7 J	0.4 J	0.6 J	0.7 J	0.8 J	0.7 J	0.5 J
Percent Lipids (GC/MS)	0.7 J	0.4 J	0.6 J			0.7 J	0.5 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP09-0-8C02	H3-TF03YP10-0-8C02	H3-TF03YP11-0-8C02	H3-TF03YP12-0-8C02	H3-TF03YP13-0-8C02	H3-TF03YP14-0-8C02	H3-TF03YP15-0-8C02
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998
Fish Length (cm)	23.5	24.9	22.8	24.6	25.1	25.2	28.6
PCBs							
PCB, Total	4.06258	13.10223	11.42721	20.47405	4.68379	10.85027	5.04444
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,4,6,7,8-HPCDF	0.0000047 UJ	0.00001 J	0.0000044 UJ		0.0000043 UJ		0.0000049 J
1,2,3,4,7,8,9-HPCDF	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,4,7,8-HXCDD	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,4,7,8-HXCDF	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,6,7,8-HXCDD	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,6,7,8-HXCDF	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,7,8,9-HXCDD	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,7,8,9-HXCDF	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,7,8-PECDD	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
1,2,3,7,8-PECDF	0.00001 UJ	0.0001 J	0.00003 UJ		0.00002 UJ		0.00002 UJ
2,3,4,6,7,8-HXCDF	0.0000047 UJ	0.0000057 UJ	0.0000044 UJ		0.0000043 UJ		0.000004 UJ
2,3,4,7,8-PECDF	0.0000047 UJ	0.0000057 UJ	0.0000028 UJ		0.0000017 UJ		0.000002 UJ
2,3,7,8-TCDD	0.0000009 UJ	0.0000011 UJ	0.0000009 UJ		0.0000009 UJ		0.0000008 UJ
2,3,7,8-TCDF	0.0000037 J	0.0000048 J	0.0000078 J		0.0000043 J		0.0000008 UJ
OCDD	0.0000094 UJ	0.00001 UJ	0.0000087 UJ		0.0000086 UJ		0.0000081 UJ
OCDF	0.0000094 UJ	0.00001 UJ	0.0000087 UJ		0.0000086 UJ		0.0000081 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.04966 J	0.17765 J	0.14245 J	0.24136 J	0.07074 J	0.14275 J	0.06686 J
PCB-114	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ
PCB-118	0.05091 J	0.11932 J	0.11881 J	0.20669 J	0.05864 J	0.09863 J	0.06354 J
PCB-126	0.00019 J	0.00024 J	0.00053 J	0.00058 J	0.00021 J	0.00032 J	0.00021 J
PCB-149/123	0.22656 J	0.87792 J	0.67605 J	1.25685 J	0.28056 J	0.6684 J	0.29821 J
PCB-156	0.01816 J	0.0609 J	0.04886 J	0.07181 J	0.0209 J	0.04801 J	0.02743 J
PCB-167	0.01099 J	0.03456 J	0.02823 J	0.05448 J	0.0102 J	0.03109 J	0.01617 J
PCB-169	0.00001 J	0.00002 J	0.000009 J	0.000001 J	0.00004 J	0.00001 UJ	0.000002 J
PCB-189	0.00418 J	0.01224 J	0.01099 J	0.02005 J	0.00403 J	0.01165 J	0.00647 J
PCB-201/157/173	0.00873 J	0.02942 J	0.01663 J	0.04266 J	0.0085 J	0.02676 J	0.01434 J
PCB-77	0.00018 J	0.00039 J	0.00094 J	0.00064 J	0.00073 J	0.00056 J	0.0002 J
PCB-81	0.00001 UJ	0.00015 J	0.00018 J	0.00012 J	0.00013 J	0.00011 J	0.00013 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01962 J	0.03077 J	0.03924 J	0.03464 J	0.02134 J	0.02919 J	0.01781 J
1,2,4,5-Tetrachlorobenzene	0.00348 J	0.00659 J	0.00852 J	0.00628 J	0.00522 J	0.00564 J	0.00339 J
4,4'-DDD	0.00253 J	0.00583 J	0.00604 J	0.00822 J	0.0027 J	0.00463 J	0.00268 J
4,4'-DDE	0.00492 J	0.00929 J	0.01251 J	0.02085 J	0.00319 J	0.00792 J	0.00534 J
4,4'-DDT	0.00053 J	0.00126 J	0.00149 J	0.00158 J	0.00055 J	0.00077 J	0.00051 J
Aldrin	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
alpha-BHC	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
alpha-Chlordane	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
beta-BHC	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
Chlorpyrifos	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
cis-Nonachlor	0.00828 J	0.02611 J	0.02153 J	0.04087 J	0.00974 J	0.02508 J	0.01275 J
delta-BHC	0.00531 J	0.00697 J	0.0112 J	0.00951 J	0.00588 J	0.00509 J	0.00335 J
Dieldrin	0.0041 J	0.00737 J	0.00976 J	0.01329 J	0.00422 J	0.00697 J	0.00458 J
Endosulfan II	0.00408 J	0.01398 J	0.01364 J	0.01654 J	0.00515 J	0.01649 J	0.00665 J
Endrin	0.00188 UJ	0.00032 J	0.0004 J	0.00195 UJ	0.00012 J	0.00005 J	0.00005 J
gamma-BHC (Lindane)	0.00188 UJ	0.00193 UJ	0.00002 J	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.000007 J
gamma-Chlordane	0.00188 UJ	0.00193 UJ	0.00032 J	0.00036 J	0.00019 J	0.00196 UJ	0.0019 UJ
Heptachlor	0.0005 J	0.00033 J	0.00032 J	0.0003 J	0.00022 J	0.00035 J	0.00027 J
Heptachlor epoxide	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
Hexachlorobenzene	0.00071 J	0.00123 J	0.00176 J	0.00151 J	0.00075 J	0.001 J	0.00063 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP09-0-8C02	H3-TF03YP10-0-8C02	H3-TF03YP11-0-8C02	H3-TF03YP12-0-8C02	H3-TF03YP13-0-8C02	H3-TF03YP14-0-8C02	H3-TF03YP15-0-8C02
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998
Fish Length (cm)	23.5	24.9	22.8	24.6	25.1	25.2	28.6
Mirex	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
o,p'-DDD	0.01058 J	0.02398 J	0.02517 J	0.04097 J	0.01161 J	0.01909 J	0.01296 J
o,p'-DDE	0.00119 J	0.00168 J	0.00178 J	0.00204 J	0.00128 J	0.00156 J	0.0008 J
o,p'-DDT	0.01038 J	0.03423 J	0.02871 J	0.05115 J	0.01231 J	0.02687 J	0.01594 J
Oxychlordane	0.00188 UJ	0.00193 UJ	0.00188 UJ	0.00195 UJ	0.00197 UJ	0.00196 UJ	0.0019 UJ
Pentachloroanisole	0.00036 J	0.00064 J	0.00084 J	0.00077 J	0.0004 J	0.00034 J	0.0003 J
Pentachlorobenzene	0.00984 J	0.01662 J	0.02211 J	0.01927 J	0.00995 J	0.01355 J	0.00852 J
Toxaphene	0.0189 UJ	0.0193 UJ	0.0188 UJ	0.0195 UJ	0.0198 UJ	0.0196 UJ	0.0191 UJ
trans-Nonachlor	0.00125 J	0.00085 J	0.00132 J	0.00151 J	0.0006 J	0.00149 J	0.00092 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	2.1 J	1.5 J	1 J	0.6 J	0.4 J	0.6 J	0.6 J
Percent Lipids (GC/MS)	2.1 J	1.5 J	1 J		0.4 J		0.6 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP16-0-8C02	H3-TF03YP17-0-8C02	H3-TF03YP18-0-8C02	H3-TF03YP19-0-8C02	H3-TF03YP20-0-8C02	H3-TF03YP21-0-8C02	H3-TF03YP22-0-8C02
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998
Fish Length (cm)	24.5	22.8	21	21.6	24.4	25.1	22.5
PCBs							
PCB, Total	6.56764	11.17856	8.21325	5.40371	3.17434	7.7682	5.62188
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD			0.0000075 UJ		0.0000048 UJ		
1,2,3,4,6,7,8-HPCDF			0.0000074 J		0.0000048 UJ		
1,2,3,4,7,8,9-HPCDF			0.0000075 UJ		0.0000048 UJ		
1,2,3,4,7,8-HXCDD			0.0000075 UJ		0.0000048 UJ		
1,2,3,4,7,8-HXCDF			0.0000075 UJ		0.0000048 UJ		
1,2,3,6,7,8-HXCDD			0.0000075 UJ		0.0000048 UJ		
1,2,3,6,7,8-HXCDF			0.0000075 UJ		0.0000048 UJ		
1,2,3,7,8,9-HXCDD			0.0000075 UJ		0.0000048 UJ		
1,2,3,7,8,9-HXCDF			0.0000075 UJ		0.0000048 UJ		
1,2,3,7,8-PECDD			0.0000075 UJ		0.0000048 UJ		
1,2,3,7,8-PECDF			0.00004 UJ		0.00001 UJ		
2,3,4,6,7,8-HXCDF			0.0000075 UJ		0.0000048 UJ		
2,3,4,7,8-PECDF			0.0000075 UJ		0.0000022 UJ		
2,3,7,8-TCDD			0.0000015 UJ		0.000001 UJ		
2,3,7,8-TCDF			0.0000015 UJ		0.0000052 J		
OCDD			0.00001 UJ		0.0000096 UJ		
OCDF			0.00001 UJ		0.0000096 UJ		
Dioxin-Like PCB Congeners							
PCB-105	0.04946 J	0.1456 J	0.12699 J	0.04359 J	0.04671 J	0.05982 J	0.04596 J
PCB-114	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ	0.00001 UJ
PCB-118	0.05308 J	0.10518 J	0.0761 J	0.0446 J	0.03517 J	0.04917 J	0.04842 J
PCB-126	0.00039 J	0.00027 J	0.00032 J	0.00017 J	0.00013 J	0.00041 J	0.00016 J
PCB-149/123	0.3109 J	0.72248 J	0.52765 J	0.27433 J	0.20722 J	0.3506 J	0.24682 J
PCB-156	0.02496 J	0.04927 J	0.04043 J	0.02715 J	0.01387 J	0.04191 J	0.03156 J
PCB-167	0.01684 J	0.03203 J	0.03688 J	0.01406 J	0.00985 J	0.02328 J	0.01854 J
PCB-169	0.00004 J	0.00002 J	0.00001 UJ	0.00001 UJ	0.00015 J	0.00002 J	0.00001 UJ
PCB-189	0.00655 J	0.01204 J	0.01232 J	0.00515 J	0.00356 J	0.01103 J	0.00688 J
PCB-201/157/173	0.01587 J	0.02621 J	0.03015 J	0.01178 J	0.00565 J	0.02235 J	0.01259 J
PCB-77	0.00026 J	0.00026 J	0.00039 J	0.00023 J	0.00033 J	0.00035 J	0.00023 J
PCB-81	0.00001 UJ	0.00022 J	0.00021 J	0.00031 J	0.00008 J	0.0002 J	0.00027 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01889 J	0.03179 J	0.02198 J	0.02053 J	0.02102 J	0.02436 J	0.02648 J
1,2,4,5-Tetrachlorobenzene	0.00291 J	0.00701 J	0.00351 J	0.00373 J	0.00419 J	0.00417 J	0.00428 J
4,4'-DDD	0.00334 J	0.00462 J	0.00447 J	0.00311 J	0.00178 J	0.00317 J	0.0034 J
4,4'-DDE	0.00553 J	0.00885 J	0.00971 J	0.00779 J	0.00375 J	0.0079 J	0.01032 J
4,4'-DDT	0.0007 J	0.00123 J	0.00109 J	0.00069 J	0.00035 J	0.00113 J	0.00097 J
Aldrin	0.00193 UJ	0.00197 UJ	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00196 UJ
alpha-BHC	0.00015 J	0.00197 UJ	0.00198 UJ	0.00013 J	0.00016 J	0.00021 J	0.00196 UJ
alpha-Chlordane	0.00193 UJ	0.00197 UJ	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00196 UJ
beta-BHC	0.00193 UJ	0.00197 UJ	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00196 UJ
Chlorpyrifos	0.00193 UJ	0.00197 UJ	0.00198 UJ	0.00188 UJ	0.00046 J	0.00198 UJ	0.00196 UJ
cis-Nonachlor	0.01436 J	0.02668 J	0.02994 J	0.01476 J	0.00636 J	0.02115 J	0.01421 J
delta-BHC	0.00193 UJ	0.00626 J	0.007 J	0.00188 UJ	0.00212 J	0.00198 UJ	0.00196 UJ
Dieldrin	0.00067 J	0.00752 J	0.00778 J	0.00049 J	0.00371 J	0.00049 J	0.00035 J
Endosulfan II	0.00912 J	0.01772 J	0.01673 J	0.01019 J	0.00934 J	0.01467 J	0.00938 J
Endrin	0.00007 J	0.00013 J	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00012 J	0.00007 J
gamma-BHC (Lindane)	0.00193 UJ	0.00001 J	0.000005 J	0.00188 UJ	0.00192 UJ	0.000008 J	0.00196 UJ
gamma-Chlordane	0.00193 UJ	0.00069 J	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00027 J
Heptachlor	0.00193 UJ	0.0003 J	0.0002 J	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00013 J
Heptachlor epoxide	0.00193 UJ	0.00197 UJ	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00196 UJ
Hexachlorobenzene	0.00068 J	0.00119 J	0.00127 J	0.00069 J	0.00079 J	0.00085 J	0.00103 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP16-0-8C02	H3-TF03YP17-0-8C02	H3-TF03YP18-0-8C02	H3-TF03YP19-0-8C02	H3-TF03YP20-0-8C02	H3-TF03YP21-0-8C02	H3-TF03YP22-0-8C02
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998	10/3/1998
Fish Length (cm)	24.5	22.8	21	21.6	24.4	25.1	22.5
Mirex	0.00193 UJ	0.00197 UJ	0.00198 UJ	0.00188 UJ	0.00192 UJ	0.00198 UJ	0.00196 UJ
o,p'-DDD	0.01537 J	0.0206 J	0.0245 J	0.01729 J	0.00599 J	0.01808 J	0.0208 J
o,p'-DDE	0.00193 UJ	0.00191 J	0.00167 J	0.00188 UJ	0.00093 J	0.00198 UJ	0.00196 UJ
o,p'-DDT	0.01695 J	0.02873 J	0.03331 J	0.01829 J	0.01097 J	0.02272 J	0.01846 J
Oxychlordane	0.00072 J	0.00197 UJ	0.00198 UJ	0.00076 J	0.00192 UJ	0.00096 J	0.00103 J
Pentachloroanisole	0.00019 J	0.00043 J	0.00033 J	0.00015 J	0.00018 J	0.00022 J	0.00022 J
Pentachlorobenzene	0.01116 J	0.01753 J	0.01509 J	0.01034 J	0.00991 J	0.01332 J	0.01274 J
Toxaphene	0.0193 UJ	0.0197 UJ	0.0198 UJ	0.0189 UJ	0.0192 UJ	0.0198 UJ	0.0196 UJ
trans-Nonachlor	0.00093 J	0.00167 J	0.00117 J	0.00072 J	0.00192 UJ	0.00092 J	0.00124 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.5 J	0.7 J	0.4 J	0.5 J	1.5 J	0.5 J	0.6 J
Percent Lipids (GC/MS)			0.4 J		1.5 J		
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP23-0-8C02	H3-TF07PS07-0-8S29	H3-TF07PS08-0-8S29	H3-TF07YP01-0-8S29	H3-TF07YP01-1-8S29	H3-TF07YP03-0-8S29	H3-TF07YP03-1-8S29
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	23.2	17.0	16.5	27.5	27.5	31.0	31.0
PCBs							
PCB, Total	5.50327	7.89024	4.12942	75.67096	11.15887	8.98014	13.35997
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,4,6,7,8-HPCDF			0.00001	0.00011	0.00027	0.00002	0.00003
1,2,3,4,7,8,9-HPCDF			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,4,7,8-HXCDD			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,4,7,8-HXCDF			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,6,7,8-HXCDD			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,6,7,8-HXCDF			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,7,8,9-HXCDD			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,7,8,9-HXCDF			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,7,8-PECDD			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
1,2,3,7,8-PECDF			0.00001	0.00025	0.00021	0.00004	0.00004
2,3,4,6,7,8-HXCDF			0.000005 U	0.0000048 U	0.0000048 U	0.0000047 U	0.0000044 U
2,3,4,7,8-PECDF			0.0000047 J	0.00001	0.0000048 U	0.0000061	0.0000044 U
2,3,7,8-TCDD			0.000001 U	0.000001 U	0.000001 U	0.0000009 U	0.0000009 U
2,3,7,8-TCDF			0.00001	0.00004	0.00001	0.00001	0.00001
OCDD			0.00001 U	0.0000096 U	0.0000096 U	0.0000094 U	0.0000089 U
OCDF			0.00001 U	0.0000096 U	0.0000096 U	0.0000094 U	0.0000089 U
Dioxin-Like PCB Congeners							
PCB-105	0.06328 J	0.01293	0.03455 J	0.449 J	0.12693 J	0.12189 J	0.02207
PCB-114	0.00001 UJ	0.00019 U	0.00019 U	0.0002 U	0.00019 U	0.00019 U	0.0002 U
PCB-118	0.05311 J	0.1519	0.06198	0.69347	0.11844	0.10977	0.08894
PCB-126	0.00024 J	0.00045	0.00055	0.00384	0.00157	0.00108	0.00081
PCB-149/123	0.23301 J	0.35192	0.20113	7.76323	0.88889	0.62247	1.2714 J
PCB-156	0.0277 J	0.04622	0.00019 U	0.0002 U	0.00019 U	0.00019 U	0.04525
PCB-167	0.02532 J	0.02726	0.0138	0.15417	0.03337	0.03222	0.03857
PCB-169	0.00002 J	0.00009	0.00004 J	0.00031	0.00008	0.00007	0.00009 J
PCB-189	0.01222 J	0.00681	0.00383	0.04487	0.00917	0.0099	0.01379
PCB-201/157/173	0.0228 J	0.02098	0.00931	0.12755	0.01677	0.01821	0.03161
PCB-77	0.00036 J	0.00099	0.00114	0.00453	0.00242	0.0012	0.00107
PCB-81	0.00032 J	0.00005 J	0.00019 U	0.00051	0.00021	0.00019 U	0.00003 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.02467 J	0.02022	0.01503	0.13584	0.02145	0.0227	0.02786 J
1,2,4,5-Tetrachlorobenzene	0.00389 J	0.00345	0.00322 U	0.02349	0.00496	0.00658	0.00795
4,4'-DDD	0.00838 J	0.0044	0.01826	0.33308	0.03779	0.03913	0.00729
4,4'-DDE	0.00837 J	0.01223	0.02762	0.0934	0.01403	0.01218	0.01457 J
4,4'-DDT	0.00134 J	0.00191 U	0.00194 U	0.01653	0.00225	0.0017 J	0.0021
Aldrin	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00195 U
alpha-BHC	0.00011 J	0.00191 U	0.00194 U	0.00049 J	0.00194 U	0.00193 U	0.00195 U
alpha-Chlordane	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00296
beta-BHC	0.000003 J	0.00191 U	0.00194 U	0.0004 J	0.00011 J	0.0001 J	0.00195 U
Chlorpyrifos	0.00005 J	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00008 J
cis-Nonachlor	0.0185 J	0.01686	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.02231 J
delta-BHC	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00195 U
Dieldrin	0.00064 J	0.00191 U	0.00039 J	0.00217	0.00076 J	0.00085 J	0.00072 J
Endosulfan II	0.00865 J	0.00191 U	0.00504	0.12183	0.02795	0.03073	0.01033 J
Endrin	0.00028 J	0.00191 U	0.00194 U	0.00198 U	0.00046 J	0.00042 J	0.00195 U
gamma-BHC (Lindane)	0.00001 J	0.00013 J	0.00009 J	0.00085 J	0.00013 J	0.00013 J	0.00031 J
gamma-Chlordane	0.00014 J	0.00191 U	0.00194 U	0.00197 J	0.00031 J	0.0003 J	0.00034 J
Heptachlor	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00195 U
Heptachlor epoxide	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00195 U
Hexachlorobenzene	0.00111 J	0.00061 J	0.00067 J	0.0046	0.00096 J	0.001 J	0.00125 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF03YP23-0-8C02	H3-TF07PS07-0-8S29	H3-TF07PS08-0-8S29	H3-TF07YP01-0-8S29	H3-TF07YP01-1-8S29	H3-TF07YP03-0-8S29	H3-TF07YP03-1-8S29
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/3/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	23.2	17.0	16.5	27.5	27.5	31.0	31.0
Mirex	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00195 U
o,p'-DDD	0.01566 J	0.00191 U	0.01307	0.23939	0.02574	0.02555	0.03308 J
o,p'-DDE	0.00195 UJ	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00195 U
o,p'-DDT	0.02151 J	0.03589	0.01275	0.20668	0.02904	0.02926	0.0376 J
Oxychlordane	0.00103 J	0.00191 U	0.00194 U	0.00198 U	0.00194 U	0.00193 U	0.00217
Pentachloroanisole	0.00031 J	0.00017 J	0.00017 U	0.00202	0.00039 J	0.00046 J	0.00065 J
Pentachlorobenzene	0.01515 J	0.00786	0.00659	0.04171	0.00977	0.00961	0.01343
Toxaphene	0.0196 UJ	0.01912 U	0.01938 U	0.01981 U	0.01941 U	0.01933 U	0.01952 U
trans-Nonachlor	0.00069 J	0.00058 J	0.00061 J	0.0082	0.00123 J	0.00111 J	0.00141 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.8 J	0.9	0.4	2.9	0.6	1.1	1.1
Percent Lipids (GC/MS)			0.4	2.9	0.6	1.1	1.1
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF07YP04-0-8S29	H3-TF07YP05-0-8S29	H3-TF07YP06-0-8S29	H3-TF08PS01-0-8S30	H3-TF08PS02-0-8S30	H3-TF08YP07-0-8S30	H3-TF08YP08-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	26.5	26.0	26.5	15.0	15.0	26.0	27.0
PCBs							
PCB, Total	4.7311	4.49074	6.60452	4.4257	4.448	3.40597	6.80333
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,4,6,7,8-HPCDF	0.00001		0.0000084	0.00002			
1,2,3,4,7,8,9-HPCDF	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,4,7,8-HXCDD	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,4,7,8-HXCDF	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,6,7,8-HXCDD	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,6,7,8-HXCDF	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,7,8,9-HXCDD	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,7,8,9-HXCDF	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,7,8-PECDD	0.0000049 U		0.0000048 U	0.00001 U			
1,2,3,7,8-PECDF	0.00003		0.00002	0.00001			
2,3,4,6,7,8-HXCDF	0.0000049 U		0.0000048 U	0.00001 U			
2,3,4,7,8-PECDF	0.0000095		0.0000056	0.0000083 J			
2,3,7,8-TCDD	0.000001 U		0.000001 U	0.0000028 U			
2,3,7,8-TCDF	0.00001		0.00001	0.00003			
OCDD	0.0000099 U		0.0000096 U	0.00002 U			
OCDF	0.0000099 U		0.0000096 U	0.00002 U			
Dioxin-Like PCB Congeners							
PCB-105	0.07061 J	0.01569	0.08221 J	0.02737 J	0.01888	0.01142	0.03252
PCB-114	0.0002 U	0.00019 U	0.00019 U	0.00019 U	0.00023 U	0.00019 U	0.0002 U
PCB-118	0.06422	0.06725	0.08266	0.07187	0.08543	0.04366	0.13982
PCB-126	0.00071	0.00017	0.00072	0.00065	0.00035	0.0001	0.00033
PCB-149/123	0.29042	0.29048	0.49451	0.23956	0.19678	0.22577	0.35422
PCB-156	0.0002 U	0.0166	0.00019 U	0.00019 U	0.01982	0.01217	0.02883
PCB-167	0.01326	0.01163	0.01998	0.0119	0.01502	0.00704	0.01788
PCB-169	0.00006 J	0.00004 J	0.00019 U	0.00007	0.00007 J	0.00001 J	0.00023
PCB-189	0.00633	0.00314	0.00488	0.00335	0.00477	0.00283	0.00496
PCB-201/157/173	0.0075	0.00977	0.01155	0.00752	0.01153	0.00622	0.01438
PCB-77	0.00064	0.00036	0.00158	0.00106	0.00068	0.00015	0.00056
PCB-81	0.0002 U	0.00001 J	0.00012	0.00019 U	0.00006 J	0.00001 J	0.00002 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.0158	0.01574	0.01967	0.01345	0.01329	0.01599	0.01919
1,2,4,5-Tetrachlorobenzene	0.00509	0.00282 U	0.00488	0.00359	0.00212 U	0.00413	0.00498
4,4'-DDD	0.01514	0.00227	0.02957	0.01265	0.00417	0.00147	0.00405
4,4'-DDE	0.00693	0.00432	0.00897	0.00632	0.00852	0.00169 J	0.0092
4,4'-DDT	0.00069 J	0.00081 J	0.00133 J	0.00188 U	0.00228 U	0.00187 U	0.00058 J
Aldrin	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
alpha-BHC	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00004 J	0.002 U
alpha-Chlordane	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
beta-BHC	0.0001 J	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
Chlorpyrifos	0.00004 J	0.0019 U	0.00194 U	0.00004 J	0.00228 U	0.00187 U	0.002 U
cis-Nonachlor	0.00199 U	0.01118	0.00194 U	0.00188 U	0.0067	0.00696	0.01601
delta-BHC	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
Dieldrin	0.00065 J	0.00042 J	0.00086 J	0.00069 J	0.00044 J	0.00028 J	0.00115 J
Endosulfan II	0.01339	0.0019 U	0.01882	0.00957	0.00228 U	0.00187 U	0.002 U
Endrin	0.00018 J	0.0019 U	0.00042 J	0.00188 U	0.00228 U	0.00187 U	0.002 U
gamma-BHC (Lindane)	0.00009 J	0.0019 U	0.0001 J	0.00007 J	0.00228 U	0.00009 U	0.002 U
gamma-Chlordane	0.0001 J	0.0019 U	0.00024 J	0.00188 U	0.00228 U	0.00187 U	0.002 U
Heptachlor	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
Heptachlor epoxide	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
Hexachlorobenzene	0.0006 J	0.00061 J	0.00091 J	0.00058 J	0.00079 J	0.00048 J	0.00058 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF07YP04-0-8S29	H3-TF07YP05-0-8S29	H3-TF07YP06-0-8S29	H3-TF08PS01-0-8S30	H3-TF08PS02-0-8S30	H3-TF08YP07-0-8S30	H3-TF08YP08-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	26.5	26.0	26.5	15.0	15.0	26.0	27.0
Mirex	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
o,p'-DDD	0.0094	0.01753	0.01947	0.01379	0.01944	0.00982	0.02792
o,p'-DDE	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
o,p'-DDT	0.01658	0.02047	0.02088	0.01292	0.02363	0.01691	0.03159
Oxychlordane	0.00199 U	0.0019 U	0.00194 U	0.00188 U	0.00228 U	0.00187 U	0.002 U
Pentachloroanisole	0.00029 J	0.00033 J	0.00033 J	0.00015 U	0.00014 J	0.00024 J	0.00044 J
Pentachlorobenzene	0.00639	0.00702	0.00896	0.0051	0.00686	0.00587	0.00762
Toxaphene	0.01994 U	0.01904 U	0.01943 U	0.01884 U	0.02283 U	0.01873 U	0.01998 U
trans-Nonachlor	0.00072 J	0.00031 J	0.00092 J	0.00069 J	0.0004 J	0.00032 J	0.00038 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.7	1	0.5	0.5	2.3	1.3	0.7
Percent Lipids (GC/MS)	0.7		0.5	0.5			
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF08YP09-0-8S30	H3-TF08YP10-0-8S30	H3-TF08YP11-0-8S30	H3-TF09PS01-0-8S30	H3-TF09PS02-0-8S30	H3-TF09PS03-0-8S30	H3-TF09PS04-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	28.0	24.0	24.0	16.5	15	16.6	15
PCBs							
PCB, Total	4.98218	8.12887	5.57526	7.06284	7.78099	1.39632	5.01027
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD			0.000005 U	0.0000041 UJ			
1,2,3,4,6,7,8-HPCDF			0.00003	0.0000013 J			
1,2,3,4,7,8,9-HPCDF			0.000005 U	0.0000041 UJ			
1,2,3,4,7,8-HXCDD			0.000005 U	0.0000041 UJ			
1,2,3,4,7,8-HXCDF			0.000005 U	0.0000041 UJ			
1,2,3,6,7,8-HXCDD			0.000005 U	0.0000041 UJ			
1,2,3,6,7,8-HXCDF			0.000005 U	0.0000041 UJ			
1,2,3,7,8,9-HXCDD			0.000005 U	0.0000041 UJ			
1,2,3,7,8,9-HXCDF			0.000005 U	0.0000041 UJ			
1,2,3,7,8-PECDD			0.000005 U	0.0000041 UJ			
1,2,3,7,8-PECDF			0.00004	0.00002 J			
2,3,4,6,7,8-HXCDF			0.000005 U	0.0000002 J			
2,3,4,7,8-PECDF			0.0000058	0.0000009 J			
2,3,7,8-TCDD			0.000001 U	0.0000008 UJ			
2,3,7,8-TCDF			0.00001	0.0000044 J			
OCDD			0.0000099 U	0.0000001 J			
OCDF			0.0000099 U	0.0000082 UJ			
Dioxin-Like PCB Congeners							
PCB-105	0.0155	0.02584	0.05469 J	0.10778	0.10312	0.01949	0.05834
PCB-114	0.0002 U	0.00019 U	0.00019 U	0.00002 U	0.00001 U	0.00001 U	0.00001 U
PCB-118	0.07326	0.11422	0.07536	0.12485	0.09804	0.01949	0.05755
PCB-126	0.00026	0.00076	0.00089	0.00037	0.00048	0.00038	0.0005
PCB-149/123	0.32648	0.54009	0.3731	0.30094	0.34767	0.08704	0.22372
PCB-156	0.01646	0.03147	0.01732	0.04006	0.0444	0.00533	0.01786
PCB-167	0.01099	0.02022	0.01986	0.02191	0.02138	0.00294	0.01335
PCB-169	0.00005 J	0.00007	0.00004 J	0.00002 U	0.00014	0.00006	0.0001
PCB-189	0.00336	0.00548	0.00523	0.00644	0.00712	0.00071	0.00422
PCB-201/157/173	0.00885	0.01783	0.00823	0.01232	0.01555	0.00203	0.00952
PCB-77	0.00042	0.00089	0.00126	0.00023	0.00055	0.00014	0.00077
PCB-81	0.00001 J	0.00009	0.00019 U	0.00002 U	0.00001 U	0.00001 U	0.00001 U
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01963	0.0154	0.01644	0.0177	0.01306	0.00598	0.01567
1,2,4,5-Tetrachlorobenzene	0.00433	0.0025 U	0.00424	0.0034	0.00193 J	0.00258	0.00433
4,4'-DDD	0.0031	0.00385	0.02355	0.00527	0.00492	0.00111 J	0.00332
4,4'-DDE	0.00373	0.00537	0.00983	0.01208	0.0115	0.00511	0.00833
4,4'-DDT	0.00199 U	0.00194 U	0.00074 J	0.00086 J	0.00083 J	0.00016 J	0.00052 J
Aldrin	0.00199 U	0.00194 U	0.00193 U	0.00195 U	0.00194 U	0.00188 U	0.00185 U
alpha-BHC	0.00003 J	0.00194 U	0.00193 U	0.0004 J	0.00056 J	0.00188 U	0.00185 U
alpha-Chlordane	0.00199 U	0.00194 U	0.00193 U	0.00195 U	0.00194 U	0.00188 U	0.00185 U
beta-BHC	0.00199 U	0.00194 U	0.00193 U	0.00195 U	0.00194 U	0.00188 U	0.00185 U
Chlorpyrifos	0.00199 U	0.00194 U	0.00005 J	0.00091 J	0.00094 J	0.00188 U	0.00086 J
cis-Nonachlor	0.01239	0.01995	0.00193 U	0.00972	0.01016	0.00158 J	0.00805
delta-BHC	0.00199 U	0.00194 U	0.00193 U	0.00195 U	0.00194 U	0.00009 J	0.00185 U
Dieldrin	0.00055 J	0.0007 J	0.00072 J	0.00602	0.00655	0.00084 J	0.005
Endosulfan II	0.00199 U	0.00194 U	0.01741	0.00323	0.00535	0.0012 J	0.0026
Endrin	0.00199 U	0.00194 U	0.00026 J	0.00195 U	0.00194 U	0.00188 U	0.00185 U
gamma-BHC (Lindane)	0.00014 J	0.00009 U	0.00007 J	0.00019 J	0.00014 J	0.00007 J	0.00018 J
gamma-Chlordane	0.00199 U	0.00194 U	0.0002 J	0.00195 U	0.00041 J	0.00188 U	0.00033 J
Heptachlor	0.00199 U	0.00194 U	0.00193 U	0.00048 J	0.0006 J	0.00188 U	0.00185 U
Heptachlor epoxide	0.00199 U	0.00194 U	0.00193 U	0.00195 U	0.00194 U	0.00188 U	0.00185 U
Hexachlorobenzene	0.00064 J	0.00079 J	0.00083 J	0.00062 J	0.00123 J	0.00016 J	0.00065 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF08YP09-0-8S30	H3-TF08YP10-0-8S30	H3-TF08YP11-0-8S30	H3-TF09PS01-0-8S30	H3-TF09PS02-0-8S30	H3-TF09PS03-0-8S30	H3-TF09PS04-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	28.0	24.0	24.0	16.5	15	16.6	15
Mirex	0.00199 U	0.00194 U	0.00193 U	0.00195 U	0.00194 U	0.00188 U	0.00185 U
o,p'-DDD	0.01736	0.03053	0.01651	0.02001	0.01881	0.00392	0.01415
o,p'-DDE	0.00199 U	0.00194 U	0.00193 U	0.0013 J	0.00154 J	0.00067 J	0.00107 J
o,p'-DDT	0.02351	0.03553	0.01989	0.01571	0.01155	0.00261	0.0081
Oxychlordane	0.00199 U	0.00194 U	0.00193 U	0.00149 J	0.00153 J	0.00082 J	0.0011 J
Pentachloroanisole	0.00033 J	0.00029 J	0.00032 J	0.00027 J	0.00031 J	0.00022 J	0.00039 J
Pentachlorobenzene	0.00721	0.00786	0.00736	0.00469	0.00355	0.00148 J	0.00322
Toxaphene	0.01987 U	0.01937 U	0.01933 U	0.0195 U	0.0194 U	0.0189 U	0.0186 U
trans-Nonachlor	0.00042 J	0.00045 J	0.00083 J	0.00203	0.00169 J	0.00038 J	0.00144 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1	0.8	0.7	1.6	0.5	0.3	1.2
Percent Lipids (GC/MS)			0.7	1.6 J			
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF09PS05-0-8S30	H3-TF09YP12-0-8S30	H3-TF09YP13-0-8S30	H3-TF09YP14-0-8S30	H3-TF09YP15-0-8S30	H3-TF09YP16-0-8S30	H3-TF10PS01-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	17	30	28	27.5	27	26	16.8
PCBs							
PCB, Total	5.02623	7.10803	6.04564	7.59019	7.06583	11.78438	4.62771
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,4,6,7,8-HPCDF		0.0000018 J	0.0000043 UJ		0.0000027 J		0.0000039 UJ
1,2,3,4,7,8,9-HPCDF		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,4,7,8-HXCDD		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,4,7,8-HXCDF		0.0000009 J	0.0000043 UJ		0.0000009 J		0.0000009 J
1,2,3,6,7,8-HXCDD		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,6,7,8-HXCDF		0.0000004 J	0.0000043 UJ		0.0000004 J		0.0000039 UJ
1,2,3,7,8,9-HXCDD		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,7,8,9-HXCDF		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,7,8-PECDD		0.0000045 UJ	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
1,2,3,7,8-PECDF		0.00001 J	0.00001 J		0.00002 J		0.00001 J
2,3,4,6,7,8-HXCDF		0.0000019 J	0.0000043 UJ		0.0000048 UJ		0.0000039 UJ
2,3,4,7,8-PECDF		0.0000056 J	0.0000043 UJ		0.0000035 J		0.0000016 J
2,3,7,8-TCDD		0.0000009 UJ	0.0000009 UJ		0.0000002 J		0.0000008 UJ
2,3,7,8-TCDF		0.00001 J	0.0000094 J		0.0000073 J		0.0000052 J
OCDD		0.0000089 UJ	0.0000086 UJ		0.0000097 UJ		0.0000078 UJ
OCDF		0.0000089 UJ	0.0000086 UJ		0.0000097 UJ		0.0000078 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.06966	0.01823 J	0.0724	0.1107	0.09197	0.12891	0.06012
PCB-114	0.00001 U	0.00001 UJ	0.00002 U	0.00002 U	0.00001 U	0.00002 U	0.00002 U
PCB-118	0.0565	0.05385 J	0.05742	0.07486	0.06163	0.17937	0.07212
PCB-126	0.0003	0.00026 J	0.00096	0.0004	0.00048	0.00132	0.00034
PCB-149/123	0.17818	0.54446 J	0.29736	0.42199	0.38296	0.57097	0.18661
PCB-156	0.02886	0.02631 J	0.02739	0.03052	0.02701	0.04623	0.02345
PCB-167	0.01502	0.02183 J	0.01517	0.01846	0.01751	0.03915	0.01297
PCB-169	0.00006 J	0.00004 UJ	0.00019	0.0001	0.00014	0.00007	0.00004 J
PCB-189	0.00689	0.00765 J	0.00547	0.00604	0.00538	0.01032	0.00383
PCB-201/157/173	0.01861	0.01469 J	0.00955	0.00999	0.01064	0.01845	0.00769
PCB-77	0.00028	0.0004 UJ	0.00253	0.00055	0.00069	0.00096	0.00053
PCB-81	0.00001 U	0.00005 J	0.00071	0.00025	0.00013	0.0003	0.00002 U
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01684	0.01715 J	0.01482	0.02091	0.01728	0.01184	0.01274
1,2,4,5-Tetrachlorobenzene	0.00424	0.00405 J	0.00695	0.00533	0.00245	0.00324	0.00262
4,4'-DDD	0.00428	0.00357 J	0.00298	0.0033	0.00307	0.0044	0.00277
4,4'-DDE	0.00694	0.00546 J	0.00721	0.00829	0.00735	0.01518	0.00966
4,4'-DDT	0.00082 J	0.00065 J	0.00048 J	0.00101 J	0.00116 J	0.00096 J	0.00198 U
Aldrin	0.00191 U	0.00185 UJ	0.00197 U	0.00197 U	0.0019 U	0.00198 U	0.00198 U
alpha-BHC	0.00191 U	0.00185 UJ	0.00197 U	0.00013 J	0.00013 J	0.00029 J	0.00198 U
alpha-Chlordane	0.00088 J	0.00185 UJ	0.00084 J	0.00044 J	0.00053 J	0.00087 J	0.00198 U
beta-BHC	0.00191 U	0.00185 UJ	0.00003 J	0.00197 U	0.0019 U	0.00009 J	0.00198 U
Chlorpyrifos	0.00191 U	0.00185 UJ	0.00197 U	0.00024 J	0.00087 J	0.00198 U	0.00198 U
cis-Nonachlor	0.00693	0.011 J	0.00877	0.0107	0.01079	0.01784	0.00678
delta-BHC	0.00057 J	0.00185 UJ	0.00103 J	0.00188 J	0.00155 J	0.0013 J	0.00198 U
Dieldrin	0.00308	0.00067 J	0.00425	0.00531	0.00464	0.00768	0.00423
Endosulfan II	0.00304	0.00495 J	0.00377	0.00301	0.00286	0.00473	0.00146 J
Endrin	0.00191 U	0.00185 UJ	0.00197 U	0.00003 J	0.0019 U	0.00198 U	0.0005 J
gamma-BHC (Lindane)	0.00016 J	0.00019 UJ	0.00017 J	0.00023 J	0.00013 J	0.00011 J	0.00022 J
gamma-Chlordane	0.00191 U	0.00036 UJ	0.00005 J	0.00034 J	0.00011 J	0.00019 J	0.00102 J
Heptachlor	0.00191 U	0.00185 UJ	0.00197 U	0.00037 J	0.00045 J	0.00022 J	0.00018 J
Heptachlor epoxide	0.00191 U	0.00036 UJ	0.00091 J	0.0013 J	0.00119 J	0.00162 J	0.001 J
Hexachlorobenzene	0.00089 J	0.00117 J	0.00081 J	0.00119 J	0.00129 J	0.00115 J	0.00034 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF09PS05-0-8S30	H3-TF09YP12-0-8S30	H3-TF09YP13-0-8S30	H3-TF09YP14-0-8S30	H3-TF09YP15-0-8S30	H3-TF09YP16-0-8S30	H3-TF10PS01-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	17	30	28	27.5	27	26	16.8
Mirex	0.00191 U	0.00185 UJ	0.00197 U	0.00197 U	0.0019 U	0.00198 U	0.00198 U
o,p'-DDD	0.01093	0.01484 J	0.01358	0.01409	0.01402	0.02625	0.01296
o,p'-DDE	0.00077 J	0.00185 UJ	0.00165 J	0.0016 J	0.00152 J	0.00142 J	0.00204
o,p'-DDT	0.01102	0.01884 J	0.0147	0.01644	0.01361	0.02961	0.00311
Oxychlordane	0.00111 J	0.00093 J	0.00197 U	0.00197 U	0.0019 U	0.00198 U	0.00198 U
Pentachloroanisole	0.00027 J	0.00058 J	0.00051 J	0.0006 J	0.00049 J	0.00038 J	0.00073 J
Pentachlorobenzene	0.0118	0.00795 J	0.00741	0.01044	0.00915	0.00664	0.00304
Toxaphene	0.0192 U	0.0186 UJ	0.0198 U	0.0198 U	0.019 U	0.0198 U	0.0198 U
trans-Nonachlor	0.00094 J	0.00091 J	0.00104 J	0.00074 J	0.00081 J	0.00199	0.00128 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.5	2.4 J	0.9	0.8	1.1	0.4	0.9
Percent Lipids (GC/MS)		2.4 J	0.9 J		1.1 J		
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF10PS02-0-8S30	H3-TF10PS03-0-8S30	H3-TF10PS04-0-8S30	H3-TF10PS05-0-8S30	H3-TF10YP17-0-8S30	H3-TF10YP18-0-8S30	H3-TF10YP18-1-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	16.8	17	18.3	18	29	28.5	28.5
PCBs							
PCB, Total	6.27039	5.35443	9.90669	3.14402	7.82914	5.60093	5.7659
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD			0.0000042 UJ	0.0000045 UJ	0.0000003 J		0.000004 UJ
1,2,3,4,6,7,8-HPCDF			0.0000042 UJ	0.0000045 UJ	0.0000023 J		0.0000015 J
1,2,3,4,7,8,9-HPCDF			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,4,7,8-HXCDD			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,4,7,8-HXCDF			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,6,7,8-HXCDD			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,6,7,8-HXCDF			0.0000042 UJ	0.0000045 UJ	0.0000003 J		0.000004 UJ
1,2,3,7,8,9-HXCDD			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,7,8,9-HXCDF			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,7,8-PECDD			0.0000042 UJ	0.0000045 UJ	0.0000039 UJ		0.000004 UJ
1,2,3,7,8-PECDF			0.0000025 J	0.00002 J	0.00003 J		0.00001 J
2,3,4,6,7,8-HXCDF			0.0000042 UJ	0.0000045 UJ	0.0000003 J		0.000004 UJ
2,3,4,7,8-PECDF			0.0000015 J	0.0000012 J	0.0000042 J		0.000002 J
2,3,7,8-TCDD			0.0000002 J	0.0000009 UJ	0.0000003 J		0.0000008 UJ
2,3,7,8-TCDF			0.000005 J	0.0000029 UJ	0.0000097 J		0.0000054 J
OCDD			0.0000084 UJ	0.000009 UJ	0.0000014 J		0.0000079 UJ
OCDF			0.0000084 UJ	0.000009 UJ	0.0000078 UJ		0.0000079 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.0759	0.07096	0.10432	0.02228	0.09696	0.08477	0.06972
PCB-114	0.00001 U	0.00002 U	0.00002 U	0.00001 U	0.00001 U	0.00001 U	0.00001 U
PCB-118	0.09475	0.07208	0.19394	0.05031	0.06663	0.05417	0.05335
PCB-126	0.0005	0.0003	0.00058	0.00017	0.00059	0.00012	0.00026
PCB-149/123	0.27912	0.22719	0.40764	0.10296	0.43272	0.26666	0.25693
PCB-156	0.02832	0.03385	0.04197	0.00677	0.03258	0.032	0.02935
PCB-167	0.01808	0.01524	0.03257	0.00889	0.02372	0.01521	0.0161
PCB-169	0.00003 J	0.00006 J	0.00002 J	0.000001 J	0.00005 J	0.00005 J	0.00001 J
PCB-189	0.00521	0.00495	0.00921	0.00362	0.0072	0.00468	0.00603
PCB-201/157/173	0.01128	0.0096	0.01569	0.00726	0.01173	0.01011	0.01043
PCB-77	0.00055	0.00048	0.00074	0.00017	0.0009	0.00009	0.00027
PCB-81	0.00004 J	0.00002 U	0.00002 U	0.00001 U	0.00006 J	0.00013	0.00005 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01258	0.01217	0.01687	0.01217	0.01614	0.01028	0.01033
1,2,4,5-Tetrachlorobenzene	0.0021	0.00244	0.00661	0.0023	0.00483	0.00514	0.00252
4,4'-DDD	0.00365	0.00463	0.0058	0.00227	0.00481	0.00322	0.00338
4,4'-DDE	0.00932	0.00867	0.01751	0.00521	0.01136	0.00735	0.00669
4,4'-DDT	0.00011 J	0.00031 J	0.00072 J	0.00026 J	0.001 J	0.00044 J	0.00047 J
Aldrin	0.00193 U	0.00198 U	0.00198 U	0.0019 U	0.00193 U	0.00192 U	0.00185 U
alpha-BHC	0.00023 J	0.00005 J	0.00198 U	0.00013 J	0.00193 U	0.00015 J	0.00041 J
alpha-Chlordane	0.00193 U	0.00198 U	0.0004 J	0.0019 U	0.0021	0.0003 J	0.00084 J
beta-BHC	0.00003 J	0.00198 U	0.00198 U	0.0019 U	0.00193 U	0.00192 U	0.00185 U
Chlorpyrifos	0.00099 J	0.00042 J	0.00098 J	0.0019 U	0.00038 J	0.00011 J	0.00029 J
cis-Nonachlor	0.0078	0.00525	0.01095	0.00574	0.01184	0.00821	0.00864
delta-BHC	0.00193 U	0.00031 J	0.00198 U	0.00037 J	0.00108 J	0.00111 J	0.00102 J
Dieldrin	0.00515	0.00441	0.00736	0.00033 J	0.00558	0.00391	0.00418
Endosulfan II	0.00202	0.00192 J	0.00551	0.00436	0.00496	0.00344	0.00498
Endrin	0.00012 J	0.00198 U	0.00198 U	0.0019 U	0.00193 U	0.00192 U	0.00185 U
gamma-BHC (Lindane)	0.00015 J	0.00017 J	0.00025 J	0.0019 U	0.00025 J	0.00014 J	0.00009 J
gamma-Chlordane	0.00019 J	0.00008 J	0.00198 U	0.0019 U	0.00047 J	0.00015 J	0.00015 J
Heptachlor	0.00022 J	0.00015 J	0.00198 U	0.0019 U	0.00193 U	0.00192 U	0.00041 J
Heptachlor epoxide	0.00193 U	0.00139 J	0.00234	0.0019 U	0.00122 J	0.00082 J	0.00134 J
Hexachlorobenzene	0.00032 J	0.00099 J	0.00045 J	0.00069 J	0.00089 J	0.00082 J	0.0007 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF10PS02-0-8S30	H3-TF10PS03-0-8S30	H3-TF10PS04-0-8S30	H3-TF10PS05-0-8S30	H3-TF10YP17-0-8S30	H3-TF10YP18-0-8S30	H3-TF10YP18-1-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998	9/30/1998
Fish Length (cm)	16.8	17	18.3	18	29	28.5	28.5
Mirex	0.00193 U	0.00198 U	0.00198 U	0.0019 U	0.00193 U	0.00192 U	0.00185 U
o,p'-DDD	0.01749	0.01469	0.029	0.01174	0.01644	0.01263	0.01327
o,p'-DDE	0.00177 J	0.00159 J	0.00233	0.0019 U	0.00214	0.00174 J	0.00253
o,p'-DDT	0.00939	0.00953	0.01947	0.01211	0.01301	0.01391	0.01287
Oxychlordane	0.00118 J	0.00198 U	0.00198 U	0.00072 J	0.00193 U	0.00192 U	0.00185 U
Pentachloroanisole	0.00018 J	0.00026 J	0.00037 J	0.00033 J	0.00073 J	0.0005 J	0.00066 J
Pentachlorobenzene	0.00336	0.00362	0.00678	0.00683	0.00539	0.00667	0.00542
Toxaphene	0.0194 U	0.0199 U	0.0198 U	0.019 U	0.0193 U	0.0192 U	0.0185 U
trans-Nonachlor	0.00193 J	0.00135 J	0.00144 J	0.0019 U	0.00159 J	0.00056 J	0.00083 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.4	0.4	0.9	0.3	0.015	0.4	0.8
Percent Lipids (GC/MS)				0.3 J			
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF10YP20-0-8S30	H3-TF10YP20-1-8S30	H3-TF10YP21-0-8S30	H3-TF10YP22-0-8S30	H3-TF11PS01-0-8C19	H3-TF11PS01-0-8S30	H3-TF11PS02-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	10/20/1998	10/1/1998	10/20/1998
Fish Length (cm)	28	28	27.5	27	17	16.2	18
PCBs							
PCB, Total	4.3578	5.04294	10.96868	8.16072	7.47915	10.24357	5.4811
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,4,6,7,8-HPCDF	0.0000044 UJ	0.0000044 U	0.0000022 J			0.0000041 J	
1,2,3,4,7,8,9-HPCDF	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,4,7,8-HXCDD	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,4,7,8-HXCDF	0.0000002 J	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,6,7,8-HXCDD	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,6,7,8-HXCDF	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,7,8,9-HXCDD	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,7,8,9-HXCDF	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,7,8-PECDD	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
1,2,3,7,8-PECDF	0.00001 J	0.00002	0.00003 J			0.00005 J	
2,3,4,6,7,8-HXCDF	0.0000044 UJ	0.0000044 U	0.0000041 UJ			0.000005 UJ	
2,3,4,7,8-PECDF	0.0000013 J	0.000002 J	0.0000059 J			0.0000021 J	
2,3,7,8-TCDD	0.0000003 J	0.0000009 U	0.0000008 UJ			0.000001 UJ	
2,3,7,8-TCDF	0.0000033 J	0.0000054	0.00001 UJ			0.000001 UJ	
OCDD	0.0000006 J	0.0000087 U	0.0000012 J			0.00001 UJ	
OCDF	0.0000088 UJ	0.0000087 U	0.0000081 UJ			0.00001 UJ	
Dioxin-Like PCB Congeners							
PCB-105	0.00828 J	0.01521 J	0.05655	0.04507	0.02391	0.08819	0.01656
PCB-114	0.00002 UJ	0.00003 UJ	0.00001 U	0.00001 U	0.00029 U	0.00002 U	0.00027 U
PCB-118	0.04256 J	0.047 J	0.17554	0.06106	0.12268	0.14352	0.09122
PCB-126	0.0002 J	0.00063 J	0.00077	0.00044	0.00071 J	0.0005	0.00036 J
PCB-149/123	0.3672 J	0.4087 J	0.43173	0.40903	0.33963	0.36123	0.29991
PCB-156	0.0126 J	0.01313 J	0.01059	0.0112	0.03708 J	0.01933	0.02307 J
PCB-167	0.01301 J	0.014 J	0.0207	0.01672	0.02679	0.0302	0.01378
PCB-169	0.00003 UJ	0.00006 J	0.00009	0.00005 J	0.00007 U	0.00007 J	0.00029 J
PCB-189	0.00402 J	0.00426 J	0.00581	0.00511	0.00642	0.00825	0.00362
PCB-201/157/173	0.00838 J	0.01006 J	0.01183	0.00956	0.01844	0.01843	0.01183
PCB-77	0.00073 J	0.00141 J	0.00098	0.00039	0.00176 J	0.0006	0.00281
PCB-81	0.00006 J	0.00018 J	0.00036	0.00016	0.00006 J	0.00024	0.00013 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01349 J	0.01541 J	0.03165	0.0216	0.01008	0.01761	0.00543
1,2,4,5-Tetrachlorobenzene	0.00296 J	0.00539 J	0.00429	0.00304	0.00406	0.00661	0.0027 J
4,4'-DDD	0.00281 J	0.00328 J	0.00664	0.00367	0.00391	0.00699	0.00312
4,4'-DDE	0.00499 J	0.00576 J	0.02081	0.01052	0.01331	0.02074	0.00297
4,4'-DDT	0.00046 J	0.00041 J	0.00043 J	0.0005 J	0.00021 J	0.00051 J	0.00021 J
Aldrin	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00294 U	0.00245 U	0.00273 U
alpha-BHC	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00005 J	0.00245 U	0.00005 J
alpha-Chlordane	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00294 U	0.00245 U	0.00273 U
beta-BHC	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00294 U	0.00245 U	0.00273 U
Chlorpyrifos	0.00004 J	0.00311 UJ	0.00106 J	0.00069 J	0.00016 J	0.00245 U	0.00007 U
cis-Nonachlor	0.00862 J	0.00981 J	0.02106	0.01632	0.01136	0.01729	0.00943
delta-BHC	0.002 UJ	0.00311 UJ	0.00259	0.00139 J	0.00294 U	0.00038 J	0.00273 U
Dieldrin	0.00033 J	0.00311 UJ	0.00034 J	0.00026 J	0.00062 J	0.00068 J	0.00101 J
Endosulfan II	0.00315 J	0.00311 UJ	0.00539	0.00465	0.00394	0.008	0.00229 J
Endrin	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00294 U	0.00245 U	0.00001 J
gamma-BHC (Lindane)	0.00014 UJ	0.00035 J	0.00032 J	0.00024 J	0.00011 J	0.00245 U	0.00006 J
gamma-Chlordane	0.00032 J	0.00032 J	0.00028 J	0.00191 U	0.00294 U	0.00245 U	0.00273 U
Heptachlor	0.002 UJ	0.00311 UJ	0.00031 J	0.00191 U	0.00294 U	0.00111 J	0.00273 U
Heptachlor epoxide	0.00032 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00294 U	0.00245 U	0.00273 U
Hexachlorobenzene	0.00099 J	0.00145 J	0.0008 J	0.00084 J	0.00077 J	0.0009 J	0.00052 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF10YP20-0-8S30	H3-TF10YP20-1-8S30	H3-TF10YP21-0-8S30	H3-TF10YP22-0-8S30	H3-TF11PS01-0-8C19	H3-TF11PS01-0-8S30	H3-TF11PS02-0-8C19
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	9/30/1998	9/30/1998	9/30/1998	9/30/1998	10/20/1998	10/1/1998	10/20/1998
Fish Length (cm)	28	28	27.5	27	17	16.2	18
Mirex	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00294 U	0.00245 U	0.00273 U
o,p'-DDD	0.0109 J	0.01112 J	0.03794	0.02451	0.03008	0.0472	0.02046
o,p'-DDE	0.002 UJ	0.00311 UJ	0.00189 U	0.00191 U	0.00017 U	0.00245 U	0.00273 U
o,p'-DDT	0.01313 J	0.01781 J	0.03899	0.02983	0.02451	0.03942	0.01244
Oxychlordane	0.00083 J	0.0009 J	0.00275	0.00105 J	0.00294 U	0.00163 J	0.00273 U
Pentachloroanisole	0.00042 J	0.00101 J	0.00057 J	0.00024 J	0.0002 J	0.00033 J	0.00013 U
Pentachlorobenzene	0.00604 J	0.00696 J	0.01563	0.01059	0.0057	0.00914	0.00252 J
Toxaphene	0.02 UJ	0.0312 UJ	0.0189 U	0.0192 U	0.02941 U	0.0246 U	0.02732 U
trans-Nonachlor	0.00061 J	0.00271 J	0.0028	0.00097 J	0.00111 J	0.00153 J	0.00072 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.7 J	0.6 J	1.7	1.4	0.4	0.7	0.4
Percent Lipids (GC/MS)			1.7 J			0.7 J	
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11PS02-0-8S30	H3-TF11PS03-0-8C19	H3-TF11PS03-0-8S30	H3-TF11PS04-0-8C21	H3-TF11PS04-0-8S30	H3-TF11PS05-0-8C21	H3-TF11PS05-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/20/1998	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/1/1998
Fish Length (cm)	17	16.5	17	17.5	17	18.5	16.9
PCBs							
PCB, Total	7.78489	5.55373	5.36632	6.17005	10.37457	6.3904	5.46806
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,4,6,7,8-HPCDF	0.0000042 UJ	0.00000996 U	0.0000017 J	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000047 J
1,2,3,4,7,8,9-HPCDF	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,4,7,8-HXCDD	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,4,7,8-HXCDF	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,6,7,8-HXCDD	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,6,7,8-HXCDF	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,7,8,9-HXCDD	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,7,8,9-HXCDF	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,7,8-PECDD	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
1,2,3,7,8-PECDF	0.00002 J	0.0000069 J	0.00001 J	0.0000062 J	0.00006 J	0.0000052 J	0.00003 J
2,3,4,6,7,8-HXCDF	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000069 U	0.000005 UJ	0.00000677 U	0.0000044 UJ
2,3,4,7,8-PECDF	0.0000042 UJ	0.00000996 U	0.0000045 UJ	0.0000027 J	0.000005 UJ	0.0000026 J	0.0000015 J
2,3,7,8-TCDD	0.0000008 UJ	0.00000199 U	0.0000009 UJ	0.00000138 U	0.000001 UJ	0.00000135 U	0.0000009 UJ
2,3,7,8-TCDF	0.00002 UJ	0.00001	0.0000031 UJ	0.00001	0.0000073 UJ	0.00001	0.0000043 UJ
OCDD	0.0000085 UJ	0.00001 U	0.0000091 UJ	0.00001 U	0.0000099 UJ	0.00001 U	0.0000088 UJ
OCDF	0.0000085 UJ	0.00001 U	0.0000091 UJ	0.00001 U	0.0000099 UJ	0.00001 U	0.0000088 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.06262	0.02044	0.03607	0.02272	0.05791	0.02211	0.03866
PCB-114	0.00002 U	0.00028 U	0.00001 U	0.00029 U	0.00001 U	0.00029 U	0.00001 U
PCB-118	0.0913	0.09487	0.06413	0.09293	0.13402	0.0825	0.05611
PCB-126	0.00097	0.00045 J	0.00038	0.00041 J	0.00044	0.00024 J	0.00041
PCB-149/123	0.27453	0.2468	0.19713	0.30822	0.31132	0.35603	0.20452
PCB-156	0.00975	0.00028 U	0.01069	0.02578 J	0.02995	0.02614 J	0.01565
PCB-167	0.01906	0.02203	0.01617	0.02144	0.03655	0.01758	0.01407
PCB-169	0.00013	0.00004 U	0.00006 J	0.00004 U	0.00009	0.00012 J	0.00007
PCB-189	0.00539	0.00508	0.00461	0.00519	0.00883	0.00574	0.00428
PCB-201/157/173	0.01138	0.01327	0.01103	0.01537	0.01959	0.01641	0.01053
PCB-77	0.00124	0.00101 J	0.00036	0.00076 J	0.00046	0.001 J	0.00023
PCB-81	0.00037	0.00003 J	0.00001 U	0.00003 J	0.00033	0.00002 J	0.00031
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.02497	0.0039	0.01066	0.01272	0.01117	0.01235	0.01536
1,2,4,5-Tetrachlorobenzene	0.00482	0.00083 J	0.00166 J	0.00386	0.00431	0.00305	0.00501
4,4'-DDD	0.0065	0.00266 J	0.003	0.00334	0.00394	0.00313	0.00328
4,4'-DDE	0.01972	0.00982	0.01277	0.00896	0.025	0.00367	0.01134
4,4'-DDT	0.00238 U	0.00277 U	0.00198 U	0.00031 J	0.00049 J	0.00022 J	0.00044 J
Aldrin	0.00238 U	0.00277 U	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
alpha-BHC	0.00238 U	0.00003 J	0.00198 U	0.00002 J	0.00198 U	0.00008 J	0.00195 U
alpha-Chlordane	0.00238 U	0.00277 U	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
beta-BHC	0.00238 U	0.00005 J	0.00198 U	0.00006 J	0.00198 U	0.00291 U	0.00195 U
Chlorpyrifos	0.00067 J	0.00005 U	0.00198 U	0.00007 U	0.00198 U	0.00008 U	0.00195 U
cis-Nonachlor	0.01542	0.00776	0.01136	0.01064	0.0134	0.01015	0.0116
delta-BHC	0.0011 J	0.00277 U	0.00028 J	0.00287 U	0.00198 U	0.00291 U	0.0007 J
Dieldrin	0.00025 J	0.00064 J	0.00037 J	0.00081 J	0.00049 J	0.00086 J	0.0004 J
Endosulfan II	0.00482	0.00277 U	0.00479	0.00303	0.00708	0.00288 J	0.00514
Endrin	0.00238 U	0.00002 J	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
gamma-BHC (Lindane)	0.00027 J	0.00004 J	0.00198 U	0.00013 J	0.00005 J	0.0001 J	0.00011 J
gamma-Chlordane	0.00238 U	0.00277 U	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
Heptachlor	0.00108 J	0.00277 U	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
Heptachlor epoxide	0.00238 U	0.00277 U	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
Hexachlorobenzene	0.00074 J	0.00031 J	0.00044 J	0.00075 J	0.00051 J	0.00073 J	0.0008 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11PS02-0-8S30	H3-TF11PS03-0-8C19	H3-TF11PS03-0-8S30	H3-TF11PS04-0-8C21	H3-TF11PS04-0-8S30	H3-TF11PS05-0-8C21	H3-TF11PS05-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/20/1998	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/1/1998
Fish Length (cm)	17	16.5	17	17.5	17	18.5	16.9
Mirex	0.00238 U	0.00277 U	0.00198 U	0.00287 U	0.00198 U	0.00291 U	0.00195 U
o,p'-DDD	0.03268	0.0208	0.02638	0.02413	0.05392	0.02075	0.02321
o,p'-DDE	0.00238 U	0.00035 J	0.00198 U	0.00053 J	0.00198 U	0.00291 U	0.00195 U
o,p'-DDT	0.02986	0.01686	0.02206	0.01881	0.04545	0.01817	0.02046
Oxychlordane	0.00211 J	0.00277 U	0.00109 J	0.00287 U	0.00137 J	0.00291 U	0.00024 J
Pentachloroanisole	0.00015 J	0.00022 J	0.00005 J	0.00021 J	0.00006 J	0.0003 J	0.00011 J
Pentachlorobenzene	0.011	0.0018 J	0.00466	0.00695	0.00559	0.0065	0.00733
Toxaphene	0.0238 U	0.0277 U	0.0198 U	0.02865 U	0.0198 U	0.02907 U	0.0195 U
trans-Nonachlor	0.00162 J	0.00114 J	0.00048 J	0.00056 J	0.0013 J	0.00087 J	0.00079 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1	0.5	0.9	0.5	0.4	0.6	0.9
Percent Lipids (GC/MS)	1 J	0.46	0.9 J	0.48	0.4 J	0.62	0.9 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11PS06-0-8C21	H3-TF11YP01-0-8C20	H3-TF11YP23-0-8S30	H3-TF11YP24-0-8S30	H3-TF11YP25-0-8S30	H3-TF11YP26-0-8S30	H4-TFWPPS01-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed
Collection Date	10/21/1998	10/20/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/21/1998
Fish Length (cm)	19.6	28.5	30.9	29.5	26.7	26.8	17.7
PCBs							
PCB, Total	4.34387	5.64918	4.16224	3.37158	4.24436	3.53259	1.79158
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,4,6,7,8-HPCDF	0.00000452 U	0.00000992 U	0.0000037 UJ		0.000001 J	0.0000048 UJ	0.00000965 U
1,2,3,4,7,8,9-HPCDF	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,4,7,8-HXCDD	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,4,7,8-HXCDF	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,6,7,8-HXCDD	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,6,7,8-HXCDF	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,7,8,9-HXCDD	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,7,8,9-HXCDF	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,7,8-PECDD	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
1,2,3,7,8-PECDF	0.0000028 J	0.00000992 U	0.00001 J		0.00001 J	0.00001 J	0.0000021 J
2,3,4,6,7,8-HXCDF	0.00000452 U	0.00000992 U	0.0000037 UJ		0.0000049 UJ	0.0000048 UJ	0.00000965 U
2,3,4,7,8-PECDF	0.0000019 J	0.000007 J	0.000002 J		0.0000024 J	0.0000048 UJ	0.0000023 J
2,3,7,8-TCDD	0.0000009 U	0.00000198 U	0.0000007 UJ		0.000001 UJ	0.000001 UJ	0.00000193 U
2,3,7,8-TCDF	0.0000088	0.00001	0.0000087 UJ		0.0000077 UJ	0.00001 UJ	0.00001
OCDD	0.00000903 U	0.00004	0.0000074 UJ		0.0000099 UJ	0.0000097 UJ	0.00001 U
OCDF	0.00000903 U	0.00004	0.0000074 UJ		0.0000099 UJ	0.0000097 UJ	0.00001 U
Dioxin-Like PCB Congeners							
PCB-105	0.0169	0.03773	0.0311	0.03322	0.02585	0.02693	0.0026
PCB-114	0.00024 U	0.00024 U	0.00001 U	0.00001 U	0.00001 U	0.00001 U	0.00024 U
PCB-118	0.0729	0.07492	0.05819	0.03022	0.03006	0.04905	0.02822
PCB-126	0.00037 J	0.00054	0.00044	0.00011	0.00035	0.00015	0.00015 J
PCB-149/123	0.24118	0.31868	0.17223	0.14823	0.19353	0.15349	0.09278
PCB-156	0.01672 J	0.02777	0.00857	0.00699	0.00647	0.00695	0.00544 J
PCB-167	0.01156	0.01551	0.01101	0.00836	0.00751	0.00988	0.00471
PCB-169	0.00003 J	0.00003 U	0.00008	0.00001 U	0.00006 J	0.00001 J	0.00003 J
PCB-189	0.00268	0.00659	0.00295	0.00245	0.00261	0.00272	0.00103
PCB-201/157/173	0.00848	0.01311	0.00654	0.00513	0.00593	0.00572	0.00338
PCB-77	0.00091 J	0.0005	0.00041	0.000009 J	0.00032	0.00012	0.00031 J
PCB-81	0.00005 J	0.00001 J	0.00043	0.00015	0.00044	0.00001 U	0.0001 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.01542	0.01798	0.01363	0.0139	0.01326	0.0124	0.00943
1,2,4,5-Tetrachlorobenzene	0.00342	0.00282	0.00591	0.00496	0.0051	0.0032	0.00298
4,4'-DDD	0.00251	0.00328	0.00326	0.00214	0.0025	0.00259	0.00087 J
4,4'-DDE	0.0048	0.00925	0.00939	0.00652	0.00761	0.00872	0.0025
4,4'-DDT	0.00021 J	0.00134 J	0.00039 J	0.00198 U	0.00195 U	0.00187 U	0.00004 J
Aldrin	0.0024 U	0.00245 U	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00243 U
alpha-BHC	0.00002 J	0.00031 J	0.00184 U	0.00198 U	0.00195 U	0.00019 J	0.0001 J
alpha-Chlordane	0.0024 U	0.00182 J	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00004 J
beta-BHC	0.00005 J	0.00245 U	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00006 J
Chlorpyrifos	0.00018 J	0.00008 J	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00012 U
cis-Nonachlor	0.00751	0.01125	0.0112	0.0086	0.00907	0.00898	0.00257
delta-BHC	0.00033 J	0.00245 U	0.0008 J	0.0008 J	0.00088 J	0.00084 J	0.00243 U
Dieldrin	0.00072 J	0.00317 J	0.00026 J	0.00036 J	0.00027 J	0.00014 J	0.00024 J
Endosulfan II	0.00106 J	0.00418 J	0.00726	0.00566	0.00611	0.00315	0.00108 J
Endrin	0.0024 U	0.0002 J	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00243 U
gamma-BHC (Lindane)	0.00016 J	0.00014 J	0.00184 U	0.00005 J	0.00006 J	0.00187 U	0.00007 J
gamma-Chlordane	0.0024 U	0.00021 J	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00243 U
Heptachlor	0.0024 U	0.00245 U	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00003 J
Heptachlor epoxide	0.0024 U	0.00245 U	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00243 U
Hexachlorobenzene	0.00104 J	0.00107 J	0.00048 J	0.00056 J	0.00055 J	0.00039 J	0.0003 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H3-TF11PS06-0-8C21	H3-TF11YP01-0-8C20	H3-TF11YP23-0-8S30	H3-TF11YP24-0-8S30	H3-TF11YP25-0-8S30	H3-TF11YP26-0-8S30	H4-TFWPPS01-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Pumpkinseed
Collection Date	10/21/1998	10/20/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/21/1998
Fish Length (cm)	19.6	28.5	30.9	29.5	26.7	26.8	17.7
Mirex	0.0024 U	0.00245 U	0.00184 U	0.00198 U	0.00195 U	0.00187 U	0.00243 U
o,p'-DDD	0.01558	0.01719	0.01722	0.01349	0.01389	0.01392	0.00729
o,p'-DDE	0.0024 U	0.00245 U	0.00184 U	0.00198 U	0.00195 U	0.00055 J	0.00243 U
o,p'-DDT	0.01375	0.02072	0.01902	0.01467	0.01475	0.01632	0.00452
Oxychlordane	0.0024 U	0.00245 U	0.00081 J	0.00054 J	0.00069 J	0.00064 J	0.00243 U
Pentachloroanisole	0.00022 J	0.00049 J	0.00009 J	0.00022 J	0.00021 J	0.00062 J	0.00015 J
Pentachlorobenzene	0.00803	0.01094	0.00649	0.00698	0.00646	0.00587	0.00329
Toxaphene	0.02398 U	0.02449 U	0.0184 U	0.0198 U	0.0196 U	0.0188 U	0.02433 U
trans-Nonachlor	0.0002 J	0.00094 J	0.00042 J	0.00029 J	0.00011 J	0.00187 U	0.00015 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.7	0.5	1.1	3	0.5	0.4	0.4
Percent Lipids (GC/MS)	0.65	0.54	1.1 J		0.5 J	0.4 J	0.45
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS01-0-8S30	H4-TFWPPS02-0-8C21	H4-TFWPPS02-0-8S30	H4-TFWPPS02-1-8C21	H4-TFWPPS03-0-8C21	H4-TFWPPS04-0-8C01	H4-TFWPPS04-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/21/1998	10/1/1998	10/21/1998
Fish Length (cm)	17.4	20	19.0	20	16.6	16.8	18.4
PCBs							
PCB, Total	8.72667	2.28924	3.84653	2.44446	5.38253	3.46918	5.51826
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,4,6,7,8-HPCDF	0.00003	0.00000998 U	0.00001	0.00000907 U		0.0000092 U	
1,2,3,4,7,8,9-HPCDF	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,4,7,8-HXCDD	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,4,7,8-HXCDF	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,6,7,8-HXCDD	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,6,7,8-HXCDF	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,7,8,9-HXCDD	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,7,8,9-HXCDF	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,7,8-PECDD	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
1,2,3,7,8-PECDF	0.00009	0.0000017 J	0.00002	0.00000907 U		0.0000087 J	
2,3,4,6,7,8-HXCDF	0.000005 U	0.00000998 U	0.0000048 U	0.00000907 U		0.0000092 U	
2,3,4,7,8-PECDF	0.0000091	0.0000025 J	0.0000071	0.00000907 U		0.00001	
2,3,7,8-TCDD	0.000001 U	0.000002 U	0.000001 U	0.00000181 U		0.0000018 U	
2,3,7,8-TCDF	0.00004	0.0000097	0.00002	0.00001		0.00004	
OCDD	0.00001 U	0.00001 U	0.0000096 U	0.00001 U		0.00001 U	
OCDF	0.00001 U	0.00001 U	0.0000096 U	0.00001 U		0.00001 U	
Dioxin-Like PCB Congeners							
PCB-105	0.0151 J	0.00724	0.00878	0.01255	0.02326	0.01702	0.01656
PCB-114	0.00021 U	0.00028 U	0.00021 U	0.00025 U	0.00023 U	0.00021 U	0.00025 U
PCB-118	0.17583 J	0.04278	0.08577	0.04503	0.09748	0.06345	0.09171
PCB-126	0.01165 J	0.00021 J	0.00281	0.00042	0.0007 J	0.00395	0.0005
PCB-149/123	0.33926 J	0.12506	0.17375	0.11474	0.25329	0.14647	0.22256
PCB-156	0.03741 J	0.00625 J	0.01599	0.00844	0.02207	0.03063	0.01687
PCB-167	0.02959 J	0.00604	0.01591	0.00796	0.01578	0.01493	0.01384
PCB-169	0.00017 J	0.00015 J	0.00003 J	0.00004 J	0.00002 J	0.00021 UJ	0.00005 J
PCB-189	0.0095 J	0.00094	0.00355	0.00146	0.00411	0.00548	0.0037
PCB-201/157/173	0.02299 J	0.00353	0.00974	0.00481	0.01376	0.01243	0.01145
PCB-77	0.02759 J	0.00058 J	0.01092	0.00173	0.00117	0.00962	0.00108
PCB-81	0.00607 J	0.000003 J	0.00235	0.00004 J	0.00012 J	0.00264	0.00001 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00691	0.0081	0.00507	0.00816	0.00664	0.00437	0.01055
1,2,4,5-Tetrachlorobenzene	0.00346	0.00212 J	0.00275	0.00172 J	0.00133 J	0.00257	0.00236 J
4,4'-DDD	0.00364	0.00088 J	0.0016	0.00134 J	0.00373	0.00319	0.00261
4,4'-DDE	0.01841	0.00426	0.01204	0.00599	0.01157	0.00925	0.01263
4,4'-DDT	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00048	0.00248 U
Aldrin	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
alpha-BHC	0.00206 U	0.00009 J	0.00214 U	0.00028 J	0.00028 J	0.00214 U	0.00036 J
alpha-Chlordane	0.00206 U	0.00282 U	0.00214 U	0.00111 J	0.00105 J	0.00214 U	0.00143 J
beta-BHC	0.00007 U	0.00282 U	0.00007 U	0.00247 U	0.00233 U	0.00004 U	0.00248 U
Chlorpyrifos	0.00011 U	0.00007 U	0.00011 U	0.00247 U	0.00233 U	0.00009 U	0.00248 U
cis-Nonachlor	0.01137	0.00321	0.00653	0.00421	0.0105	0.00738	0.00896
delta-BHC	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.000006 U	0.00248 U
Dieldrin	0.00074	0.00026 J	0.00052	0.00038 J	0.00054 J	0.00048	0.00053 J
Endosulfan II	0.00206 U	0.00122 J	0.00214 U	0.00294	0.00378	0.00214 U	0.00342
Endrin	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00008 J
gamma-BHC (Lindane)	0.00015	0.00008 J	0.00012	0.00007 J	0.00005 J	0.00016	0.00008 J
gamma-Chlordane	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
Heptachlor	0.00206 U	0.00003 J	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
Heptachlor epoxide	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
Hexachlorobenzene	0.00029	0.00029 J	0.00018	0.00029 J	0.00062 J	0.00045	0.00041 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS01-0-8S30	H4-TFWPPS02-0-8C21	H4-TFWPPS02-0-8S30	H4-TFWPPS02-1-8C21	H4-TFWPPS03-0-8C21	H4-TFWPPS04-0-8C01	H4-TFWPPS04-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/21/1998	10/1/1998	10/21/1998
Fish Length (cm)	17.4	20	19.0	20	16.6	16.8	18.4
Mirex	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
o,p'-DDD	0.02501	0.00994	0.01473	0.01219	0.0238	0.00738	0.02527
o,p'-DDE	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
o,p'-DDT	0.02315	0.00616	0.01133	0.0078	0.0182	0.0108	0.01765
Oxychlordane	0.00206 U	0.00282 U	0.00214 U	0.00247 U	0.00233 U	0.00214 U	0.00248 U
Pentachloroanisole	0.00013 U	0.00014 J	0.00012 U	0.00018 J	0.00017 J	0.00013 U	0.00028 J
Pentachlorobenzene	0.00292	0.00289	0.00173	0.00344	0.00381	0.00347	0.00454
Toxaphene	0.02058 U	0.02817 U	0.02141 U	0.02467 U	0.02332 U	0.02137 U	0.02484 U
trans-Nonachlor	0.00052	0.00065 J	0.00043	0.00104 J	0.00109 J	0.0007	0.00105 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1.1	0.6	1.4	0.5	0.5	1.2	0.6
Percent Lipids (GC/MS)	1.1	0.56	1.4	0.5		1.2	
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS05-0-8C01	H4-TFWPPS05-0-8C21	H4-TFWPPS06-0-8C21	H4-TFWPPS07-0-8C01	H4-TFWPPS07-0-8C21	H4-TFWPPS08-0-8C01	H4-TFWPPS08-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/21/1998	10/20/1998	10/1/1998	10/20/1998	10/1/1998	10/21/1998
Fish Length (cm)	16.5	17.2	17.5	18.5	16.2	17	16.6
PCBs							
PCB, Total	4.16368	4.1789	5.89803	4.23238	2.15366	10.44983	3.58393
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,4,6,7,8-HPCDF			0.00000482 U			0.0000034 J	0.00000982 U
1,2,3,4,7,8,9-HPCDF			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,4,7,8-HXCDD			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,4,7,8-HXCDF			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,6,7,8-HXCDD			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,6,7,8-HXCDF			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,7,8,9-HXCDD			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,7,8,9-HXCDF			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,7,8-PECDD			0.00000482 U			0.0000048 UJ	0.00000982 U
1,2,3,7,8-PECDF			0.0000042 J			0.00002 J	0.0000022 J
2,3,4,6,7,8-HXCDF			0.00000482 U			0.0000048 UJ	0.00000982 U
2,3,4,7,8-PECDF			0.0000017 J			0.0000011 J	0.00000982 U
2,3,7,8-TCDD			0.00000096 U			0.000001 UJ	0.00000196 U
2,3,7,8-TCDF			0.00001			0.00001 J	0.00001
OCDD			0.00000963 U			0.0000097 UJ	0.00001 U
OCDF			0.00000963 U			0.0000097 UJ	0.00001 U
Dioxin-Like PCB Congeners							
PCB-105	0.01161	0.0147	0.0236	0.03215	0.01325	0.0453	0.01302
PCB-114	0.00024 U	0.00024 U	0.00023 U	0.00002 U	0.00023 U	0.00002 U	0.00024 U
PCB-118	0.07505	0.07853	0.10089	0.06944	0.0358	0.18677	0.06154
PCB-126	0.00023 J	0.00047	0.00057	0.00026	0.00022	0.00082	0.00069
PCB-149/123	0.18734	0.19098	0.27896	0.2675	0.08885	0.59358	0.14546
PCB-156	0.0209	0.01517	0.0233	0.02088	0.00752	0.05228	0.01286
PCB-167	0.01803	0.01275	0.01839	0.01609	0.00692	0.04503	0.00885
PCB-169	0.00012 J	0.00008 J	0.00006 U	0.00005 U	0.00002 U	0.00012 U	0.00004 J
PCB-189	0.00532	0.00304	0.00505	0.00459	0.00169	0.01094	0.00222
PCB-201/157/173	0.00992	0.00856	0.01431	0.00999	0.00474	0.0213	0.00675
PCB-77	0.00032 J	0.00113	0.00114	0.00041	0.0004	0.00144	0.00091
PCB-81	0.00006 J	0.00002 J	0.00007 J	0.00002 J	0.00001 J	0.00007	0.00006 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00271	0.0076	0.0087	0.0054	0.0069	0.004	0.00865
1,2,4,5-Tetrachlorobenzene	0.00123	0.00145 J	0.00197 J	0.00163 J	0.00144 J	0.00116 J	0.0018 J
4,4'-DDD	0.00302	0.00197 J	0.00358	0.00182 J	0.00078 J	0.00256	0.00146 J
4,4'-DDE	0.00798	0.00798	0.01233	0.00966	0.00508	0.02893	0.00878
4,4'-DDT	0.00053	0.00039 J	0.00058 J	0.00041 J	0.0023 U	0.00045 J	0.00245 U
Aldrin	0.00243 U	0.00244 U	0.00233 U	0.00076 J	0.0023 U	0.00056 J	0.00245 U
alpha-BHC	0.00243 U	0.00028 J	0.00022 J	0.00016 J	0.00024 J	0.00011 J	0.00026 J
alpha-Chlordane	0.00042	0.00092 J	0.00101 J	0.0007 J	0.00015 U	0.00073 J	0.00086 J
beta-BHC	0.00243 U	0.00244 U	0.00233 U	0.00197 U	0.0023 U	0.00199 U	0.00245 U
Chlorpyrifos	0.00008 U	0.00244 U	0.00233 U	0.00001 J	0.0023 U	0.00199 U	0.00245 U
cis-Nonachlor	0.00659	0.00654	0.01142	0.00668	0.00291	0.01728	0.00551
delta-BHC	0.00243 U	0.00244 U	0.00233 U	0.00038 J	0.0023 U	0.00029 J	0.00245 U
Dieldrin	0.00243 U	0.00041 J	0.00058 J	0.00055 J	0.00021 J	0.001 J	0.00067 J
Endosulfan II	0.00243 U	0.00272	0.00343	0.00327	0.00151 J	0.00199 U	0.00248
Endrin	0.00243 U	0.00244 U	0.00233 U	0.00197 U	0.0023 U	0.00199 U	0.00245 U
gamma-BHC (Lindane)	0.00003 U	0.00006 J	0.00007 J	0.00023 J	0.00005 J	0.0002 J	0.00006 J
gamma-Chlordane	0.00243 U	0.00244 U	0.00233 U	0.00197 U	0.00001 U	0.00199 U	0.00245 U
Heptachlor	0.00243 U	0.00244 U	0.00233 U	0.00012 J	0.0023 U	0.00017 J	0.00245 U
Heptachlor epoxide	0.00243 U	0.00244 U	0.00233 U	0.00019 J	0.0023 U	0.00052 J	0.00245 U
Hexachlorobenzene	0.00025	0.00043 J	0.00056 J	0.00053 J	0.00016 J	0.00051 J	0.00027 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS05-0-8C01	H4-TFWPPS05-0-8C21	H4-TFWPPS06-0-8C21	H4-TFWPPS07-0-8C01	H4-TFWPPS07-0-8C21	H4-TFWPPS08-0-8C01	H4-TFWPPS08-0-8C21
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/21/1998	10/20/1998	10/1/1998	10/20/1998	10/1/1998	10/21/1998
Fish Length (cm)	16.5	17.2	17.5	18.5	16.2	17	16.6
Mirex	0.00243 U	0.00244 U	0.00233 U	0.00197 U	0.0023 U	0.00199 U	0.00245 U
o,p'-DDD	0.01779	0.01738	0.02322	0.01791	0.01065	0.04051	0.0172
o,p'-DDE	0.00243 U	0.00244 U	0.00233 U	0.00037 J	0.0023 U	0.00056 J	0.00245 U
o,p'-DDT	0.01541	0.01303	0.02009	0.01204	0.00672	0.02665	0.0108
Oxychlordane	0.00243 U	0.00244 U	0.00233 U	0.00154 J	0.0023 U	0.00356	0.00245 U
Pentachloroanisole	0.00008 U	0.0002 J	0.00018 J	0.00024 J	0.00014 U	0.0002 J	0.00017 J
Pentachlorobenzene	0.00084	0.00362	0.00448	0.00175 J	0.0023	0.00148 J	0.00326
Toxaphene	0.02429 U	0.02442 U	0.02334 U	0.0197 U	0.02297 U	0.0199 U	0.02446 U
trans-Nonachlor	0.00074	0.00064 J	0.00093 J	0.00087 J	0.00016 U	0.00149 J	0.00072 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.1	0.7	0.3	0.5	0.5	0.7	0.3
Percent Lipids (GC/MS)			0.27			0.7 J	0.31
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS09-0-8C01	H4-TFWPPS09-0-8C21	H4-TFWPPS10-0-8C01	H4-TFWPPS10-0-8C21	H4-TFWPPS11-0-8C01	H4-TFWPPS11-0-8C21	H4-TFWPPS12-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/1/1998
Fish Length (cm)	16	17	17	18.8	16	19.2	18
PCBs							
PCB, Total	5.88158	6.97135	4.34926	4.83165	5.10912	1.11078	10.97381
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000002 J			0.00000994 U		0.00000994 U	0.0000003 J
1,2,3,4,6,7,8-HPCDF	0.000002 J			0.00000994 U		0.00000994 U	0.0000031 J
1,2,3,4,7,8,9-HPCDF	0.000005 UJ			0.00000994 U		0.00000994 U	0.0000049 UJ
1,2,3,4,7,8-HXCDD	0.0000001 J			0.00000994 U		0.00000994 U	0.0000049 UJ
1,2,3,4,7,8-HXCDF	0.000005 UJ			0.00000994 U		0.00000994 U	0.0000049 UJ
1,2,3,6,7,8-HXCDD	0.000005 UJ			0.00000994 U		0.00000994 U	0.0000049 UJ
1,2,3,6,7,8-HXCDF	0.0000005 J			0.00000994 U		0.00000994 U	0.0000003 J
1,2,3,7,8,9-HXCDD	0.000005 UJ			0.00000994 U		0.00000994 U	0.0000049 UJ
1,2,3,7,8,9-HXCDF	0.000005 UJ			0.00000994 U		0.00000994 U	0.0000004 J
1,2,3,7,8-PECDD	0.000005 UJ			0.00000994 U		0.00000994 U	0.0000049 UJ
1,2,3,7,8-PECDF	0.00001 J			0.0000035 J		0.0000046 J	0.00003 J
2,3,4,6,7,8-HXCDF	0.000001 J			0.00000994 U		0.00000994 U	0.0000049 UJ
2,3,4,7,8-PECDF	0.0000044 J			0.00000994 U		0.00000994 U	0.0000061 J
2,3,7,8-TCDD	0.000001 UJ			0.00000199 U		0.00000199 U	0.000001 UJ
2,3,7,8-TCDF	0.00002 J			0.00001		0.00001	0.00003 J
OCDD	0.0000003 J			0.00001 U		0.00001 U	0.0000004 J
OCDF	0.0000099 UJ			0.00001 U		0.00001 U	0.0000005 J
Dioxin-Like PCB Congeners							
PCB-105	0.03965	0.02649	0.03038	0.02002	0.04311	0.00736	0.05707
PCB-114	0.00001 U	0.00023 U	0.00001 U	0.00024 U	0.00001 U	0.00024 U	0.00001 U
PCB-118	0.0729	0.11545	0.06879	0.08646	0.11177	0.01827	0.17744
PCB-126	0.00074	0.00064	0.0003	0.00048	0.00035	0.0001	0.00069
PCB-149/123	0.25489	0.29146	0.14883	0.18966	0.18829	0.0609	0.44547
PCB-156	0.01167	0.03578	0.01206	0.02674	0.01102	0.00332	0.06355
PCB-167	0.02048	0.02537	0.01623	0.01926	0.01887	0.00268	0.05403
PCB-169	0.00007	0.00006 J	0.00004 J	0.00073 J	0.00007	0.00001 J	0.00011
PCB-189	0.00568	0.00746	0.00503	0.00504	0.00538	0.00071	0.01215
PCB-201/157/173	0.01188	0.01883	0.01194	0.01397	0.01022	0.00268	0.02031
PCB-77	0.00112	0.0012	0.00045	0.00067	0.00041	0.00023	0.00081
PCB-81	0.0002	0.00006 J	0.00001 U	0.00024 U	0.00003 J	0.000007 J	0.00003 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.0161	0.01645	0.00494	0.00808	0.00546	0.00578	0.01527
1,2,4,5-Tetrachlorobenzene	0.00418	0.00377	0.00144 J	0.00186 J	0.00252	0.00198 J	0.00679
4,4'-DDD	0.00413	0.00416	0.00237	0.00231 J	0.00303	0.00044 J	0.01259
4,4'-DDE	0.01203	0.01567	0.01215	0.01257	0.01299	0.00225 J	0.03541
4,4'-DDT	0.00082 J	0.00064 J	0.00022 J	0.00239 U	0.00036 J	0.0024 U	0.00132 J
Aldrin	0.00198 U	0.00231 U	0.00199 U	0.00239 U	0.00199 U	0.0024 U	0.00197 U
alpha-BHC	0.00023 J	0.00029 J	0.00024 J	0.00034 J	0.00008 J	0.00034 J	0.00001 J
alpha-Chlordane	0.00198 U	0.00148 J	0.00199 U	0.0009 J	0.00199 U	0.0024 U	0.00197 U
beta-BHC	0.00198 U	0.00231 U	0.00007 J	0.00239 U	0.00199 U	0.0024 U	0.00197 U
Chlorpyrifos	0.00198 U	0.00231 U	0.00199 U	0.00239 U	0.00199 U	0.0024 U	0.00197 U
cis-Nonachlor	0.01107	0.01285	0.00834	0.00804	0.00985	0.00193 J	0.01782
delta-BHC	0.00198 U	0.00231 U	0.00199 U	0.00239 U	0.00199 U	0.0024 U	0.00024 J
Dieldrin	0.0007 J	0.00075 J	0.00056 J	0.00045 J	0.0006 J	0.00015 J	0.00105 J
Endosulfan II	0.00388	0.00352	0.00256	0.00308	0.00339	0.00088 J	0.00895
Endrin	0.00198 U	0.00231 U	0.00199 U	0.00239 U	0.00199 U	0.0024 U	0.00197 U
gamma-BHC (Lindane)	0.00019 J	0.00013 J	0.00007 J	0.00009 J	0.00018 J	0.00005 J	0.00039 J
gamma-Chlordane	0.00015 J	0.00231 U	0.00199 U	0.00024 J	0.00199 U	0.0024 U	0.00013 J
Heptachlor	0.00198 U	0.00231 U	0.00199 U	0.00239 U	0.00199 U	0.0024 U	0.00024 J
Heptachlor epoxide	0.00198 U	0.00231 U	0.00199 U	0.00061 J	0.00199 U	0.0024 U	0.00197 U
Hexachlorobenzene	0.00102 J	0.00052 J	0.0004 J	0.00036 J	0.00068 J	0.00022 J	0.00064 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS09-0-8C01	H4-TFWPPS09-0-8C21	H4-TFWPPS10-0-8C01	H4-TFWPPS10-0-8C21	H4-TFWPPS11-0-8C01	H4-TFWPPS11-0-8C21	H4-TFWPPS12-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed
Collection Date	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/1/1998	10/21/1998	10/1/1998
Fish Length (cm)	16	17	17	18.8	16	19.2	18
Mirex	0.00198 U	0.00231 U	0.00199 U	0.0002 J	0.00199 U	0.0024 U	0.00197 U
o,p'-DDD	0.01974	0.03121	0.01792	0.02436	0.01773	0.00511	0.04114
o,p'-DDE	0.00198 U	0.00231 U	0.00199 U	0.00239 U	0.00199 U	0.0024 U	0.00197 U
o,p'-DDT	0.01214	0.02487	0.01207	0.01949	0.01103	0.00339	0.03024
Oxychlordane	0.00215	0.00231 U	0.00179 J	0.00239 U	0.00203	0.0024 U	0.0047
Pentachloroanisole	0.00034 J	0.00028 J	0.00009 J	0.00013 U	0.00028 J	0.00012 U	0.00034 J
Pentachlorobenzene	0.00703	0.00598	0.00206	0.00375	0.0019 J	0.00214 J	0.00435
Toxaphene	0.0198 U	0.02315 U	0.0199 U	0.02392 U	0.0199 U	0.02396 U	0.0197 U
trans-Nonachlor	0.00118 J	0.00155 J	0.00039 J	0.00112 J	0.00056 J	0.00016 U	0.00219
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.7	0.8	0.3	0.3	0.5	0.2	1.4
Percent Lipids (GC/MS)	0.7 J			0.35		0.23	1.4 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS12-0-8C21	H4-TFWPPS13-0-8C01	H4-TFWPPS14-0-8C01	H4-TFWPPS15-0-8C01	H4-TFWPYP01-0-8S30	H4-TFWPYP02-0-8S30	H4-TFWPYP03-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/21/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	17.9	16	14.5	18.5	21.7	19.7	21.1
PCBs							
PCB, Total	4.6687	6.37555	11.69399	47.45448	0.66409	0.63294	2.10485
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000099 U		0.0000084 UJ	0.0000002 J			0.0000095 U
1,2,3,4,6,7,8-HPCDF	0.0000099 U		0.0000052 J	0.00001 J			0.0000095 U
1,2,3,4,7,8,9-HPCDF	0.0000099 U		0.0000084 UJ	0.0000005 J			0.0000095 U
1,2,3,4,7,8-HXCDD	0.0000099 U		0.0000084 UJ	0.0000043 UJ			0.0000095 U
1,2,3,4,7,8-HXCDF	0.0000099 U		0.0000084 UJ	0.0000043 UJ			0.0000095 U
1,2,3,6,7,8-HXCDD	0.0000099 U		0.0000084 UJ	0.0000043 UJ			0.0000095 U
1,2,3,6,7,8-HXCDF	0.0000099 U		0.0000002 J	0.0000043 UJ			0.0000095 U
1,2,3,7,8,9-HXCDD	0.0000099 U		0.0000084 UJ	0.0000043 UJ			0.0000095 U
1,2,3,7,8,9-HXCDF	0.0000099 U		0.0000002 J	0.0000043 UJ			0.0000095 U
1,2,3,7,8-PECDD	0.0000099 U		0.0000084 UJ	0.0000043 UJ			0.0000095 U
1,2,3,7,8-PECDF	0.0000093 J		0.00003 J	0.00021 J			0.00001
2,3,4,6,7,8-HXCDF	0.0000099 U		0.0000016 J	0.0000043 J			0.0000095 U
2,3,4,7,8-PECDF	0.0000039 J		0.00001 J	0.00001 J			0.00001
2,3,7,8-TCDD	0.00000198 U		0.0000003 J	0.0000025 J			0.0000019 U
2,3,7,8-TCDF	0.00001		0.00003 J	0.00017 J			0.00004
OCDD	0.00001 U		0.0000009 J	0.0000006 J			0.00001 U
OCDF	0.00001 U		0.0000009 J	0.0000005 J			0.00001 U
Dioxin-Like PCB Congeners							
PCB-105	0.01345	0.05433	0.07547	0.29474	0.00241	0.002	0.00448
PCB-114	0.00025 U	0.00001 U	0.00001 U	0.00002 U	0.00023 U	0.00023 U	0.00022 U
PCB-118	0.08959	0.10137	0.15607	0.6971	0.01169	0.0123	0.04029
PCB-126	0.00083	0.00046	0.00073	0.00255	0.00004 J	0.00005 J	0.00229
PCB-149/123	0.17571	0.24612	0.49149	1.54385	0.03463	0.02948	0.09075
PCB-156	0.02084	0.02832	0.06167	0.12006	0.0024	0.0021	0.01049
PCB-167	0.01686	0.02353	0.05851	0.19903	0.00162	0.00178	0.0064
PCB-169	0.00004 J	0.00008	0.0001	0.00042	0.00002 J	0.00002 J	0.00002 J
PCB-189	0.00522	0.00616	0.01327	0.06546	0.00033	0.00039	0.00145
PCB-201/157/173	0.01381	0.01431	0.0252	0.09495	0.0014	0.00098	0.00509
PCB-77	0.00084	0.00035	0.00067	0.00282	0.00014 J	0.00009 J	0.00772
PCB-81	0.00004 J	0.00002 J	0.00003 J	0.0001	0.00005 J	0.000009 J	0.00196
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00339	0.01081	0.02667	0.02514	0.00098	0.00093	0.00443
1,2,4,5-Tetrachlorobenzene	0.00184 J	0.00295	0.00647	0.01471	0.00053	0.00226 U	0.0024
4,4'-DDD	0.00186 J	0.00561	0.01266	0.03544	0.00058	0.00035	0.00115
4,4'-DDE	0.01296	0.02015	0.02758	0.14191	0.00096	0.00709	0.00335
4,4'-DDT	0.00245 U	0.00064 J	0.00157 J	0.00453	0.00005 U	0.00226 U	0.00006 U
Aldrin	0.00245 U	0.00199 U	0.00199 U	0.00199 U	0.00227 U	0.00008 J	0.00221 U
alpha-BHC	0.00024 J	0.00009 J	0.00011 J	0.00001 J	0.00227 U	0.00226 U	0.00221 U
alpha-Chlordane	0.00081 J	0.00199 U	0.00199 U	0.00199 U	0.00024	0.00019	0.00221 U
beta-BHC	0.00245 U	0.00199 U	0.00199 U	0.00199 U	0.00227 U	0.00002 J	0.00003 U
Chlorpyrifos	0.00245 U	0.00199 U	0.00005 J	0.00199 U	0.00005 U	0.00007 U	0.00221 U
cis-Nonachlor	0.00831	0.01373	0.02552	0.05693	0.00192	0.00168	0.00575
delta-BHC	0.00245 U	0.00199 U	0.00013 J	0.00199 U	0.00227 U	0.00226 U	0.00221 U
Dieldrin	0.00057 J	0.00096 J	0.00097 J	0.00138 J	0.00227 U	0.00226 U	0.00038
Endosulfan II	0.00326	0.00741	0.00717	0.02629	0.00227 U	0.00226 U	0.00221 U
Endrin	0.00245 U	0.00199 U	0.00199 U	0.00199 U	0.00227 U	0.00226 U	0.00221 U
gamma-BHC (Lindane)	0.00006 J	0.00011 J	0.00033 J	0.00166 J	0.00002 U	0.00002 J	0.00009
gamma-Chlordane	0.00021 J	0.00011 J	0.00199 U	0.00199 U	0.00227 U	0.00226 U	0.00221 U
Heptachlor	0.00245 U	0.00014 J	0.00021 J	0.00199 U	0.00227 U	0.00226 U	0.00221 U
Heptachlor epoxide	0.00245 U	0.00199 U	0.00199 U	0.00199 U	0.00227 U	0.00226 U	0.00221 U
Hexachlorobenzene	0.0002 J	0.00066 J	0.0016 J	0.0019 J	0.00007 J	0.00003 U	0.00048

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPPS12-0-8C21	H4-TFWPPS13-0-8C01	H4-TFWPPS14-0-8C01	H4-TFWPPS15-0-8C01	H4-TFWPYP01-0-8S30	H4-TFWPYP02-0-8S30	H4-TFWPYP03-0-8S30
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Pumpkinseed	Pumpkinseed	Pumpkinseed	Pumpkinseed	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/21/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	17.9	16	14.5	18.5	21.7	19.7	21.1
Mirex	0.00008 J	0.00199 U	0.00199 U	0.00199 U	0.00227 U	0.00226 U	0.00221 U
o,p'-DDD	0.01924	0.02763	0.04354	0.19375	0.00304	0.0032	0.00916
o,p'-DDE	0.00245 U	0.00199 U	0.00199 U	0.00199 U	0.00009 J	0.00226 U	0.00221 U
o,p'-DDT	0.0171	0.01802	0.02882	0.22173	0.00241	0.00261	0.00791
Oxychlordane	0.00245 U	0.0029	0.00408	0.01364	0.00227 U	0.00226 U	0.00221 U
Pentachloroanisole	0.0001 U	0.0002 J	0.00052 J	0.00074 J	0.00009 U	0.00008 U	0.00022
Pentachlorobenzene	0.00158 J	0.00397	0.01003	0.0104	0.00028	0.00012 J	0.00358
Toxaphene	0.02453 U	0.0199 U	0.0199 U	0.02 U	0.02266 U	0.02264 U	0.02208 U
trans-Nonachlor	0.00062 J	0.00127 J	0.00257	0.0059	0.00026	0.00015	0.00035
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.4	0.5	1.2	5.6	0.006	0.004	1
Percent Lipids (GC/MS)	0.36		1.2 J	5.6 J			1
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP04-0-8S30	H4-TFWPYP05-0-8C01	H4-TFWPYP06-0-8C01	H4-TFWPYP07-0-8C01	H4-TFWPYP08-0-8C01	H4-TFWPYP09-0-8C01	H4-TFWPYP10-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	24.6	25.2	24.2	25.5	26.8	22.7	24.0
PCBs							
PCB, Total	4.59716	4.21174	2.54179	4.16503	0.54488	4.40325	6.35362
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,4,6,7,8-HPCDF	0.00001 U	0.00002	0.0000056 J	0.0000099 U		0.0000048 J	0.0000087 J
1,2,3,4,7,8,9-HPCDF	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,4,7,8-HXCDD	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,4,7,8-HXCDF	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,6,7,8-HXCDD	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,6,7,8-HXCDF	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,7,8,9-HXCDD	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,7,8,9-HXCDF	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,7,8-PECDD	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
1,2,3,7,8-PECDF	0.00003	0.00004	0.00001	0.00003		0.00001	0.00005
2,3,4,6,7,8-HXCDF	0.00001 U	0.0000096 U	0.0000097 U	0.0000099 U		0.000007 U	0.0000098 U
2,3,4,7,8-PECDF	0.00001 U	0.00001	0.00001	0.00001		0.00001	0.00001
2,3,7,8-TCDD	0.000002 U	0.0000019 U	0.0000019 U	0.000002 U		0.0000014 U	0.000002 U
2,3,7,8-TCDF	0.00006	0.00005	0.00004	0.00005		0.00004	0.00004
OCDD	0.00001 U	0.00001 U	0.00001 U	0.00001 U		0.00001 U	0.00001 U
OCDF	0.00001 U	0.00001 U	0.00001 U	0.00001 U		0.00001 U	0.00001 U
Dioxin-Like PCB Congeners							
PCB-105	0.01465	0.01007 J	0.00716	0.01068 J	0.00148 J	0.01078 J	0.02119 J
PCB-114	0.00019 U	0.00018 U	0.00022 U	0.00019 U	0.00025 UJ	0.0002 U	0.00019 U
PCB-118	0.10687	0.08698 J	0.04513	0.08267 J	0.01106 J	0.08677 J	0.12427 J
PCB-126	0.00532	0.00458 J	0.00219	0.00433 J	0.00001 J	0.0045 J	0.00773 J
PCB-149/123	0.21638	0.18497 J	0.11374	0.19746 J	0.02858 J	0.1809 J	0.23435 J
PCB-156	0.02304	0.01756 J	0.01203	0.02282 J	0.00224 J	0.01871 J	0.03534 J
PCB-167	0.015	0.01307 J	0.00757	0.01398 J	0.00152 J	0.01312 J	0.02484 J
PCB-169	0.00005 J	0.00005 J	0.00002 J	0.00002 J	0.00002 J	0.00006 J	0.00007 J
PCB-189	0.00322	0.00272 J	0.00178	0.00334 J	0.00039 J	0.00289 J	0.00621 J
PCB-201/157/173	0.0101	0.0093 J	0.00638	0.01025 J	0.00118 J	0.00997 J	0.01822 J
PCB-77	0.01752	0.01552 J	0.00713	0.01488 J	0.00012 J	0.01357 J	0.01674 J
PCB-81	0.00391	0.00355 J	0.0017	0.00368 J	0.00004 J	0.00354 J	0.00493 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00297	0.00555	0.00263	0.00566	0.00218	0.00423	0.00648
1,2,4,5-Tetrachlorobenzene	0.00208	0.00246	0.00174	0.0022	0.00092	0.00218	0.0025
4,4'-DDD	0.0021	0.002	0.00111	0.00214	0.00028	0.0023	0.00345
4,4'-DDE	0.00932	0.0087	0.00399	0.0097	0.00143	0.00817	0.0148
4,4'-DDT	0.0019 U	0.00179 U	0.00013 U	0.00002 U	0.00249 U	0.00027	0.00191 U
Aldrin	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
alpha-BHC	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
alpha-Chlordane	0.0019 U	0.00179 U	0.00217 U	0.00217 U	0.00011 J	0.00201 U	0.00191 U
beta-BHC	0.00002 U	0.00006 U	0.00001 U	0.000009 U	0.00249 U	0.00002 U	0.00002 U
Chlorpyrifos	0.00006 U	0.00012 U	0.00004 U	0.00003 U	0.00249 U	0.00006 U	0.00018 U
cis-Nonachlor	0.01034	0.00902	0.00653	0.00912	0.00128	0.01085	0.01554
delta-BHC	0.0019 U	0.00179 U	0.000008 U	0.00193 U	0.00249 U	0.000004 U	0.000003 U
Dieldrin	0.00059	0.00073	0.00039	0.00048	0.00249 U	0.00101	0.00109
Endosulfan II	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
Endrin	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
gamma-BHC (Lindane)	0.00008	0.00012	0.00005 J	0.00007 J	0.00003 U	0.00008 J	0.00009
gamma-Chlordane	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
Heptachlor	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
Heptachlor epoxide	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
Hexachlorobenzene	0.00025	0.00051	0.00031	0.00054	0.00017 J	0.0006	0.00051

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP04-0-8S30	H4-TFWPYP05-0-8C01	H4-TFWPYP06-0-8C01	H4-TFWPYP07-0-8C01	H4-TFWPYP08-0-8C01	H4-TFWPYP09-0-8C01	H4-TFWPYP10-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	24.6	25.2	24.2	25.5	26.8	22.7	24.0
Mirex	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
o,p'-DDD	0.01605	0.01653	0.01155	0.01532	0.00287	0.01927	0.02892
o,p'-DDE	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
o,p'-DDT	0.01539	0.01485	0.00942	0.015	0.0022	0.01653	0.02426
Oxychlordane	0.0019 U	0.00179 U	0.00217 U	0.00193 U	0.00249 U	0.00201 U	0.00191 U
Pentachloroanisole	0.00011 U	0.00025	0.00014 U	0.0002	0.00014 U	0.00015 U	0.00019
Pentachlorobenzene	0.00141	0.00326	0.00179	0.00376	0.00067	0.00337	0.00305
Toxaphene	0.01898 U	0.01792 U	0.02169 U	0.01931 U	0.0249 U	0.02008 U	0.01908 U
trans-Nonachlor	0.0005	0.00037	0.00024	0.00037	0.00249 U	0.00053	0.00071
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1.1	0.8	0.7	1.2	0.008	1.2	0.1
Percent Lipids (GC/MS)	1.1	0.8	0.7	1.2		1.2	0.1
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP11-0-8C01	H4-TFWPYP12-0-8C01	H4-TFWPYP13-0-8C01	H4-TFWPYP14-0-8C01	H4-TFWPYP15-0-8C01	H4-TFWPYP16-0-8C01	H4-TFWPYP17-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	19.7	21.2	21.9	21.4	29.4	25.6	26.2
PCBs							
PCB, Total	4.7117	0.69436	6.13039	0.72986	5.69461	1.27703	3.64084
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.00001 U		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,4,6,7,8-HPCDF	0.0000065 J		0.0000098 U		0.0000054 J		0.0000041 J
1,2,3,4,7,8,9-HPCDF	0.0000043 J		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,4,7,8-HXCDD	0.00001 U		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,4,7,8-HXCDF	0.0000098 J		0.0000098 U		0.0000098 U		0.0000047 J
1,2,3,6,7,8-HXCDD	0.00001 U		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,6,7,8-HXCDF	0.000004 J		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,7,8,9-HXCDD	0.00001 U		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,7,8,9-HXCDF	0.000004 J		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,7,8-PECDD	0.00001 U		0.0000098 U		0.0000098 U		0.0000096 U
1,2,3,7,8-PECDF	0.00002		0.00003		0.00002		0.00001
2,3,4,6,7,8-HXCDF	0.000005 J		0.0000098 U		0.0000098 U		0.0000096 U
2,3,4,7,8-PECDF	0.00001 J		0.00001		0.0000076 J		0.0000096 U
2,3,7,8-TCDD	0.0000033 U		0.000002 U		0.000002 U		0.0000007 J
2,3,7,8-TCDF	0.00004		0.00005		0.00002		0.00004
OCDD	0.00001 J		0.00001 U		0.0000037 J		0.0000029 J
OCDF	0.00001 J		0.00001 U		0.0000025 J		0.0000038 J
Dioxin-Like PCB Congeners							
PCB-105	0.01209	0.00268	0.0103 J	0.00107	0.02243 J	0.00446 J	0.01296
PCB-114	0.00033 U	0.0002 U	0.00033 U	0.00019 U	0.0002 U	0.0002 J	0.0002 U
PCB-118	0.10639	0.01178	0.12094 J	0.0153	0.09943 J	0.02063 J	0.07912
PCB-126	0.00472	0.00007 J	0.00567 J	0.00023 J	0.00042 J	0.00032 J	0.00047 J
PCB-149/123	0.20475	0.03033	0.25475 J	0.04138	0.32194 J	0.07428 J	0.21218
PCB-156	0.02473	0.00244	0.02445 J	0.00271	0.02627 J	0.00464 J	0.01605
PCB-167	0.01746	0.00163	0.01976 J	0.00209	0.0163 J	0.00339 J	0.0106
PCB-169	0.00004 J	0.00008 J	0.00005 J	0.00007 J	0.00005 J	0.00005 J	0.00006 J
PCB-189	0.00327	0.00037	0.00416 J	0.0004	0.00418 J	0.00083 J	0.00274
PCB-201/157/173	0.01098	0.00143	0.01313 J	0.00132	0.01231 J	0.00245 J	0.00773
PCB-77	0.01469	0.00017 J	0.01859 J	0.00027 J	0.00067 J	0.00022 J	0.00067
PCB-81	0.00317	0.00005 J	0.00449 J	0.00006 J	0.0002 U	0.00006 J	0.00003 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00282	0.00114	0.00417	0.0015	0.01288	0.00263 J	0.00832
1,2,4,5-Tetrachlorobenzene	0.00107	0.00026 J	0.00223	0.00069	0.00431	0.0009 J	0.00197 U
4,4'-DDD	0.0022	0.00042	0.0027	0.00034	0.00352	0.00061 J	0.00217
4,4'-DDE	0.0115	0.0012	0.01351	0.00157	0.01169	0.00173 J	0.00708
4,4'-DDT	0.00329 U	0.00006 U	0.00011 U	0.00193 U	0.00017 J	0.00196 UJ	0.00197 U
Aldrin	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
alpha-BHC	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
alpha-Chlordane	0.00329 U	0.0002	0.00326 U	0.00025	0.00199 U	0.00029 J	0.00197 U
beta-BHC	0.00329 U	0.00196 U	0.00021 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Chlorpyrifos	0.00329 U	0.00003 U	0.00015 U	0.00006 U	0.00199 U	0.00006 UJ	0.00197 U
cis-Nonachlor	0.01114	0.00182	0.01378	0.00187	0.01367	0.00291 J	0.00812
delta-BHC	0.00329 U	0.00196 U	0.00004 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Dieldrin	0.00069	0.00196 U	0.00326 U	0.00193 U	0.00045	0.00196 UJ	0.00065
Endosulfan II	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Endrin	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00008 J	0.00196 UJ	0.00197 U
gamma-BHC (Lindane)	0.0001	0.00002 U	0.00012	0.00003 U	0.00012	0.00002 UJ	0.00009
gamma-Chlordane	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Heptachlor	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Heptachlor epoxide	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Hexachlorobenzene	0.00022	0.00008 J	0.00057	0.00008 J	0.00065	0.00013 J	0.00029

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP11-0-8C01	H4-TFWPYP12-0-8C01	H4-TFWPYP13-0-8C01	H4-TFWPYP14-0-8C01	H4-TFWPYP15-0-8C01	H4-TFWPYP16-0-8C01	H4-TFWPYP17-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	19.7	21.2	21.9	21.4	29.4	25.6	26.2
Mirex	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
o,p'-DDD	0.01833	0.00366	0.02486	0.00396	0.02002	0.00585 J	0.01361
o,p'-DDE	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
o,p'-DDT	0.01925	0.00268	0.01728	0.00304	0.0199	0.00499 J	0.01258
Oxychlordane	0.00329 U	0.00196 U	0.00326 U	0.00193 U	0.00199 U	0.00196 UJ	0.00197 U
Pentachloroanisole	0.00014 U	0.00007 U	0.00016	0.00007 U	0.0003	0.00019 UJ	0.00031
Pentachlorobenzene	0.00129	0.00026	0.0031	0.00036	0.00686	0.00098 J	0.00333
Toxaphene	0.03286 U	0.01955 U	0.03259 U	0.01933 U	0.01985 U	0.0196 U	0.01967 U
trans-Nonachlor	0.00037	0.00018	0.00134	0.00193 U	0.00074	0.00019 J	0.00035
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	0.9	0.012	1.4	0.006	0.8	0.009	1
Percent Lipids (GC/MS)	0.9		1.4		0.8		1
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP18-0-8C01	H4-TFWPYP19-0-8C01	H4-TFWPYP20-0-8C01	H4-TFWPYP21-0-8C01	H4-TFWPYP22-0-8C01	H4-TFWPYP23-0-8C01	H4-TFWPYP24-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	28.7	26.9	27	24.6	24.2	24.1	27.4
PCBs							
PCB, Total	2.24568	4.49881	5.61325	3.53437	6.10032	2.89303	3.55136
Dioxins/Furans							
1,2,3,4,6,7,8-HPCDD	0.0000025 J		0.0000049 UJ				0.0000049 UJ
1,2,3,4,6,7,8-HPCDF	0.0000025 J		0.0000017 J				0.0000049 UJ
1,2,3,4,7,8,9-HPCDF	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,4,7,8-HXCDD	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,4,7,8-HXCDF	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,6,7,8-HXCDD	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,6,7,8-HXCDF	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,7,8,9-HXCDD	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,7,8,9-HXCDF	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,7,8-PECDD	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
1,2,3,7,8-PECDF	0.00001 J		0.00002 J				0.00001 J
2,3,4,6,7,8-HXCDF	0.00001 UJ		0.0000049 UJ				0.0000049 UJ
2,3,4,7,8-PECDF	0.0000049 J		0.0000035 J				0.0000019 J
2,3,7,8-TCDD	0.0000029 UJ		0.000001 UJ				0.000001 UJ
2,3,7,8-TCDF	0.00001 J		0.00001 J				0.000001 UJ
OCDD	0.00002 UJ		0.0000098 UJ				0.0000097 UJ
OCDF	0.00002 UJ		0.0000098 UJ				0.0000097 UJ
Dioxin-Like PCB Congeners							
PCB-105	0.01411 J	0.04336	0.03892	0.02623	0.03211	0.02575	0.02892
PCB-114	0.00002 UJ	0.00002 U	0.00002 U	0.00002 U	0.00002 U	0.00002 U	0.00002 U
PCB-118	0.04531 J	0.07434	0.10063	0.05647	0.1128	0.04616	0.05486
PCB-126	0.0003 J	0.00028	0.00043	0.00016	0.00045	0.00022	0.00035
PCB-149/123	0.14575 J	0.28321	0.38187	0.24762	0.38428	0.19467	0.25128
PCB-156	0.01283 J	0.02369	0.02673	0.01886	0.02647	0.01268	0.01497
PCB-167	0.0075 J	0.01598	0.01913	0.01	0.01846	0.00842	0.01245
PCB-169	0.00004 J	0.00004 J	0.00008	0.00011	0.00005 U	0.00002 J	0.00008
PCB-189	0.00197 J	0.00384	0.00503	0.00236	0.00446	0.00196	0.00332
PCB-201/157/173	0.00376 J	0.0074	0.00982	0.00644	0.01017	0.00516	0.00665
PCB-77	0.00008 J	0.00059	0.00064	0.00043	0.00052	0.00026	0.00026
PCB-81	0.00002 UJ	0.00001 J	0.00002 J	0.00007	0.00003 J	0.00004 J	0.00005 J
Pesticides							
1,2,3,4-Tetrachlorobenzene	0.00747 J	0.01015	0.01045	0.00495	0.00603	0.0076	0.00926
1,2,4,5-Tetrachlorobenzene	0.00225 J	0.00404	0.00408	0.00239	0.00147 J	0.0019 J	0.00305
4,4'-DDD	0.00211 J	0.00157 J	0.00187 J	0.00125 J	0.00221	0.00133 J	0.00121 J
4,4'-DDE	0.00649 J	0.01018	0.01338	0.0073	0.01643	0.0068	0.00766
4,4'-DDT	0.00197 UJ	0.00032 J	0.00038 J	0.00043 J	0.00042 J	0.00047 J	0.00036 J
Aldrin	0.00197 UJ	0.00021 J	0.00047 J	0.00051 J	0.00035 J	0.00065 J	0.00024 J
alpha-BHC	0.00002 J	0.00008 J	0.00014 J	0.00012 J	0.00012 J	0.0002 J	0.00011 J
alpha-Chlordane	0.00021 J	0.00064 J	0.00067 J	0.00079 J	0.00081 J	0.00068 J	0.00091 J
beta-BHC	0.00197 UJ	0.00026 J	0.00199 U	0.00199 U	0.00008 J	0.00198 U	0.002 U
Chlorpyrifos	0.00004 J	0.00009 J	0.00199 U	0.00001 J	0.00198 U	0.00198 U	0.00004 J
cis-Nonachlor	0.0044 J	0.01126	0.01382	0.00858	0.01319	0.00697	0.00861
delta-BHC	0.000009 J	0.00145 J	0.00156 J	0.00077 J	0.00117 J	0.00109 J	0.00105 J
Dieldrin	0.00007 J	0.00069 J	0.00071 J	0.00072 J	0.00104 J	0.00049 J	0.00056 J
Endosulfan II	0.00195 J	0.00435	0.00352	0.00417	0.00391	0.00345	0.00353
Endrin	0.00006 J	0.00199 U	0.00004 J	0.00199 U	0.00198 U	0.00198 U	0.002 U
gamma-BHC (Lindane)	0.00007 J	0.00027 J	0.00017 J	0.00011 J	0.00011 J	0.0001 J	0.00019 J
gamma-Chlordane	0.00011 J	0.00199 U	0.00199 U	0.00025 J	0.00198 U	0.00033 J	0.00033 J
Heptachlor	0.00197 UJ	0.00013 J	0.00007 J	0.0001 J	0.00017 J	0.00015 J	0.00013 J
Heptachlor epoxide	0.00197 UJ	0.00032 J	0.00053 J	0.00011 J	0.00052 J	0.00198 U	0.00015 J
Hexachlorobenzene	0.00027 J	0.001 J	0.00106 J	0.0005 J	0.00056 J	0.00087 J	0.00093 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP18-0-8C01	H4-TFWPYP19-0-8C01	H4-TFWPYP20-0-8C01	H4-TFWPYP21-0-8C01	H4-TFWPYP22-0-8C01	H4-TFWPYP23-0-8C01	H4-TFWPYP24-0-8C01
Source	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE	EPA_COE
Species	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch	Yellow Perch
Collection Date	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998	10/1/1998
Fish Length (cm)	28.7	26.9	27	24.6	24.2	24.1	27.4
Mirex	0.00197 UJ	0.00199 U	0.00199 U	0.00199 U	0.00198 U	0.00198 U	0.002 U
o,p'-DDD	0.01022 J	0.01718	0.02013	0.01561	0.0238	0.01054	0.01322
o,p'-DDE	0.00197 UJ	0.00064 J	0.0007 J	0.00093 J	0.00063 J	0.00069 J	0.0007 J
o,p'-DDT	0.00927 J	0.0149	0.01917	0.01064	0.01961	0.00878	0.01105
Oxychlordane	0.00075 J	0.00174 J	0.00228	0.00123 J	0.00278	0.00075 J	0.00132 J
Pentachloroanisole	0.00033 J	0.00042 J	0.00055 J	0.00035 J	0.00041 J	0.00039 J	0.00045 J
Pentachlorobenzene	0.00247 J	0.00536	0.00567	0.00284	0.00163 J	0.00393	0.00391
Toxaphene	0.0198 UJ	0.0199 U	0.0199 U	0.0199 U	0.0198 U	0.0198 U	0.02 U
trans-Nonachlor	0.00023 J	0.00068 J	0.00081 J	0.00059 J	0.00065 J	0.00048 J	0.00091 J
Metals							
Lead							
Mercury							
Lipids							
Percent Lipids (GC)	1.4 J	1.1	0.8	0.3	0.6	0.6	0.6
Percent Lipids (GC/MS)	1.4 J		0.8 J				0.6 J
Percent Lipids (Other)							

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP25-0-8C01
Source	EPA_COE
Species	Yellow Perch
Collection Date	10/1/1998
Fish Length (cm)	25.9
PCBs	
PCB, Total	3.45007
Dioxins/Furans	
1,2,3,4,6,7,8-HPCDD	0.000005 UJ
1,2,3,4,6,7,8-HPCDF	0.000005 UJ
1,2,3,4,7,8,9-HPCDF	0.000005 UJ
1,2,3,4,7,8-HXCDD	0.000005 UJ
1,2,3,4,7,8-HXCDF	0.000005 UJ
1,2,3,6,7,8-HXCDD	0.000005 UJ
1,2,3,6,7,8-HXCDF	0.000005 UJ
1,2,3,7,8,9-HXCDD	0.000005 UJ
1,2,3,7,8,9-HXCDF	0.000005 UJ
1,2,3,7,8-PECDD	0.000005 UJ
1,2,3,7,8-PECDF	0.00001 J
2,3,4,6,7,8-HXCDF	0.000005 UJ
2,3,4,7,8-PECDF	0.0000014 J
2,3,7,8-TCDD	0.000001 UJ
2,3,7,8-TCDF	0.0000075 J
OCDD	0.0000099 UJ
OCDF	0.0000099 UJ
Dioxin-Like PCB Congeners	
PCB-105	0.03372
PCB-114	0.00002 U
PCB-118	0.05909
PCB-126	0.00028
PCB-149/123	0.2412
PCB-156	0.01873
PCB-167	0.01213
PCB-169	0.00004 U
PCB-189	0.00307
PCB-201/157/173	0.00568
PCB-77	0.00024
PCB-81	0.00002 U
Pesticides	
1,2,3,4-Tetrachlorobenzene	0.00625
1,2,4,5-Tetrachlorobenzene	0.00179 J
4,4'-DDD	0.00084 J
4,4'-DDE	0.00799
4,4'-DDT	0.0002 J
Aldrin	0.0005 J
alpha-BHC	0.00012 J
alpha-Chlordane	0.00057 J
beta-BHC	0.00199 U
Chlorpyrifos	0.00002 J
cis-Nonachlor	0.00828
delta-BHC	0.0009 J
Dieldrin	0.00053 J
Endosulfan II	0.00296
Endrin	0.00199 U
gamma-BHC (Lindane)	0.00009 J
gamma-Chlordane	0.00199 U
Heptachlor	0.00199 U
Heptachlor epoxide	0.00015 J
Hexachlorobenzene	0.00058 J

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

Reaches 5 and 6 Fillet Data Used in the Fish Consumption Risk Assessment

Field Sample ID	H4-TFWPYP25-0-8C01
Source	EPA_COE
Species	Yellow Perch
Collection Date	10/1/1998
Fish Length (cm)	25.9
Mirex	0.00199 U
o,p'-DDD	0.01303
o,p'-DDE	0.00049 J
o,p'-DDT	0.01177
Oxychlordane	0.00105 J
Pentachloroanisole	0.00028 J
Pentachlorobenzene	0.00423
Toxaphene	0.0199 U
trans-Nonachlor	0.00048 J
Metals	
Lead	
Mercury	
Lipids	
Percent Lipids (GC)	0.4
Percent Lipids (GC/MS)	0.4 J
Percent Lipids (Other)	

Note: The third part of the sample ID code indicates primary (0) or duplicate (1) field sample; e.g., H3-TF03LB01-1-8C20 is the duplicate corresponding to H3-TF03LB01-0-8C20.

ATTACHMENT C.4

TOTAL TEQ CALCULATIONS

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H3-03BB01--8C20**		**H3-09BB01--8S30**		**H3-10BB02--8S30**		**H3-10BB03--8S30**		**H3-11BB01--8C19**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	2.30E-08	U	1.95E-08	U	2.00E-08	U	1.85E-08	U	3.35E-08	U
1,2,3,4,7,8-HXCDD	2.30E-07	U	1.95E-07	U	2.00E-07	U	1.85E-07	U	3.35E-07	U
1,2,3,6,7,8-HXCDD	2.30E-07	U	1.95E-07	U	2.00E-07	U	1.85E-07	U	3.35E-07	U
1,2,3,7,8,9-HXCDD	2.30E-07	U	1.95E-07	U	2.00E-07	U	1.85E-07	U	3.35E-07	U
1,2,3,7,8-PECDD	2.30E-06	U	6.00E-07		2.00E-06	U	1.85E-06	U	3.35E-06	U
2,3,7,8-TCDD	4.50E-07	U	1.00E-06		4.00E-07	U	1.20E-06		6.50E-07	U
OCDD	4.60E-10	U	6.00E-11		1.10E-10		3.65E-10	U	5.00E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	2.30E-08	U	3.10E-08		1.00E-07		4.70E-08		1.80E-08	
1,2,3,4,7,8,9-HPCDF	2.30E-08	U	1.95E-08	U	2.00E-08	U	1.85E-08	U	3.35E-08	U
1,2,3,4,7,8-HXCDF	2.30E-07	U	1.95E-07	U	2.00E-07	U	1.85E-07	U	3.35E-07	U
1,2,3,6,7,8-HXCDF	2.30E-07	U	6.00E-08		2.00E-07	U	1.85E-07	U	3.35E-07	U
1,2,3,7,8,9-HXCDF	2.30E-07	U	1.95E-07	U	2.00E-07	U	1.85E-07	U	3.35E-07	U
1,2,3,7,8-PECDF	2.25E-07		2.00E-06		9.00E-06		2.50E-06		5.00E-07	
2,3,4,6,7,8-HXCDF	2.30E-07	U	7.00E-08		2.00E-07	U	1.85E-07	U	3.35E-07	U
2,3,4,7,8-PECDF	3.40E-06		5.00E-06		1.50E-05		5.00E-06		5.00E-06	
2,3,7,8-TCDF	3.00E-07		3.30E-07		1.00E-06	U	1.35E-07	U	4.70E-07	
OCDF	4.60E-10	U	3.90E-10	U	3.95E-10	U	3.65E-10	U	5.00E-10	U
PCB Congeners										
PCB-105	5.76E-07		1.47E-05		6.91E-06		8.15E-06		7.88E-07	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	3.02E-06		1.09E-05		2.82E-05		1.02E-05		2.08E-06	
PCB-123	3.16E-08		1.50E-07		1.40E-07		7.75E-08		1.97E-08	
PCB-126	2.31E-04		8.30E-05		3.24E-04		5.90E-05		1.10E-04	
PCB-156	4.35E-06		2.38E-05		7.90E-06		6.34E-06		2.49E-06	
PCB-157	4.16E-07		1.91E-06		1.53E-06		1.29E-06		2.36E-07	
PCB-167	4.90E-08		3.11E-07		2.20E-07		1.74E-07		2.97E-08	
PCB-169	2.00E-07		1.30E-06		4.10E-06		4.00E-07		3.00E-07	
PCB-189	1.75E-07		1.01E-06		5.77E-07		6.11E-07		7.80E-08	
PCB-77	6.30E-07		5.70E-08		1.87E-07		4.90E-08		3.43E-07	
PCB-81	2.19E-07		2.40E-08		2.10E-08		9.20E-08		9.40E-08	
TEQ from Dioxin Congeners	**3.46E-06**	**U**	**2.20E-06**		**3.02E-06**		**3.62E-06**		**5.04E-06**	**U**
TEQ from Furan Congeners	**4.89E-06**		**7.90E-06**		**2.59E-05**		**8.44E-06**		**7.36E-06**	
TEQ from Dioxin-like PCB Congeners	**2.41E-04**		**1.37E-04**		**3.74E-04**		**8.64E-05**		**1.16E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H3-11BB02--8C19		H3-11BB03--8C19		H3-11BB04--8C19		H3-11BB04--8S30		H3-11BB05--8C19	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	2.35E-08	U	2.40E-08	U	2.45E-08	U	1.90E-08	U	2.40E-08	U
1,2,3,4,7,8-HXCDD	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	2.40E-07	U
1,2,3,6,7,8-HXCDD	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	2.40E-07	U
1,2,3,7,8,9-HXCDD	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	2.40E-07	U
1,2,3,7,8-PECDD	2.35E-06	U	2.40E-06	U	2.45E-06	U	1.90E-06	U	2.40E-06	U
2,3,7,8-TCDD	4.50E-07	U	5.00E-07	U	5.00E-07	U	7.00E-07		5.00E-07	U
OCDD	4.70E-10	U	4.80E-10	U	4.95E-10	U	3.85E-10	U	4.80E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	4.20E-08		3.30E-08		1.30E-08		1.90E-08	U	1.20E-08	
1,2,3,4,7,8,9-HPCDF	2.35E-08	U	2.40E-08	U	2.45E-08	U	1.90E-08	U	2.40E-08	U
1,2,3,4,7,8-HXCDF	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	1.80E-07	
1,2,3,6,7,8-HXCDF	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	2.40E-07	U
1,2,3,7,8,9-HXCDF	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	2.40E-07	U
1,2,3,7,8-PECDF	1.50E-06		1.00E-06		4.85E-07		3.00E-06		5.00E-07	
2,3,4,6,7,8-HXCDF	2.35E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07	U	2.40E-07	U
2,3,4,7,8-PECDF	5.00E-06		5.00E-06		5.00E-06		5.00E-06		4.40E-06	
2,3,7,8-TCDF	6.00E-07		5.30E-07		4.90E-07		4.00E-08	U	3.60E-07	
OCDF	4.70E-10	U	4.80E-10	U	4.95E-10	U	3.85E-10	U	4.80E-10	U
PCB Congeners										
PCB-105	1.11E-06		1.83E-06		1.19E-06		5.08E-06		2.77E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	4.02E-06		8.73E-06		5.50E-06		4.50E-06		9.60E-06	
PCB-123	3.91E-08		8.65E-08		5.14E-08		6.27E-08		1.36E-07	
PCB-126	4.16E-04		1.18E-03		4.17E-04		3.00E-05		9.40E-05	
PCB-156	5.74E-06		1.49E-05		8.84E-06		4.08E-06		1.94E-05	
PCB-157	6.08E-07		1.68E-06		8.31E-07		9.60E-07		2.45E-06	
PCB-167	8.85E-08		2.35E-07		1.01E-07		1.05E-07		2.95E-07	
PCB-169	5.00E-07		6.00E-07		2.00E-07		5.00E-07		2.30E-06	U
PCB-189	2.62E-07		6.66E-07		3.02E-07		3.42E-07		8.33E-07	
PCB-77	9.21E-07		2.59E-06		1.21E-06		1.80E-08		1.11E-07	
PCB-81	2.55E-07		7.16E-07		2.80E-07		3.30E-08		7.80E-08	
TEQ from Dioxin Congeners	**3.53E-06**	**U**	**3.64E-06**	**U**	**3.71E-06**	**U**	**3.19E-06**		**3.64E-06**	**U**
TEQ from Furan Congeners	**8.11E-06**		**7.55E-06**		**6.99E-06**		**8.84E-06**		**6.20E-06**	
TEQ from Dioxin-like PCB Congeners	**4.30E-04**		**1.21E-03**		**4.35E-04**		**4.57E-05**		**1.32E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H3-11BB05--8S30**		**H3-11BB06--8C19**		**H3-11BB07--8C19**		**H3-11BB07--8S30**		**H3-11BB08--8C20**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	2.30E-08	U					2.45E-08	U	2.35E-08	U
1,2,3,4,7,8-HXCDD	2.30E-07	U					2.45E-07	U	2.35E-07	U
1,2,3,6,7,8-HXCDD	2.30E-07	U					2.45E-07	U	2.35E-07	U
1,2,3,7,8,9-HXCDD	2.30E-07	U					2.45E-07	U	2.35E-07	U
1,2,3,7,8-PECDD	2.30E-06	U					2.45E-06	U	2.35E-06	U
2,3,7,8-TCDD	4.50E-07	U					5.00E-07	U	4.50E-07	U
OCDD	4.60E-10	U					4.85E-10	U	3.20E-10	
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	6.30E-08						9.10E-08		2.35E-08	U
1,2,3,4,7,8,9-HPCDF	2.30E-08	U					2.45E-08	U	2.35E-08	U
1,2,3,4,7,8-HXCDF	2.30E-07	U					2.45E-07	U	1.80E-07	
1,2,3,6,7,8-HXCDF	2.30E-07	U					2.45E-07	U	2.35E-07	U
1,2,3,7,8,9-HXCDF	2.30E-07	U					2.45E-07	U	2.35E-07	U
1,2,3,7,8-PECDF	1.00E-06						1.23E-07	U	4.25E-07	
2,3,4,6,7,8-HXCDF	2.30E-07	U					2.45E-07	U	2.35E-07	U
2,3,4,7,8-PECDF	1.15E-06	U					5.00E-06		4.15E-06	
2,3,7,8-TCDF	5.00E-06	U					1.00E-06		3.90E-07	
OCDF	4.60E-10	U					4.85E-10	U	4.65E-10	U
PCB Congeners										
PCB-105	8.33E-06		1.78E-06		1.07E-06		2.49E-06		5.40E-07	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	2.83E-05		4.92E-06		4.46E-06		1.46E-05		1.59E-06	
PCB-123	2.10E-07		4.53E-08		4.60E-08		1.34E-07		1.50E-08	
PCB-126	1.26E-04		4.36E-04		3.64E-04		9.26E-04		1.03E-04	
PCB-156	1.35E-05		6.13E-06		5.22E-06		1.96E-05		1.75E-06	
PCB-157	2.45E-06		7.83E-07		7.14E-07		2.62E-06		2.27E-07	
PCB-167	4.60E-07		8.92E-08		9.71E-08		3.68E-07		2.64E-08	
PCB-169	3.20E-06		8.00E-07		6.00E-07		1.10E-06		1.40E-06	U
PCB-189	1.14E-06		2.90E-07		2.92E-07		1.01E-06		7.10E-08	
PCB-77	2.70E-08		1.18E-06		9.94E-07		2.78E-06		2.78E-07	
PCB-81	9.00E-09		3.42E-07		2.69E-07		7.00E-07		7.70E-08	
TEQ from Dioxin Congeners	**3.46E-06**	U					**3.71E-06**	U	**3.53E-06**	
TEQ from Furan Congeners	**8.16E-06**						**7.22E-06**		**5.90E-06**	
TEQ from Dioxin-like PCB Congeners	**1.84E-04**		**4.52E-04**		**3.78E-04**		**9.71E-04**		**1.09E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H3-11BB09--8C20**		**H3-11BB10--8C20**		**H3-11BB11--8C20**		**H4-WPBB01--8C21**		**H4-WPBB01--8S30**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	3.40E-08	U	2.40E-08	U	2.45E-08	U	2.85E-08	U	4.85E-08	U
1,2,3,4,7,8-HXCDD	3.40E-07	U	2.40E-07	U	2.45E-07	U	2.85E-07	U	4.85E-07	U
1,2,3,6,7,8-HXCDD	3.40E-07	U	2.40E-07	U	2.45E-07	U	2.85E-07	U	4.85E-07	U
1,2,3,7,8,9-HXCDD	3.40E-07	U	2.40E-07	U	2.45E-07	U	2.85E-07	U	4.85E-07	U
1,2,3,7,8-PECDD	3.40E-06	U	2.40E-06	U	2.45E-06	U	2.85E-06	U	4.85E-06	U
2,3,7,8-TCDD	7.00E-07	U	5.00E-07	U	5.00E-07	U	1.50E-06		9.50E-07	U
OCDD	5.00E-10	U	4.85E-10	U	4.95E-10	U	4.73E-10	U	5.00E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	3.40E-08	U	2.40E-08	U	1.90E-08		1.15E-08		1.10E-06	
1,2,3,4,7,8,9-HPCDF	3.40E-08	U	2.40E-08	U	2.45E-08	U	2.85E-08	U	4.85E-08	U
1,2,3,4,7,8-HXCDF	3.40E-07	U	2.40E-07	U	2.90E-07		3.40E-07		4.85E-07	U
1,2,3,6,7,8-HXCDF	3.40E-07	U	2.40E-07	U	2.45E-07	U	1.90E-07		4.85E-07	U
1,2,3,7,8,9-HXCDF	3.40E-07	U	2.40E-07	U	2.45E-07	U	2.85E-07	U	4.85E-07	U
1,2,3,7,8-PECDF	2.20E-07		1.95E-07		5.00E-07		5.00E-07		2.00E-05	
2,3,4,6,7,8-HXCDF	3.40E-07	U	2.40E-07	U	2.45E-07	U	1.50E-07		4.85E-07	U
2,3,4,7,8-PECDF	4.75E-06		2.95E-06		5.00E-06		1.50E-05		1.50E-05	
2,3,7,8-TCDF	4.60E-07		3.40E-07		5.20E-07		9.20E-07		4.00E-06	
OCDF	5.00E-10	U	4.85E-10	U	4.95E-10	U	8.00E-11		5.00E-10	U
PCB Congeners										
PCB-105	5.08E-07		2.00E-07		1.12E-06		7.01E-06		9.53E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	3.38E-06		5.69E-07		3.42E-06		3.36E-05		6.03E-05	
PCB-123	3.12E-08		5.52E-09		4.31E-08		2.00E-07		5.89E-07	
PCB-126	3.89E-04		7.90E-05		3.39E-04		1.85E-04		3.48E-03	
PCB-156	6.81E-06		9.65E-07		4.97E-06		4.12E-05		5.50E-08	U
PCB-157	7.06E-07		1.28E-07		6.07E-07		7.02E-06		1.13E-05	
PCB-167	9.46E-08		1.35E-08		6.51E-08		7.97E-07		1.78E-06	
PCB-169	5.00E-07		3.00E-07		4.00E-07		2.85E-06	U	7.80E-06	
PCB-189	2.90E-07		1.65E-08	U	2.16E-07		1.80E-06		4.82E-06	
PCB-77	8.69E-07		9.80E-08		8.63E-07		9.25E-08		1.16E-05	
PCB-81	2.35E-07		3.40E-08		2.48E-07		1.33E-08	U	2.16E-06	
TEQ from Dioxin Congeners	**5.15E-06**	**U**	**3.64E-06**	**U**	**3.71E-06**	**U**	**5.23E-06**		**7.30E-06**	**U**
TEQ from Furan Congeners	**6.86E-06**		**4.49E-06**		**7.09E-06**		**1.74E-05**		**4.21E-05**	
TEQ from Dioxin-like PCB Congeners	**4.02E-04**		**8.13E-05**		**3.51E-04**		**2.80E-04**		**3.59E-03**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H4-WPBB02--8C01**		**H4-WPBB02--8C21**		**H4-WPBB03--8C01**		**H4-WPBB03--8C21**		**H4-WPBB04--8C01**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD			3.52E-08	U	2.45E-08	U	5.00E-08	U		
1,2,3,4,7,8-HXCDD			3.52E-07	U	2.45E-07	U	5.00E-07	U		
1,2,3,6,7,8-HXCDD			3.52E-07	U	2.45E-07	U	5.00E-07	U		
1,2,3,7,8,9-HXCDD			3.52E-07	U	2.45E-07	U	5.00E-07	U		
1,2,3,7,8-PECDD			3.52E-06	U	2.45E-06	U	5.00E-06	U		
2,3,7,8-TCDD			7.05E-07	U	5.00E-07	U	1.19E-06	U		
OCDD			5.00E-10	U	1.60E-10		1.00E-09	U		
Furan Congeners										
1,2,3,4,6,7,8-HPCDF			3.52E-08	U	2.00E-07		2.00E-08			
1,2,3,4,7,8,9-HPCDF			3.52E-08	U	2.45E-08	U	5.00E-08	U		
1,2,3,4,7,8-HXCDF			3.00E-07		2.45E-07	U	5.00E-07	U		
1,2,3,6,7,8-HXCDF			1.80E-07		2.45E-07	U	5.00E-07	U		
1,2,3,7,8,9-HXCDF			3.52E-07	U	2.45E-07	U	5.00E-07	U		
1,2,3,7,8-PECDF			5.00E-07		1.00E-05		5.00E-07			
2,3,4,6,7,8-HXCDF			1.20E-07		2.45E-07	U	5.00E-07	U		
2,3,4,7,8-PECDF			1.00E-05		2.00E-05		5.00E-06			
2,3,7,8-TCDF			1.00E-06		5.10E-07		3.00E-06			
OCDF			5.00E-10	U	4.95E-10	U	1.00E-09	U		
PCB Congeners										
PCB-105	4.91E-05		5.52E-06		3.66E-05		5.08E-06		3.74E-05	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	4.74E-05		3.14E-05		3.14E-05		1.65E-05		2.79E-05	
PCB-123	5.85E-07		2.77E-07		3.59E-07		1.05E-07		4.03E-07	
PCB-126	2.33E-04		1.27E-04		1.51E-04		1.17E-04		1.40E-04	
PCB-156	6.62E-05		4.57E-05		4.60E-05		5.00E-08	U	4.07E-05	
PCB-157	5.36E-06		7.08E-06		4.38E-06		2.82E-06		3.65E-06	
PCB-167	8.77E-07		8.61E-07		7.85E-07		4.43E-07		7.75E-07	
PCB-169	3.40E-06		1.00E-06	U	3.90E-06		2.20E-06		2.80E-06	
PCB-189	2.74E-06		1.87E-06		2.62E-06		1.45E-06		2.14E-06	
PCB-77	1.71E-07		9.00E-08		6.00E-08		9.40E-08		1.00E-07	
PCB-81	1.50E-08		1.00E-09		4.00E-09		1.00E-08		1.60E-08	
TEQ from Dioxin Congeners			**5.32E-06**	**U**	**3.71E-06**		**7.74E-06**	**U**		
TEQ from Furan Congeners			**1.25E-05**		**3.17E-05**		**1.06E-05**			
TEQ from Dioxin-like PCB Congeners	**4.09E-04**		**2.21E-04**		**2.77E-04**		**1.46E-04**		**2.56E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H4-WPBB04--8C21		H4-WPBB05--8C01		H4-WPBB05--8C21		H4-WPBB06--8C01		H4-WPBB06--8C21	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	1.30E-08		2.25E-08	U	4.53E-08	U				
1,2,3,4,7,8-HXCDD	3.56E-07	U	2.25E-07	U	4.53E-07	U				
1,2,3,6,7,8-HXCDD	1.90E-07		2.25E-07	U	4.53E-07	U				
1,2,3,7,8,9-HXCDD	3.56E-07	U	2.25E-07	U	4.53E-07	U				
1,2,3,7,8-PECDD	1.90E-06		2.25E-06	U	4.53E-06	U				
2,3,7,8-TCDD	7.10E-07	U	4.50E-07	U	9.05E-07	U				
OCDD	5.00E-10	U	8.00E-11		5.00E-10	U				
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	2.40E-08		2.25E-08	U	8.00E-09					
1,2,3,4,7,8,9-HPCDF	3.56E-08	U	2.25E-08	U	4.53E-08	U				
1,2,3,4,7,8-HXCDF	5.90E-07		2.25E-07	U	1.70E-07					
1,2,3,6,7,8-HXCDF	3.00E-07		2.25E-07	U	4.53E-07	U				
1,2,3,7,8,9-HXCDF	3.56E-07	U	2.25E-07	U	4.53E-07	U				
1,2,3,7,8-PECDF	1.00E-06		2.50E-06		3.80E-07					
2,3,4,6,7,8-HXCDF	2.30E-07		2.25E-07	U	4.53E-07	U				
2,3,4,7,8-PECDF	2.00E-05		1.00E-05		5.00E-06					
2,3,7,8-TCDF	1.00E-06		4.50E-08	U	9.10E-07					
OCDF	5.00E-10	U	4.50E-10	U	5.00E-10	U				
PCB Congeners										
PCB-105	6.05E-06		4.34E-05		1.42E-06		3.28E-05		3.96E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	2.81E-05		3.35E-05		1.18E-05		2.66E-05		2.94E-05	
PCB-123	2.34E-07		3.67E-07		9.44E-08		2.75E-07		3.01E-07	
PCB-126	2.02E-04		2.59E-04		9.70E-05		1.21E-04		1.57E-04	
PCB-156	3.57E-05		5.29E-05		1.31E-05		4.15E-05		2.76E-05	
PCB-157	5.99E-06		3.44E-06		1.45E-06		2.50E-06		6.99E-06	
PCB-167	7.67E-07		6.95E-07		2.11E-07		6.41E-07		9.17E-07	
PCB-169	1.80E-06	U	5.10E-06		2.00E-06	U	2.30E-06		2.85E-06	U
PCB-189	1.75E-06		2.29E-06		5.07E-07		1.81E-06		2.13E-06	
PCB-77	1.29E-07		1.51E-07		6.30E-08		1.03E-07		1.34E-07	
PCB-81	1.20E-08		1.50E-08		9.00E-10		8.00E-09		1.10E-08	
TEQ from Dioxin Congeners	**3.52E-06**		**3.40E-06**		**6.84E-06**	U				
TEQ from Furan Congeners	**2.35E-05**		**1.35E-05**		**7.87E-06**					
TEQ from Dioxin-like PCB Congeners	**2.83E-04**		**4.01E-04**		**1.28E-04**		**2.29E-04**		**2.31E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H4-WPBB07--8C01**		**H4-WPBB07--8C21**		**H4-WPBB08--8C01**		**H4-WPBB08--8C21**		**H4-WPBB09--8C01**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	2.45E-08	U	4.89E-08	U	8.00E-09					
1,2,3,4,7,8-HXCDD	2.45E-07	U	4.89E-07	U	2.45E-07	U				
1,2,3,6,7,8-HXCDD	2.45E-07	U	4.89E-07	U	1.00E-07					
1,2,3,7,8,9-HXCDD	2.45E-07	U	4.89E-07	U	3.00E-08					
1,2,3,7,8-PECDD	2.45E-06	U	4.89E-06	U	2.45E-06	U				
2,3,7,8-TCDD	5.00E-07	U	9.80E-07	U	6.00E-07					
OCDD	4.85E-10	U	5.00E-10	U	4.90E-10	U				
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	6.60E-08		1.70E-08		3.60E-08					
1,2,3,4,7,8,9-HPCDF	2.45E-08	U	4.89E-08	U	2.45E-08	U				
1,2,3,4,7,8-HXCDF	2.45E-07	U	3.10E-07		4.70E-07					
1,2,3,6,7,8-HXCDF	1.10E-07		4.89E-07	U	1.00E-07					
1,2,3,7,8,9-HXCDF	2.45E-07	U	4.89E-07	U	2.45E-07	U				
1,2,3,7,8-PECDF	3.00E-06		5.00E-07		1.50E-06					
2,3,4,6,7,8-HXCDF	2.45E-07	U	4.89E-07	U	1.00E-07					
2,3,4,7,8-PECDF	5.00E-06		1.00E-05		1.00E-05					
2,3,7,8-TCDF	1.00E-06		1.00E-06		1.00E-06					
OCDF	4.85E-10	U	5.00E-10	U	4.90E-10	U				
PCB Congeners										
PCB-105	1.09E-05		1.47E-06		1.59E-05		1.15E-06		1.04E-05	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	1.84E-05		1.23E-05		2.15E-05		8.24E-06		2.78E-05	
PCB-123	1.07E-07		1.08E-07		1.58E-07		8.23E-08		1.61E-07	
PCB-126	1.29E-04		8.60E-05		1.50E-04		7.00E-05		2.79E-04	
PCB-156	2.09E-05		1.52E-05		2.73E-05		1.06E-05		1.90E-05	
PCB-157	2.10E-06		1.86E-06		3.08E-06		1.16E-06		3.01E-06	
PCB-167	4.77E-07		2.60E-07		7.10E-07		1.57E-07		7.33E-07	
PCB-169	3.00E-06		1.55E-06	U	2.50E-06		5.00E-07	U	5.60E-06	
PCB-189	1.33E-06		6.71E-07		1.83E-06		3.73E-07		2.08E-06	
PCB-77	1.17E-07		6.60E-08		5.80E-08		4.90E-08		9.30E-08	
PCB-81	1.90E-08		3.00E-09		5.00E-09		2.00E-09		1.30E-08	
TEQ from Dioxin Congeners	**3.71E-06**	U	**7.39E-06**	U	**3.43E-06**					
TEQ from Furan Congeners	**9.94E-06**		**1.33E-05**		**1.35E-05**					
TEQ from Dioxin-like PCB Congeners	**1.86E-04**		**1.20E-04**		**2.23E-04**		**9.23E-05**		**3.48E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H4-WPBB09--8C21		H4-WPBB10--8C01		H4-WPBB11--8C01		H4-WPBB12--8C01		H4-WPBB13--8C01	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD			2.40E-08	U	8.00E-09				4.00E-09	
1,2,3,4,7,8-HXCDD			2.40E-07	U	6.00E-08				2.40E-07	U
1,2,3,6,7,8-HXCDD			2.40E-07	U	4.00E-08				2.40E-07	U
1,2,3,7,8,9-HXCDD			2.40E-07	U	4.00E-08				2.40E-07	U
1,2,3,7,8-PECDD			2.40E-06	U	2.40E-06	U			2.40E-06	U
2,3,7,8-TCDD			5.00E-07	U	5.00E-07				7.00E-07	
OCDD			1.70E-10		2.40E-10				1.50E-10	
Furan Congeners										
1,2,3,4,6,7,8-HPCDF			5.30E-08		1.00E-07				4.70E-08	
1,2,3,4,7,8,9-HPCDF			2.00E-09		6.00E-09				3.00E-09	
1,2,3,4,7,8-HXCDF			2.40E-07	U	2.40E-07	U			2.40E-07	U
1,2,3,6,7,8-HXCDF			9.00E-08		2.40E-07	U			6.00E-08	
1,2,3,7,8,9-HXCDF			2.40E-07	U	4.00E-08				4.00E-08	
1,2,3,7,8-PECDF			3.00E-06		3.50E-06				1.50E-06	
2,3,4,6,7,8-HXCDF			1.00E-07		2.70E-07				2.40E-07	U
2,3,4,7,8-PECDF			1.00E-05		5.00E-06				5.00E-06	
2,3,7,8-TCDF			1.00E-06		1.00E-06				1.00E-06	
OCDF			4.85E-10	U	1.40E-10				8.00E-11	
PCB Congeners										
PCB-105	3.38E-06		2.33E-05		6.36E-06		6.65E-05		6.17E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	2.00E-05		3.61E-05		1.49E-05		1.15E-04		1.39E-05	
PCB-123	1.59E-07		2.36E-07		8.86E-08		1.06E-06		7.06E-08	
PCB-126	1.07E-04		3.08E-04		1.11E-04		8.39E-04		1.08E-04	
PCB-156	2.70E-05		3.97E-05		3.85E-05		1.16E-04		1.62E-05	
PCB-157	4.29E-06		5.40E-06		3.52E-06		1.98E-05		1.95E-06	
PCB-167	6.11E-07		1.21E-06		7.64E-07		3.55E-06		4.20E-07	
PCB-169	1.30E-06	U	7.00E-06		2.70E-06		2.05E-05		2.40E-06	
PCB-189	1.23E-06		3.30E-06		2.07E-06		1.26E-05		1.13E-06	
PCB-77	5.90E-08		1.67E-07		4.90E-08		4.10E-07		4.80E-08	
PCB-81	4.00E-09		1.20E-08		5.00E-09		4.30E-08		1.00E-09	
TEQ from Dioxin Congeners			**3.64E-06**		**3.05E-06**				**3.82E-06**	
TEQ from Furan Congeners			**1.47E-05**		**1.04E-05**				**8.13E-06**	
TEQ from Dioxin-like PCB Congeners	**1.65E-04**		**4.24E-04**		**1.80E-04**		**1.19E-03**		**1.50E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H4-WPBB14--8C01		H4-WPBB15--8C01		H4-WPBB16--8C01		H3-03LB01--8C20		H3-03LB03--8C20	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD			4.00E-09				2.18E-08	U	2.50E-08	U
1,2,3,4,7,8-HXCDD			2.00E-08				2.18E-07	U	2.50E-07	U
1,2,3,6,7,8-HXCDD			2.00E-08				2.18E-07	U	2.50E-07	U
1,2,3,7,8,9-HXCDD			2.40E-07	U			2.18E-07	U	2.50E-07	U
1,2,3,7,8-PECDD			2.40E-06	U			2.18E-06	U	2.50E-06	U
2,3,7,8-TCDD			4.00E-07				4.25E-07	U	5.00E-07	U
OCDD			9.00E-11				4.33E-10	U	5.00E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF			2.70E-08				2.18E-08	U	1.40E-08	
1,2,3,4,7,8,9-HPCDF			3.00E-09				2.18E-08	U	1.00E-08	
1,2,3,4,7,8-HXCDF			2.40E-07	U			2.18E-07	U	2.50E-07	U
1,2,3,6,7,8-HXCDF			6.00E-08				2.18E-07	U	2.50E-07	U
1,2,3,7,8,9-HXCDF			2.40E-07	U			2.18E-07	U	2.50E-07	U
1,2,3,7,8-PECDF			1.00E-06				4.75E-07		1.75E-07	
2,3,4,6,7,8-HXCDF			1.40E-07				2.18E-07	U	2.50E-07	U
2,3,4,7,8-PECDF			5.00E-06				7.75E-07		9.50E-07	
2,3,7,8-TCDF			1.00E-06				2.55E-07		3.40E-07	
OCDF			7.00E-11				4.33E-10	U	1.00E-09	
PCB Congeners										
PCB-105	6.97E-06		1.80E-05		4.83E-06		5.71E-07		3.57E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	1.28E-05		2.86E-05		7.26E-06		1.71E-06		6.46E-06	
PCB-123	9.75E-08		2.54E-07		8.76E-08		1.74E-08		4.19E-08	
PCB-126	1.08E-04		1.30E-04		1.08E-04		1.13E-04		2.80E-05	
PCB-156	1.40E-05		3.94E-05		6.96E-06		2.83E-06		2.22E-06	
PCB-157	1.89E-06		3.94E-06		1.46E-06		3.14E-07		5.12E-07	
PCB-167	3.31E-07		7.69E-07		2.33E-07		3.05E-08		1.22E-07	
PCB-169	1.60E-06		3.10E-06		1.00E-06		3.00E-07		7.00E-07	
PCB-189	1.03E-06		2.22E-06		8.22E-07		1.02E-07		2.76E-07	
PCB-77	5.40E-08		6.20E-08		5.50E-08		2.43E-07		3.40E-08	
PCB-81	5.00E-09		8.00E-09		1.80E-08		7.90E-08		2.00E-09	
TEQ from Dioxin Congeners			**3.08E-06**				**3.27E-06**	**U**	**3.78E-06**	**U**
TEQ from Furan Congeners			**7.71E-06**				**2.42E-06**		**2.49E-06**	
TEQ from Dioxin-like PCB Congeners	**1.47E-04**		**2.26E-04**		**1.31E-04**		**1.19E-04**		**4.19E-05**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H3-07LB01--8S29		H3-07LB02--8S29		H3-07LB05--8S29		H3-08LB08--8S30		H3-08LB09--8S30	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD					2.45E-08	U	1.65E-08	U	1.65E-08	U
1,2,3,4,7,8-HXCDD					2.45E-07	U	1.65E-07	U	1.65E-07	U
1,2,3,6,7,8-HXCDD					2.45E-07	U	1.65E-07	U	1.65E-07	U
1,2,3,7,8,9-HXCDD					2.45E-07	U	1.65E-07	U	1.65E-07	U
1,2,3,7,8-PECDD					2.45E-06	U	1.65E-06	U	1.65E-06	U
2,3,7,8-TCDD					5.00E-07	U	3.50E-07	U	3.50E-07	U
OCDD					4.95E-10	U	3.30E-10	U	3.35E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF					2.00E-07		1.65E-08	U	1.65E-08	U
1,2,3,4,7,8,9-HPCDF					2.45E-08	U	1.65E-08	U	1.65E-08	U
1,2,3,4,7,8-HXCDF					2.45E-07	U	1.65E-07	U	1.65E-07	U
1,2,3,6,7,8-HXCDF					2.45E-07	U	1.65E-07	U	1.65E-07	U
1,2,3,7,8,9-HXCDF					2.45E-07	U	1.65E-07	U	1.65E-07	U
1,2,3,7,8-PECDF					1.00E-06		1.65E-07		1.75E-07	
2,3,4,6,7,8-HXCDF					2.45E-07	U	1.65E-07	U	1.65E-07	U
2,3,4,7,8-PECDF					3.30E-06		8.25E-07	U	2.05E-06	
2,3,7,8-TCDF					9.90E-07		5.30E-07		7.20E-07	
OCDF					4.95E-10	U	3.30E-10	U	3.35E-10	U
PCB Congeners										
PCB-105	1.95E-06		7.81E-06		7.02E-06		2.76E-06		3.02E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	9.07E-06		3.02E-05		9.18E-06		8.46E-06		2.16E-05	
PCB-123	8.18E-08		3.15E-07		1.18E-07		1.82E-07		2.79E-07	
PCB-126	3.90E-05		1.56E-04		5.90E-05		1.04E-04		1.89E-04	
PCB-156	1.60E-05		1.03E-04		4.75E-08	U	2.58E-05		1.75E-05	
PCB-157	1.33E-06		8.55E-06		1.07E-06		2.21E-06		3.46E-06	
PCB-167	2.29E-07		1.09E-06		2.74E-07		3.05E-07		5.64E-07	
PCB-169	1.00E-06		1.10E-06		7.00E-07		1.20E-06		1.60E-06	
PCB-189	7.57E-07		2.72E-06		7.31E-07		1.02E-06		1.60E-06	
PCB-77	4.30E-08		1.84E-07		2.15E-07		8.50E-08		2.26E-07	
PCB-81	1.00E-09		3.30E-08		9.50E-09	U	1.00E-08	U	2.00E-08	
TEQ from Dioxin Congeners					**3.71E-06**	**U**	**2.51E-06**	**U**	**2.51E-06**	**U**
TEQ from Furan Congeners					**6.49E-06**		**2.21E-06**		**3.64E-06**	
TEQ from Dioxin-like PCB Congeners	**6.95E-05**		**3.11E-04**		**7.84E-05**		**1.46E-04**		**2.39E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H3-09LB11--8S30		H3-09LB12--8S30		H3-09LB15--8S30		H3-10LB16--8S30		H3-10LB17--8S30	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	1.85E-08	U	1.85E-08	U			2.20E-08	U	1.75E-08	U
1,2,3,4,7,8-HXCDD	1.85E-07	U	1.85E-07	U			2.20E-07	U	1.75E-07	U
1,2,3,6,7,8-HXCDD	1.85E-07	U	1.85E-07	U			2.20E-07	U	1.75E-07	U
1,2,3,7,8,9-HXCDD	1.85E-07	U	1.85E-07	U			2.20E-07	U	1.75E-07	U
1,2,3,7,8-PECDD	1.85E-06	U	1.85E-06	U			2.20E-06	U	1.75E-06	U
2,3,7,8-TCDD	3.50E-07	U	2.30E-06				4.50E-07	U	3.50E-07	U
OCDD	3.75E-10	U	3.40E-10				4.45E-10	U	3.00E-11	
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	4.20E-08		1.00E-07				6.80E-08		2.90E-08	
1,2,3,4,7,8,9-HPCDF	1.85E-08	U	1.00E-08				2.20E-08	U	4.00E-09	
1,2,3,4,7,8-HXCDF	1.85E-07	U	2.10E-07				1.80E-07		8.00E-08	
1,2,3,6,7,8-HXCDF	4.00E-08		2.90E-07				5.00E-08		1.75E-07	U
1,2,3,7,8,9-HXCDF	1.85E-07	U	1.85E-07	U			2.20E-07	U	1.75E-07	U
1,2,3,7,8-PECDF	2.50E-06		8.50E-06				4.00E-06		1.50E-06	
2,3,4,6,7,8-HXCDF	1.85E-07	U	3.70E-07				2.20E-07	U	9.00E-08	
2,3,4,7,8-PECDF	4.30E-06		1.50E-05				4.15E-06		2.40E-06	
2,3,7,8-TCDF	9.20E-07		2.00E-06				1.00E-06		7.50E-07	
OCDF	3.75E-10	U	1.80E-10				4.45E-10	U	3.53E-10	U
PCB Congeners										
PCB-105	1.92E-05		1.27E-04		6.71E-06		2.23E-05		2.07E-05	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	2.85E-05		1.16E-04		1.62E-05		7.46E-05		2.49E-05	
PCB-123	3.01E-07		2.70E-06		2.58E-07		6.15E-07		1.59E-07	
PCB-126	1.03E-04		4.08E-04		4.80E-05		1.91E-04		1.14E-04	
PCB-156	6.84E-05		1.44E-04		3.81E-05		1.44E-04		5.36E-05	
PCB-157	4.22E-06		3.95E-05		5.19E-06		1.88E-05		2.77E-06	
PCB-167	1.12E-06		4.72E-06		5.60E-07		1.82E-06		6.39E-07	
PCB-169	1.70E-06		7.70E-06		3.00E-07		3.50E-06		1.20E-06	
PCB-189	3.51E-06		2.43E-05		2.24E-06		6.36E-06		1.99E-06	
PCB-77	1.17E-07		4.04E-07		7.90E-08		3.95E-07		8.95E-08	
PCB-81	3.80E-08		4.70E-08		1.60E-08		8.70E-08		9.00E-09	
TEQ from Dioxin Congeners	**2.77E-06**	**U**	**4.72E-06**				**3.33E-06**	**U**	**2.64E-06**	
TEQ from Furan Congeners	**8.38E-06**		**2.67E-05**				**9.91E-06**		**5.20E-06**	
TEQ from Dioxin-like PCB Congeners	**2.30E-04**		**8.74E-04**		**1.18E-04**		**4.63E-04**		**2.20E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H3-10LB19--8S30**		**H3-11LB22--8S30**		**H3-11LB23--8S30**		**H3-11LB24--8S30**		**H4-WPLB01--8S30**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	1.75E-08	U	1.80E-08	U					1.60E-08	U
1,2,3,4,7,8-HXCDD	1.75E-07	U	1.80E-07	U					1.60E-07	U
1,2,3,6,7,8-HXCDD	1.75E-07	U	1.80E-07	U					1.60E-07	U
1,2,3,7,8,9-HXCDD	1.75E-07	U	1.80E-07	U					1.60E-07	U
1,2,3,7,8-PECDD	1.75E-06	U	1.80E-06	U					1.60E-06	U
2,3,7,8-TCDD	3.50E-07	U	3.50E-07	U					3.25E-07	U
OCDD	3.55E-10	U	3.50E-10						3.23E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	1.30E-08		1.00E-07						8.25E-08	
1,2,3,4,7,8,9-HPCDF	1.75E-08	U	1.80E-08	U					1.60E-08	U
1,2,3,4,7,8-HXCDF	1.75E-07	U	1.80E-07	U					1.60E-07	U
1,2,3,6,7,8-HXCDF	1.75E-07	U	1.80E-07	U					1.60E-07	U
1,2,3,7,8,9-HXCDF	1.75E-07	U	1.80E-07	U					1.60E-07	U
1,2,3,7,8-PECDF	5.00E-07		7.50E-06						1.50E-06	
2,3,4,6,7,8-HXCDF	1.75E-07	U	1.80E-07	U					1.60E-07	U
2,3,4,7,8-PECDF	1.20E-06		1.40E-06						2.70E-06	
2,3,7,8-TCDF	4.30E-07		1.15E-07	U					1.00E-06	
OCDF	3.55E-10	U	3.20E-10						3.23E-10	U
PCB Congeners										
PCB-105	4.36E-06		3.16E-06		1.56E-06		4.50E-05		2.60E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	4.13E-06		3.41E-06		4.87E-06		1.29E-04		1.46E-05	
PCB-123	4.77E-08		4.84E-08		1.29E-07		7.18E-07		8.50E-08	
PCB-126	2.00E-05		3.30E-05		1.90E-05		4.44E-04		7.21E-04	
PCB-156	8.28E-06		4.81E-06		8.80E-06		1.97E-04		1.54E-05	
PCB-157	4.18E-07		7.51E-07		8.58E-07		1.69E-05		1.53E-06	
PCB-167	8.96E-08		1.25E-07		1.87E-07		3.90E-06		2.45E-07	
PCB-169	3.00E-07		7.00E-07		8.00E-07		1.44E-05		1.20E-06	
PCB-189	2.48E-07		4.24E-07		5.98E-07		1.16E-05		5.55E-07	
PCB-77	3.50E-08		2.40E-08		2.10E-08		3.41E-07		2.12E-06	
PCB-81	1.00E-09	U	2.30E-08		2.40E-08		3.50E-08		4.84E-07	
TEQ from Dioxin Congeners	**2.64E-06**	**U**	**2.71E-06**						**2.42E-06**	**U**
TEQ from Furan Congeners	**2.86E-06**		**9.85E-06**						**5.94E-06**	
TEQ from Dioxin-like PCB Congeners	**3.79E-05**		**4.65E-05**		**3.68E-05**		**8.63E-04**		**7.60E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	**H4-WPLB03--8S30**		**H4-WPLB04--8S30**		**H4-WPLB06--8C01**		**H4-WPLB07--8C01**		**H4-WPLB11--8C01**	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD	1.65E-08	U			4.85E-08	U	1.65E-08	U		
1,2,3,4,7,8-HXCDD	1.65E-07	U			4.85E-07	U	1.65E-07	U		
1,2,3,6,7,8-HXCDD	1.65E-07	U			4.85E-07	U	1.65E-07	U		
1,2,3,7,8,9-HXCDD	1.65E-07	U			4.85E-07	U	1.65E-07	U		
1,2,3,7,8-PECDD	1.65E-06	U			4.85E-06	U	1.65E-06	U		
2,3,7,8-TCDD	3.50E-07	U			9.50E-07	U	3.50E-07	U		
OCDD	3.30E-10	U			2.00E-09		3.30E-10	U		
Furan Congeners										
1,2,3,4,6,7,8-HPCDF	1.00E-07				9.10E-08		1.70E-08			
1,2,3,4,7,8,9-HPCDF	1.65E-08	U			4.85E-08	U	1.65E-08	U		
1,2,3,4,7,8-HXCDF	1.65E-07	U			4.85E-07	U	1.65E-07	U		
1,2,3,6,7,8-HXCDF	1.65E-07	U			4.85E-07	U	1.65E-07	U		
1,2,3,7,8,9-HXCDF	1.65E-07	U			4.85E-07	U	1.65E-07	U		
1,2,3,7,8-PECDF	3.00E-06				1.00E-06		5.00E-07			
2,3,4,6,7,8-HXCDF	1.65E-07	U			4.85E-07	U	1.65E-07	U		
2,3,4,7,8-PECDF	2.10E-06				4.90E-06		1.95E-06			
2,3,7,8-TCDF	1.00E-06				3.00E-06		1.00E-06			
OCDF	3.30E-10	U			1.00E-09		3.30E-10	U		
PCB Congeners										
PCB-105	1.77E-06		3.29E-06		1.85E-06		7.10E-07		4.01E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	1.33E-05		1.36E-05		5.99E-06		3.78E-06		1.26E-05	
PCB-123	8.63E-08		2.54E-07		4.43E-08		4.40E-08		1.01E-07	
PCB-126	6.67E-04		4.80E-05		6.48E-04		3.30E-05		6.60E-05	
PCB-156	1.98E-05		4.92E-05		1.26E-05		5.80E-06		1.58E-05	
PCB-157	1.58E-06		3.29E-06		1.13E-06		5.06E-07		9.00E-07	
PCB-167	2.96E-07		5.19E-07		1.71E-07		8.11E-08		2.48E-07	
PCB-169	1.00E-06		1.70E-06		7.00E-07		6.00E-07		6.00E-07	
PCB-189	6.62E-07		2.00E-06		4.70E-07		2.27E-07		5.33E-07	
PCB-77	1.70E-06		9.50E-08		1.65E-06		4.60E-08		8.20E-08	
PCB-81	3.71E-07		1.20E-08		4.40E-07		1.00E-08	U	1.00E-09	
TEQ from Dioxin Congeners	**2.51E-06**	**U**			**7.31E-06**		**2.51E-06**	**U**		
TEQ from Furan Congeners	**6.88E-06**				**1.10E-05**		**4.14E-06**			
TEQ from Dioxin-like PCB Congeners	**7.08E-04**		**1.22E-04**		**6.73E-04**		**4.48E-05**		**1.01E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H4-WPLB12--8C01		H4-WPLB13--8C01		H4-WPLB14--8C01		H4-WPLB15--8C01		H4-WPLB17--8C01	
Dioxin Congeners										
1,2,3,4,6,7,8-HPCDD					2.45E-08	U	2.50E-08	U	2.20E-08	U
1,2,3,4,7,8-HXCDD					2.45E-07	U	2.50E-07	U	2.20E-07	U
1,2,3,6,7,8-HXCDD					2.45E-07	U	2.50E-07	U	2.20E-07	U
1,2,3,7,8,9-HXCDD					2.45E-07	U	2.50E-07	U	2.20E-07	U
1,2,3,7,8-PECDD					2.45E-06	U	2.50E-06	U	2.20E-06	U
2,3,7,8-TCDD					5.00E-07	U	5.00E-07	U	4.50E-07	U
OCDD					4.85E-10	U	4.95E-10	U	4.45E-10	U
Furan Congeners										
1,2,3,4,6,7,8-HPCDF					2.45E-08	U	2.50E-08	U	2.20E-08	U
1,2,3,4,7,8,9-HPCDF					2.45E-08	U	2.50E-08	U	2.20E-08	U
1,2,3,4,7,8-HXCDF					2.45E-07	U	2.50E-07	U	2.20E-07	U
1,2,3,6,7,8-HXCDF					2.45E-07	U	2.50E-07	U	2.20E-07	U
1,2,3,7,8,9-HXCDF					2.45E-07	U	2.50E-07	U	2.20E-07	U
1,2,3,7,8-PECDF					5.00E-07		5.00E-07		2.00E-08	U
2,3,4,6,7,8-HXCDF					2.45E-07	U	2.50E-07	U	5.00E-08	
2,3,4,7,8-PECDF					1.23E-06	U	6.00E-07		2.75E-07	U
2,3,7,8-TCDF					5.00E-08	U	1.90E-07		8.00E-08	U
OCDF					1.30E-10		4.95E-10	U	4.45E-10	U
PCB Congeners										
PCB-105	5.18E-06		7.02E-06		6.45E-06		4.06E-06		5.26E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U		U		U
PCB-118	1.14E-05		1.54E-05		7.03E-06		6.20E-06		1.38E-05	
PCB-123	1.31E-07		1.91E-07		9.73E-08		1.03E-07		2.16E-07	
PCB-126	4.60E-05		6.40E-05		4.30E-05		3.10E-05		7.50E-05	
PCB-156	2.31E-05		2.69E-05		7.58E-06		1.52E-05		3.55E-05	
PCB-157	1.08E-06		1.83E-06		7.88E-07		8.92E-07		2.85E-06	
PCB-167	2.64E-07		4.81E-07		1.60E-07		1.70E-07		4.50E-07	
PCB-169	3.00E-07	U	4.00E-07	U	6.00E-07		3.00E-07	U	1.40E-06	
PCB-189	7.28E-07		1.25E-06		4.18E-07		5.19E-07		1.73E-06	
PCB-77	4.00E-08		5.70E-08		3.30E-08		4.00E-08		8.80E-08	
PCB-81	2.00E-09		4.00E-09		1.20E-08		9.00E-09		2.00E-08	
TEQ from Dioxin Congeners					**3.71E-06**	**U**	**3.78E-06**	**U**	**3.33E-06**	**U**
TEQ from Furan Congeners					**2.80E-06**		**2.34E-06**		**1.13E-06**	
TEQ from Dioxin-like PCB Congeners	**8.82E-05**		**1.18E-04**		**6.62E-05**		**5.85E-05**		**1.36E-04**	

Table C.4-1

Total TEQ Calculations for Brown Bullhead/Largemouth Bass Data Set (units in mg TEQ/kg fish tissue)
Reaches 5 and 6
(Continued)

Contaminant	H4-WPLB21--8C01		H4-WPLB22--8C01		H4-WPLB23--8C01	
Dioxin Congeners						
1,2,3,4,6,7,8-HPCDD	2.35E-08	U	2.45E-08	U	2.45E-08	U
1,2,3,4,7,8-HXCDD	2.35E-07	U	2.45E-07	U	2.45E-07	U
1,2,3,6,7,8-HXCDD	2.35E-07	U	2.45E-07	U	2.45E-07	U
1,2,3,7,8,9-HXCDD	2.35E-07	U	2.45E-07	U	2.45E-07	U
1,2,3,7,8-PECDD	2.35E-06	U	2.45E-06	U	2.45E-06	U
2,3,7,8-TCDD	4.50E-07	U	5.00E-07	U	5.00E-07	U
OCDD	4.65E-10	U	4.90E-10	U	4.90E-10	U
Furan Congeners						
1,2,3,4,6,7,8-HPCDF	1.50E-09	U	2.10E-08		1.90E-08	
1,2,3,4,7,8,9-HPCDF	2.35E-08	U	2.45E-08	U	2.45E-08	U
1,2,3,4,7,8-HXCDF	2.35E-07	U	2.45E-07	U	2.45E-07	U
1,2,3,6,7,8-HXCDF	2.35E-07	U	2.45E-07	U	2.45E-07	U
1,2,3,7,8,9-HXCDF	2.35E-07	U	2.45E-07	U	2.45E-07	U
1,2,3,7,8-PECDF	1.00E-08	U	5.00E-07		5.00E-07	
2,3,4,6,7,8-HXCDF	2.35E-07	U	2.45E-07	U	2.45E-07	U
2,3,4,7,8-PECDF	2.25E-07	U	9.50E-07		2.75E-06	
2,3,7,8-TCDF	6.50E-08	U	1.90E-07		1.00E-06	
OCDF	4.65E-10	U	4.90E-10	U	4.90E-10	U
PCB Congeners						
PCB-105	2.59E-06		6.37E-06		3.06E-06	
PCB-114 - Removed since not detected in BB & LB		U		U		U
PCB-118	3.96E-06		1.73E-05		1.59E-05	
PCB-123	7.05E-08		1.87E-07		1.37E-07	
PCB-126	3.60E-05		8.80E-05		1.00E-04	
PCB-156	4.05E-06		2.13E-05		2.62E-05	
PCB-157	7.05E-07		1.34E-06		2.33E-06	
PCB-167	1.10E-07		3.40E-07		6.36E-07	
PCB-169	6.00E-07		6.00E-07	U	1.20E-06	
PCB-189	3.60E-07		8.79E-07		1.56E-06	
PCB-77	2.70E-08		8.60E-08		6.20E-08	
PCB-81	5.00E-10	U	7.00E-09		4.00E-09	
TEQ from Dioxin Congeners	**3.53E-06**	**U**	**3.71E-06**	**U**	**3.71E-06**	**U**
TEQ from Furan Congeners	**1.27E-06**	**U**	**2.67E-06**		**5.27E-06**	
TEQ from Dioxin-like PCB Congeners	**4.85E-05**		**1.36E-04**		**1.51E-04**	

ATTACHMENT C.5

FISH STATISTICS

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 1 7/12/02 11:11:31 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Summary Section of BB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
43	13.2327	14.90198	2.27253	0.40645	90.21707	89.81062

Counts Section of BB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
127	43	84	43	569.0062	16856.38	9326.896

Means Section of BB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	13.2327	9.47491	8.356322	4.340819	569.0062	
Std Error	2.27253				97.7188	
95% LCL	8.64655	6.57099			371.8016	
95% UCL	17.81885	13.18094			766.2107	
T-Value	5.8229					
Prob Level	0.000001					
Count	43		43	43		

Variation Section of BB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	222.0689	14.90198	14.99094	2.27253	13.88593	89.81062
Std Error	139.5682	6.622587		1.009935		
95% LCL	150.9774	12.28729		1.873794		
95% UCL	358.7452	18.94057		2.88841		

Skewness and Kurtosis Section of BB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	3.478666	17.98502	3.605685	17.03922	1.126148	0.8876719
Std Error	0.5993329	7.982124			0.2181315	

Trimmed Section of BB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	11.06492	10.78471	10.64414	10.2867	9.800203	9.471731
Trim-Std Dev	6.99398	6.088846	5.465971	3.789634	2.126742	0.6681998
Count	38.7	34.4	30.1	21.5	12.9	4.3

Mean-Deviation Section of BB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	8.925897	8.410612	216.9045	11112.6	846151.6
Std Error	1.367928		136.3225	9317.126	727744.1

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 2 7/12/02 11:11:31 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

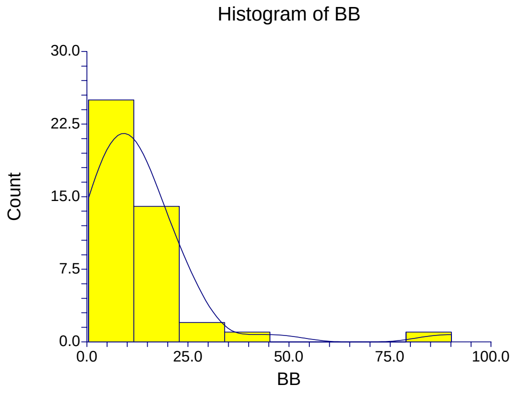
Quartile Section of BB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	2.158856	4.79244	9.47491	18.67837	23.0666
95% LCL	0.40645	2.30822	6.57099	12.78059	19.64147
95% UCL	3.10894	7.34771	13.18094	22.29519	90.21707

Normality Test Section of BB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.6472377	0.000000			Reject Normality
Anderson-Darling	3.430349	0.000000			Reject Normality
Martinez-Iglewicz	3.639199		1.107535	1.164879	Reject Normality
Kolmogorov-Smirnov	0.2013651		0.123	0.134	Reject Normality
D'Agostino Skewness	6.0034	0.000000	1.645	1.960	Reject Normality
D'Agostino Kurtosis	5.0306	0.000000	1.645	1.960	Reject Normality
D'Agostino Omnibus	61.3487	0.000000	4.605	5.991	Reject Normality

Plots Section of BB



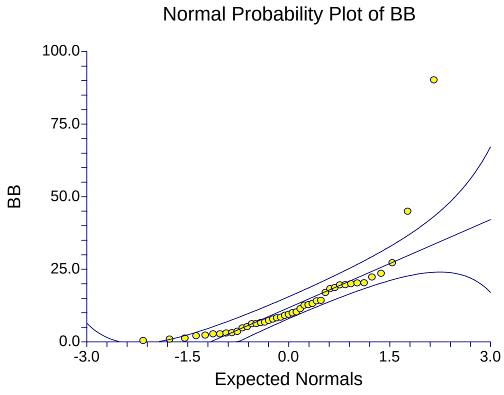


Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 3 7/12/02 11:11:32 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Percentile Section of BB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	90.21707			
95.0	41.42505			
90.0	23.0666	19.64147	90.21707	96.4853
85.0	20.2878	18.28808	44.97181	97.0684
80.0	19.70856	14.0896	23.58088	96.5880
75.0	18.67837	12.78059	22.29519	96.5888
70.0	16.43693	11.37169	20.27923	95.3315
65.0	13.72614	9.09184	19.60534	95.5885
60.0	12.67955	8.24526	18.28808	95.2305
55.0	10.48748	7.34771	14.25138	95.0782
50.0	9.47491	6.57099	13.18094	95.1233
45.0	8.423052	6.18432	12.61219	95.3589
40.0	7.64069	4.79244	10.26643	95.7776
35.0	6.646578	3.10894	9.47491	96.3691
30.0	6.205398	2.74634	8.24526	95.3315
25.0	4.79244	2.30822	7.34771	96.5888
20.0	3.09355	1.22943	6.28971	95.9131
15.0	2.736116	0.92827	5.21935	97.0684
10.0	2.158856	0.40645	3.10894	96.4853
5.0	0.988502			
1.0	0.40645			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of BB

```
Depth      Stem   Leaves
3            0* |  001
10            T |  2222333
12            F |  45
18            S |  666677
(5)           . |  88999
20           1* |  01
18            T |  223
15            F |  44
13            S |  6
12            . |  88999
7            2* |  00
5             T |  23
3             F |
3             S |  7
High            |  44, 90
```

Unit = 1 Example: 1 |2 Represents 12

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 4 7/12/02 11:11:32 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Summary Section of LB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
30	16.67693	29.76019	5.433442	1.17576	151.0984	149.9227

Counts Section of LB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
127	30	97	30	500.3078	34027.98	25684.39

Means Section of LB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	16.67693	6.57561	8.598569	5.77407	500.3078	
Std Error	5.433442				163.0033	
95% LCL	5.56429	5.15863			166.9287	
95% UCL	27.78956	11.36232			833.6868	
T-Value	3.0693					
Prob Level	0.004622					
Count	30		30	30		

Variation Section of LB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	885.6686	29.76019	30.0178	5.433442	9.258605	149.9227
Std Error	620.8	14.75031		2.693026		
95% LCL	561.7477	23.70122		4.32723		
95% UCL	1600.566	40.00707		7.304258		

Skewness and Kurtosis Section of LB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	3.588765	15.73948	3.780477	15.37936	1.784513	1.859882
Std Error	1.235561	10.66906			0.2225641	

Trimmed Section of LB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	11.31443	9.193363	8.54734	7.850303	7.452138	6.856223
Trim-Std Dev	12.89075	5.795765	4.303271	2.565619	1.800052	0.9565006
Count	27	24	21	15	9	3

Mean-Deviation Section of LB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	15.79979	12.22986	856.1464	89901.52	1.153683E+07
Std Error	3.268561		600.1068	67751.41	9056685

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 5 7/12/02 11:11:32 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

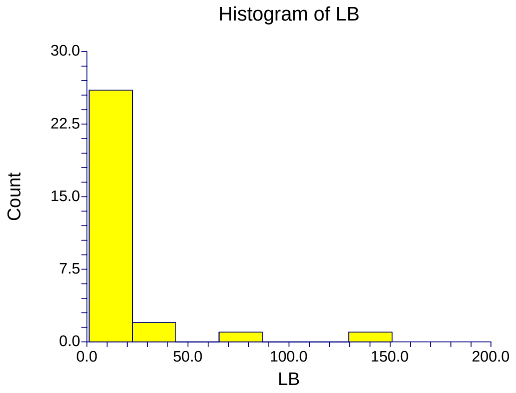
Quartile Section of LB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	2.972167	4.7028	6.57561	13.9614	37.93802
95% LCL	1.17576	2.95838	5.15863	9.20097	11.47063
95% UCL	5.15863	6.11945	11.36232	39.3466	151.0984

Normality Test Section of LB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.4763237	0.000000			Reject Normality
Anderson-Darling	5.816683	0.000000			Reject Normality
Martinez-Iglewicz	33.87231		1.148522	1.228175	Reject Normality
Kolmogorov-Smirnov	0.3427348		0.146	0.159	Reject Normality
D'Agostino Skewness	5.5143	0.000000	1.645	1.960	Reject Normality
D'Agostino Kurtosis	4.5921	0.000004	1.645	1.960	Reject Normality
D'Agostino Omnibus	51.4943	0.000000	4.605	5.991	Reject Normality

Plots Section of LB



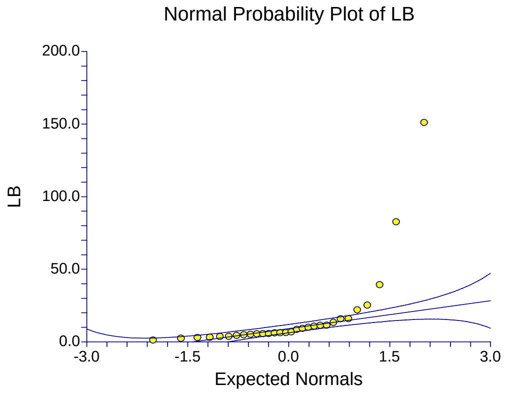


Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time	6 7/12/02 11:11:32 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Percentile Section of LB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	151.0984			
95.0	113.4551			
90.0	37.93802	11.47063	151.0984	95.5589
85.0	23.15401	11.47063	151.0984	96.4591
80.0	15.94765	10.73934	82.65609	96.3861
75.0	13.9614	9.20097	39.3466	96.7810
70.0	11.43814	6.76669	22.01959	95.2908
65.0	10.83279	6.28418	15.97553	96.4380
60.0	9.669222	6.11945	15.83615	96.1577
55.0	8.583233	5.53611	11.47063	95.4959
50.0	6.57561	5.15863	11.36232	97.0551
45.0	6.275943	4.8221	9.98139	95.4451
40.0	5.833934	3.71419	9.20097	97.3101
35.0	5.527198	3.55948	6.76669	96.2399
30.0	5.254051	3.09625	6.28418	95.0631
25.0	4.7028	2.95838	6.11945	96.7810
20.0	3.840332	2.43179	5.53611	96.3861
15.0	3.39735	1.17576	5.15863	96.4591
10.0	2.972167	1.17576	5.15863	95.5589
5.0	1.866577			
1.0	1.17576			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LB

Depth	Stem	Leaves
1	0*|	1
6	T|	22333
12	F|	445555
(4)	S|	6666
14	.|	899
11	1*|	011
8	T|	3
7	F|	55
5	S|	
5	.|	
5	2*|	
5	T|	2
4	F|	5
High	|	39, 82, 151

Unit = 1   Example: 1 |2 Represents 12

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time	22 7/12/02 11:11:33 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Summary Section of LN_BB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
43	2.123018	1.047568	0.1597526	-0.9002944	4.502219	5.402513

Counts Section of LN_BB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
127	43	84	43	91.28979	239.9006	46.09071

Means Section of LN_BB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	2.123018	2.248647	2.012817	3.913901	91.28979	
Std Error	0.1597526				6.86936	
95% LCL	1.800625	1.882665			77.42686	
95% UCL	2.445412	2.578772			105.1527	
T-Value	13.2894					
Prob Level	0.000000					
Count	43		41	43		

Variation Section of LN_BB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	1.097398	1.047568	1.053821	0.1597526	1.360327	5.402513
Std Error	0.2731787	0.1843953		2.812002E-02		
95% LCL	0.746085	0.8637621		0.1317225		
95% UCL	1.772811	1.331469		0.2030472		

Skewness and Kurtosis Section of LN_BB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.6019886	3.664612	-0.6239694	0.9025627	0.4934331	0.3519621
Std Error	0.3821881	0.7289684			8.234514E-02	

Trimmed Section of LN_BB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	2.155803	2.191281	2.219301	2.267386	2.260772	2.246372
Trim-Std Dev	0.7781228	0.6605996	0.5763395	0.3650219	0.216575	7.140289E-02
Count	38.7	34.4	30.1	21.5	12.9	4.3

Mean-Deviation Section of LN_BB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.7988987	0.7914387	1.071877	-0.668045	4.210347
Std Error	9.616154E-02		0.2668257	0.4928374	1.956976

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 23 7/12/02 11:11:33 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

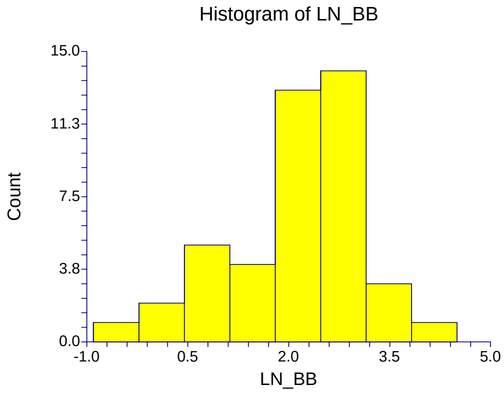
Quartile Section of LN_BB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.7680045	1.56704	2.248647	2.927366	3.13801
95% LCL	-0.9002944	0.8364767	1.882665	2.547928	2.977643
95% UCL	1.134282	1.994389	2.578772	3.104371	4.502219

Normality Test Section of LN_BB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.964856	0.208146			Accept Normality
Anderson-Darling	0.5907378	0.123484			Accept Normality
Martinez-Iglewicz	1.113145		1.107535	1.164879	Accept Normality
Kolmogorov-Smirnov	9.124359E-02		0.123	0.134	Accept Normality
D'Agostino Skewness	-1.7295	0.083725	1.645	1.960	Accept Normality
D'Agostino Kurtosis	1.2902	0.196975	1.645	1.960	Accept Normality
D'Agostino Omnibus	4.6557	0.097504	4.605	5.991	Accept Normality

Plots Section of LN_BB



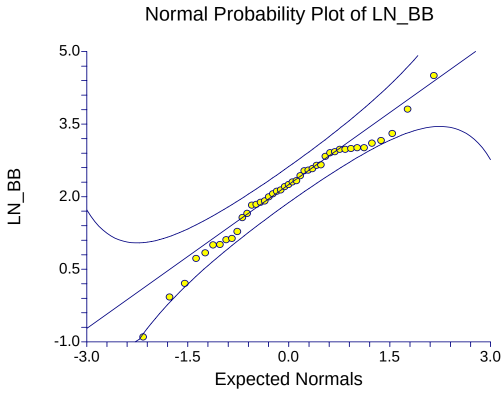


Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic
Reaches 5 and 6

```
                              Descriptive Statistics Report
Page/Date/Time      24    7/12/02 11:11:33 AM
Database            L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Percentile Section of LN_BB

Percentile     Value           95% LCL         95% UCL         Exact Conf. Level
99.0           4.502219
95.0           3.705751
90.0           3.13801         2.977643        4.502219        96.4853
85.0           3.01002         2.90625         3.806036        97.0684
80.0           2.98103         2.645437        3.160436        96.5880
75.0           2.927366        2.547928        3.104371        96.5888
70.0           2.797156        2.431127        3.009597        95.3315
65.0           2.618771        2.207377        2.975802        95.5885
60.0           2.539969        2.109638        2.90625         95.2305
55.0           2.349329        1.994389        2.656854        95.0782
50.0           2.248647        1.882665        2.578772        95.1233
45.0           2.130916        1.822017        2.534664        95.3589
40.0           2.032993        1.56704         2.328879        95.7776
35.0           1.894006        1.134282        2.248647        96.3691
30.0           1.825397        1.010269        2.109638        95.3315
25.0           1.56704         0.8364767       1.994389        96.5888
20.0           1.129269        0.2065506       1.838915        95.9131
15.0           1.006529        -7.443264E-02   1.652373        97.0684
10.0           0.7680045       -0.9002944      1.134282        96.4853
5.0            -1.823598E-02
1.0            -0.9002944
Percentile Formula:  Ave X(p[n+1])

Stem-Leaf Plot Section of LN_BB

Depth          Stem   Leaves
Low                |  -9
3               0* |  02
5                . |  78
10              1* |  00112
17               . |  5688899
(8)             2* |  01122334
18               . |  55566899999
7               3* |  00113
2                . |  8
1               4* |
1                . |  5

Unit = .1   Example:  1 |2 Represents 1.2
```

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic
Reaches 5 and 6

```
                                  Descriptive Statistics Report
Page/Date/Time    25   7/12/02 11:11:33 AM
Database          L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Summary Section of LN_LB
                                Standard        Standard
Count           Mean            Deviation       Error           Minimum         Maximum         Range
30              2.151596        1.018731        0.185994        0.1619148       5.017931        4.856017

Counts Section of LN_LB
                Sum of          Missing         Distinct                        Total           Adjusted
Rows            Frequencies     Values          Values          Sum             Sum Squares     Sum Squares
127             30              97              30              64.54787        168.9775        30.09659

Means Section of LN_LB
                                                Geometric       Harmonic
Parameter       Mean            Median          Mean            Mean            Sum             Mode
Value           2.151596        1.882945        1.878765        1.39363         64.54787
Std Error       0.185994                                                        5.579821
95% LCL         1.771195        1.640671                                        53.13586
95% UCL         2.531996        2.430303                                        75.95988
T-Value         11.5681
Prob Level      0.000000
Count           30                              30              30

Variation Section of LN_LB
                                Standard        Unbiased        Std Error       Interquartile
Parameter       Variance        Deviation       Std Dev         of Mean         Range           Range
Value           1.037813        1.018731        1.02755         0.185994        1.086294        4.856017
Std Error       0.3336135       0.2315629                       4.227741E-02
95% LCL         0.6582476       0.8113247                       0.1481269
95% UCL         1.875519        1.369496                        0.2500346

Skewness and Kurtosis Section of LN_LB
                                                                                Coefficient     Coefficient
Parameter       Skewness        Kurtosis        Fisher's g1     Fisher's g2     of Variation    of Dispersion
Value           0.8921745       4.10006         0.9398345       1.538298        0.4734771       0.3929377
Std Error       0.3789081       1.064105                                        6.562961E-02

Trimmed Section of LN_LB
                5%              10%             15%             25%             35%             45%
Parameter       Trimmed         Trimmed         Trimmed         Trimmed         Trimmed         Trimmed
Trim-Mean       2.100606        2.054486        2.036545        2.012686        1.983841        1.919305
Trim-Std Dev    0.7466165       0.5720902       0.4711841       0.3170063       0.2325324       0.1291029
Count           27              24              21              15              9               3

Mean-Deviation Section of LN_LB

Parameter       |X-Mean|        |X-Median|      (X-Mean)^2      (X-Mean)^3      (X-Mean)^4
Average         0.7562243       0.7398801       1.00322         0.8964866       4.126503
Std Error       0.1118873                       0.3224931       0.5545025       2.052661
```

Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 26 7/12/02 11:11:33 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Quartile Section of LN_LB

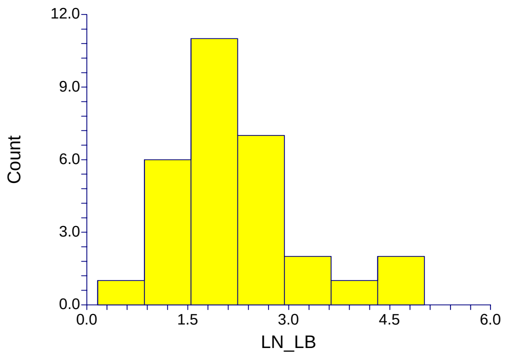
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.089197	1.547158	1.882945	2.633452	3.628094
95% LCL	0.1619148	1.084642	1.640671	2.219309	2.43979
95% UCL	1.640671	1.811472	2.430303	3.67241	5.017931

Normality Test Section of LN_LB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9425408	0.106491			Accept Normality
Anderson-Darling	0.6258327	0.103117			Accept Normality
Martinez-Iglewicz	1.339664		1.148522	1.228175	Reject Normality
Kolmogorov-Smirnov	0.1262982		0.146	0.159	Accept Normality
D'Agostino Skewness	2.1407	0.032302	1.645	1.960	Reject Normality
D'Agostino Kurtosis	1.6354	0.101957	1.645	1.960	Accept Normality
D'Agostino Omnibus	7.2571	0.026555	4.605	5.991	Reject Normality

Plots Section of LN_LB

Histogram of LN_LB



Normal Probability Plot of LN_LB

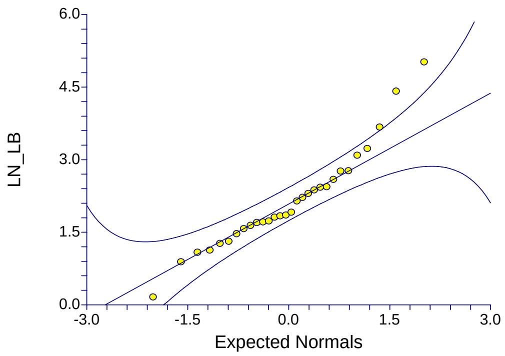


Exhibit C.5-1

Brown Bullhead and Largemouth Bass Shapiro-Wilk Test Statistic
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 27 7/12/02 11:11:33 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\PSA PCBs.S0

Percentile Section of LN_LB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	5.017931			
95.0	4.686148			
90.0	3.628094	2.43979	5.017931	95.5589
85.0	3.139995	2.43979	5.017931	96.4591
80.0	2.769306	2.373914	4.414689	96.3861
75.0	2.633452	2.219309	3.67241	96.7810
70.0	2.436944	1.912012	3.091933	95.2908
65.0	2.382372	1.838035	2.771058	96.4380
60.0	2.268157	1.811472	2.762295	96.1577
55.0	2.14968	1.711292	2.43979	95.4959
50.0	1.882945	1.640671	2.430303	97.0551
45.0	1.836707	1.57321	2.300722	95.4451
40.0	1.762901	1.312161	2.219309	97.3101
35.0	1.709674	1.269614	1.912012	96.2399
30.0	1.658621	1.130192	1.838035	95.0631
25.0	1.547158	1.084642	1.811472	96.7810
20.0	1.343529	0.8886276	1.711292	96.3861
15.0	1.220816	0.1619148	1.640671	96.4591
10.0	1.089197	0.1619148	1.640671	95.5589
5.0	0.5616068			
1.0	0.1619148			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_LB

```
Depth     Stem  Leaves
1          0* | 1
2           . | 8
7          1* | 01234
(9)         . | 567778889
14         2* | 123344
8           . | 577
5          3* | 02
3           . | 6
High          | 44, 50
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-2

Lilliefors Test Statistic
Total PCB Fillet Data
Reaches 5 and 6

From File	Sunfish
Summary Statistics for	1.110784
Number of Samples	52
Minimum	1.110784
Maximum	47.45448
Mean	6.520256
Median	5.423976
Standard Deviation	6.273444
Variance	39.3561
Coefficient of Variation	0.962147
Skewness	5.63707
Lilliefors Test Statisitic	0.259721
Lilliefors 5% Critical Value	0.122866
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	7.977703
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	8.677898
Modified-t	8.091049
95 % Non-parametric UCL	
CLT	7.951229
Jackknife	7.977703
Standard Bootstrap	7.948557
Bootstrap-t	9.773449
Chebyshev (Mean, Std)	10.31237

From File	Yellow perch
Summary Statistics for	0.544885
Number of Samples	79
Minimum	0.544885
Maximum	75.67096
Mean	7.43187
Median	5.503271
Standard Deviation	9.909959
Variance	98.20728
Coefficient of Variation	1.333441
Skewness	5.359425
Lilliefors Test Statisitic	0.291362
Lilliefors 5% Critical Value	0.099683
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	9.287855
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	9.984174
Modified-t	9.399905
95 % Non-parametric UCL	
CLT	9.265812
Jackknife	9.287855
Standard Bootstrap	9.210939
Bootstrap-t	11.86285
Chebyshev (Mean, Std)	12.29186

Exhibit C.5-3

Brown Bullhead vs. Largemouth Bass and Sunfish vs. Yellow Perch Total PCB t-Tests Reaches 5 and 6

Two-Sample Test Report

Page/Date/Time 1 7/12/02 1:33:16 PM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\PSA PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_BB	43	2.123018	1.047568	0.1597526	1.800625	2.445412
LN_LB	30	2.151596	1.018731	0.185994	1.771195	2.531996

Note: T-alpha (LN_BB) = 2.0181, T-alpha (LN_LB) = 2.0452

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	71	-2.857738E-02	1.035886	0.2464215	-0.519928	0.4627732
Unequal	63.65	-2.857738E-02	1.461236	0.2451829	-0.5184382	0.4612834

Note: T-alpha (Equal) = 1.9939, T-alpha (Unequal) = 1.9979

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-0.1160	0.908004	Accept Ho	0.051501	0.010480
Difference < 0	-0.1160	0.454002	Accept Ho	0.063010	0.013464
Difference > 0	-0.1160	0.545998	Accept Ho	0.039227	0.007341

Difference: (LN_BB)-(LN_LB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-0.1166	0.907579	Accept Ho	0.051511	0.010482
Difference < 0	-0.1166	0.453790	Accept Ho	0.063066	0.013475
Difference > 0	-0.1166	0.546210	Accept Ho	0.039189	0.007334

Difference: (LN_BB)-(LN_LB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_BB)	-1.7295	0.083725	Cannot reject normality
Kurtosis Normality (LN_BB)	1.2902	0.196975	Cannot reject normality
Omnibus Normality (LN_BB)	4.6557	0.097504	Cannot reject normality
Skewness Normality (LN_LB)	2.1407	0.032302	Reject normality
Kurtosis Normality (LN_LB)	1.6354	0.101957	Cannot reject normality
Omnibus Normality (LN_LB)	7.2571	0.026555	Reject normality
Variance-Ratio Equal-Variance Test	1.0574	0.871079	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.0935	0.760679	Cannot reject equal variances

Exhibit C.5-3

Brown Bullhead vs. Largemouth Bass and Sunfish vs. Yellow Perch Total PCB t-Tests Reaches 5 and 6

Two-Sample Test Report

Page/Date/Time 2 7/12/02 1:33:16 PM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\PSA PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
LN_BB	698	1644	1591	89.1908
LN_LB	592	1057	1110	89.1908

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**
Diff<>0			-0.5942	0.552357	Accept Ho	-0.5886	0.556112	Accept Ho
Diff<0			-0.5942	0.723821	Accept Ho	-0.5998	0.725693	Accept Ho
Diff>0			-0.5942	0.276179	Accept Ho	-0.5886	0.278056	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.174419	0.3235	.050	Accept Ho	0.5818
D(1)<D(2)	0.096124	0.3235	.025	Accept Ho	
D(1)>D(2)	0.174419	0.3235	.025	Accept Ho	

Exhibit C.5-3

Brown Bullhead vs. Largemouth Bass and Sunfish vs. Yellow Perch Total PCB t-Tests Reaches 5 and 6

```
                                   Two-Sample Test Report
Page/Date/Time     1   7/12/02 1:41:55 PM
Database           L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\PSA PCBS.S0

Descriptive Statistics Section
                                    Standard      Standard      95% LCL       95% UCL
Variable              Count  Mean       Deviation     Error         of Mean       of Mean
SF                    52     6.520256   6.273444      0.8699702     4.773718      8.266794
YP                    75     7.396546   10.1448       1.17142       5.06244       9.730651
Note: T-alpha (SF) = 2.0076,   T-alpha (YP) = 1.9925

Confidence-Limits of Difference Section

Variance                     Mean       Standard      Standard      95% LCL       95% UCL
Assumption            DF     Difference Deviation     Error         of Mean       of Mean
Equal                 125    -0.87629   8.774057      1.583325      -4.009886     2.257306
Unequal               123.59 -0.87629   11.92782      1.459134      -3.76442      2.01184
Note: T-alpha (Equal) = 1.9791,   T-alpha (Unequal) = 1.9793

Equal-Variance T-Test Section

Alternative                             Prob          Decision      Power         Power
Hypothesis                   T-Value    Level         (5%)          (Alpha=.05)   (Alpha=.01)
Difference <> 0              -0.5534    0.580944      Accept Ho     0.085209      0.022093
Difference < 0               -0.5534    0.290472      Accept Ho     0.136891      0.037632
Difference > 0               -0.5534    0.709528      Accept Ho     0.014070      0.002027
Difference: (SF)-(YP)

Aspin-Welch Unequal-Variance Test Section

Alternative                             Prob          Decision      Power         Power
Hypothesis                   T-Value    Level         (5%)          (Alpha=.05)   (Alpha=.01)
Difference <> 0              -0.6006    0.549236      Accept Ho     0.091570      0.024435
Difference < 0               -0.6006    0.274618      Accept Ho     0.147416      0.041607
Difference > 0               -0.6006    0.725382      Accept Ho     0.012476      0.001748
Difference: (SF)-(YP)

Tests of Assumptions Section

Assumption                              Value       Probability   Decision(5%)
Skewness Normality (SF)                 7.8072      0.000000      Reject normality
Kurtosis Normality (SF)                 6.1569      0.000000      Reject normality
Omnibus Normality (SF)                  98.8591     0.000000      Reject normality
Skewness Normality (YP)                 8.6399      0.000000      Reject normality
Kurtosis Normality (YP)                 6.5203      0.000000      Reject normality
Omnibus Normality (YP)                  117.1611    0.000000      Reject normality
Variance-Ratio Equal-Variance Test      2.6150      0.000281      Reject equal variances
Modified-Levene Equal-Variance Test     0.9219      0.338839      Cannot reject equal variances
```

Exhibit C.5-3

Brown Bullhead vs. Largemouth Bass and Sunfish vs. Yellow Perch Total PCB t-Tests Reaches 5 and 6

Two-Sample Test Report

Page/Date/Time 2 7/12/02 1:41:55 PM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\PSA PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
SF	1983	3361	3328	203.9608
YP	1917	4767	4800	203.9608

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			0.1618	0.871467	Accept Ho	0.1593	0.873398	Accept Ho
Diff<0			0.1618	0.564267	Accept Ho	0.1642	0.565232	Accept Ho
Diff>0			0.1618	0.435733	Accept Ho	0.1593	0.436699	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.105385	0.2454	.050	Accept Ho	0.8392
D(1)<D(2)	0.102308	0.2454	.025	Accept Ho	
D(1)>D(2)	0.105385	0.2454	.025	Accept Ho	

Exhibit C.5-4

Total PCB by Species Box Plots
Reaches 5 and 6

Page/Date/Time 1 8/13/02 11:36:32 AM
Database C:\PROGRAM FILES\NCSS97\HH FISH.S0

Box Plot Section

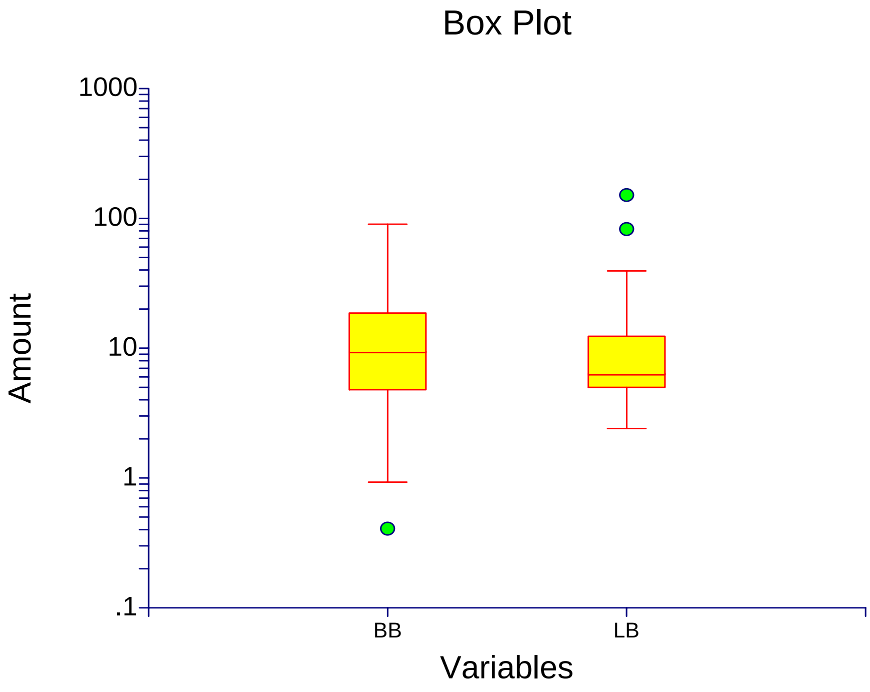


Exhibit C.5-4

Total PCB by Species Box Plots
Reaches 5 and 6

Page/Date/Time 1 8/13/02 11:37:31 AM
Database C:\PROGRAM FILES\NCSS97\HH FISH.S0

Box Plot Section

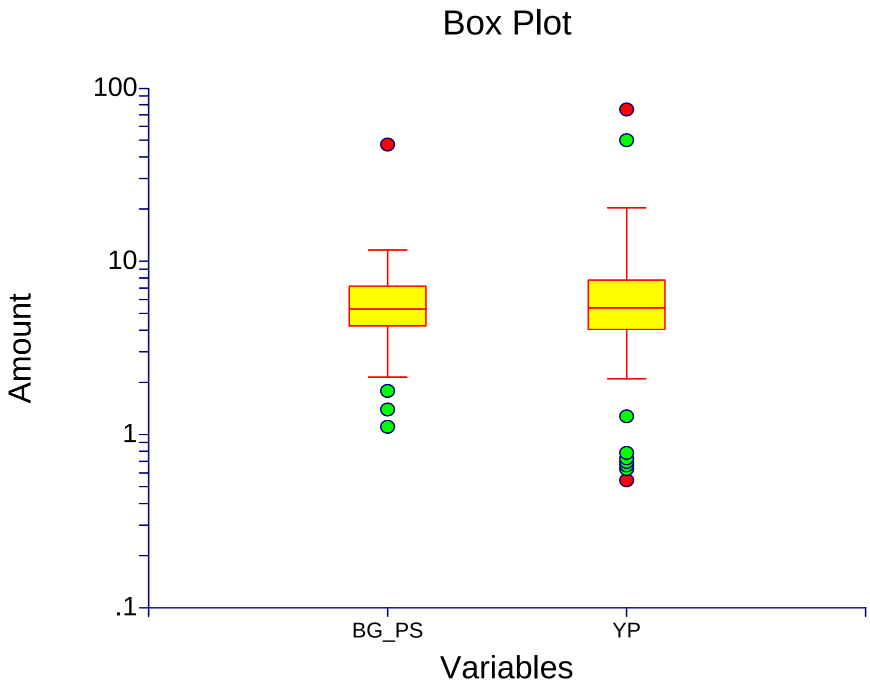


Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 13 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of All_BB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
22	4.469797	3.019418	0.6437422	0.78381	13	12.21619

Counts Section of All_BB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	22	9	22	98.33554	630.9946	191.4547

Means Section of All_BB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	4.469797	4.399825	3.520593	2.654755	98.33554	
Std Error	0.6437422				14.16233	
95% LCL	3.131062	1.728528			68.88337	
95% UCL	5.808533	5.03			127.7877	
T-Value	6.9435					
Prob Level	0.000001					
Count	22		22	22		

Variation Section of All_BB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	9.116888	3.019418	3.055565	0.6437422	3.851301	12.21619
Std Error	3.433834	0.8041571		0.1714469		
95% LCL	5.3963	2.322994		0.4952639		
95% UCL	18.61875	4.314944		0.9199492		

Skewness and Kurtosis Section of All_BB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	1.093746	4.120958	1.175459	1.756375	0.6755158	0.498413
Std Error	0.3555981	1.240406			0.1012212	

Trimmed Section of All_BB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	4.215697	4.091005	4.056918	4.054901	4.199644	4.379841
Trim-Std Dev	2.306663	1.910163	1.649534	0.9503814	0.5953826	0.2749198
Count	19.8	17.6	15.4	11	6.6	2.2

Mean-Deviation Section of All_BB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	2.19293	2.19293	8.702484	28.07898	312.0934
Std Error	0.3869604		3.27775	18.63507	194.467

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 14 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

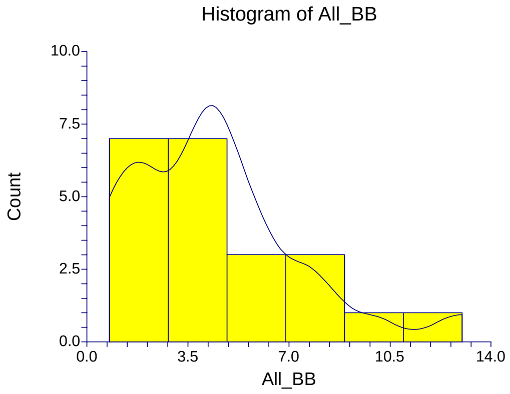
Quartile Section of All_BB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.156563	1.676198	4.399825	5.5275	9.021
95% LCL		1.149379	1.728528	4.67	
95% UCL		3.69	5.03	9.66	

Normality Test Section of All_BB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9025831	0.033492			Reject Normality
Anderson-Darling	0.6345677	0.098121			Accept Normality
Martinez-Iglewicz	1.150059		1.19765	1.318967	Accept Normality
Kolmogorov-Smirnov	0.1978344		0.169	0.184	Reject Normality
D'Agostino Skewness	2.2953	0.021715	1.645	1.960	Reject Normality
D'Agostino Kurtosis	1.6335	0.102365	1.645	1.960	Accept Normality
D'Agostino Omnibus	7.9368	0.018903	4.605	5.991	Reject Normality

Plots Section of All_BB


Histogram of All_BB

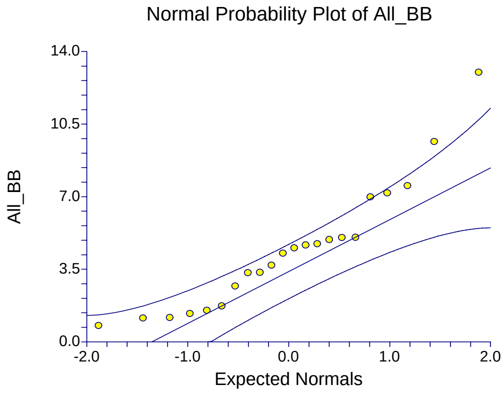

Normal Probability Plot of All_BB

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 15 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of All_BB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	13			
95.0	12.499			
90.0	9.021			
85.0	7.3725	4.93	13	96.0610
80.0	7.066	4.73	13	97.2480
75.0	5.5275	4.67	9.66	95.5626
70.0	5.031	4.26965	7.53	96.5299
65.0	4.92	3.69	7.18	95.7513
60.0	4.718	3.35	6.99	95.1952
55.0	4.621	3.33	6.99	96.7366
50.0	4.399825	1.728528	5.03	96.5310
45.0	3.892878	1.51921	4.93	96.7366
40.0	3.418	1.361639	4.73	97.0971
35.0	3.331	1.173326	4.67	97.5925
30.0	2.593853	1.149379	4.26965	95.7178
25.0	1.676198	1.149379	3.69	95.5626
20.0	1.456182	0.78381	3.35	97.2480
15.0	1.258067	0.78381	3.33	96.0610
10.0	1.156563			
5.0	0.8386453			
1.0	0.78381			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of All_BB

```
Depth      Stem  Leaves
1             0|  7
6             1|  11357
7             2|  6
10            3|  336
(5)           4|  25679
7             5|  00
5             6|  9
4             7|  15
2             8|
2             9|  6
High           |  130
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 1 8/13/02 11:48:22 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of LB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
11	3.837662	1.325516	0.3996581	1.693812	5.83816	4.144348

Counts Section of LB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	11	20	11	42.21428	179.5741	17.56993

Means Section of LB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	3.837662	3.59859	3.608289	3.363683	42.21428	
Std Error	0.3996581				4.396239	
95% LCL	2.947168	2.45481			32.41885	
95% UCL	4.728156	4.826577			52.00971	
T-Value	9.6024					
Prob Level	0.000002					
Count	11		11	11		

Variation Section of LB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	1.756993	1.325516	1.359016	0.3996581	2.043276	4.144348
Std Error	0.4706637	0.2510792		7.570322E-02		
95% LCL	0.8577736	0.9261607		0.2792479		
95% UCL	5.411172	2.326193		0.7013735		

Skewness and Kurtosis Section of LB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-5.631693E-02	1.789358	-6.562856E-02	-1.184403	0.3453968	0.3074168
Std Error	0.4613253	0.2727886			5.930918E-02	

Trimmed Section of LB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	3.845626	3.852798	3.847713	3.8542	3.889351	3.639452
Trim-Std Dev	1.20114	1.04748	0.9693813	0.8547406	0.6789247	0.7039192
Count	9.9	8.8	7.7	5.5	3.3	1.1

Mean-Deviation Section of LB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	1.128001	1.106267	1.597266	-0.1136855	4.565116
Std Error	0.239564		0.4278761	0.9335283	2.049318

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 2 8/13/02 11:48:23 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

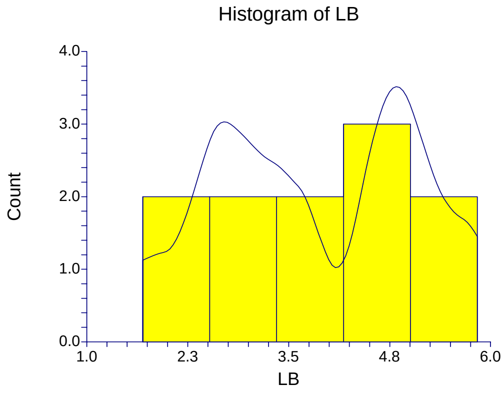
Quartile Section of LB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.846012	2.783301	3.59859	4.826577	5.734925
95% LCL		1.693812	2.45481	3.489639	
95% UCL		4.606492	4.826577	5.83816	

Normality Test Section of LB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9554961	0.714545			Accept Normality
Anderson-Darling	0.275278	0.660127			Accept Normality
Martinez-Iglewicz	1.018227		1.390037	1.823783	Accept Normality
Kolmogorov-Smirnov	0.1463726		0.231	0.251	Accept Normality
D'Agostino Skewness	-0.1036	0.917449	1.645	1.960	Accept Normality
D'Agostino Kurtosis	-1.0468	0.295195	1.645	1.960	Accept Normality
D'Agostino Omnibus	1.1065	0.575072	4.605	5.991	Accept Normality

Plots Section of LB



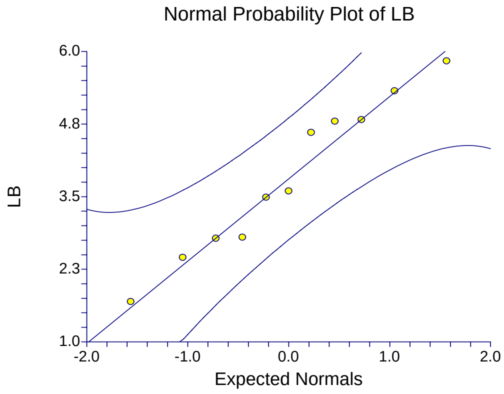


Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 3 8/13/02 11:48:23 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of LB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	5.83816			
95.0	5.83816			
90.0	5.734925			
85.0	5.425221			
80.0	5.123823			
75.0	4.826577	3.489639	5.83816	95.0204
70.0	4.810089	3.489639	5.83816	95.8608
65.0	4.760576	2.801814	5.83816	97.9007
60.0	4.645013	2.783301	5.321987	96.3842
55.0	4.203331	2.783301	5.321987	97.1266
50.0	3.59859	2.45481	4.826577	96.1426
45.0	3.533219	1.693812	4.826577	98.3804
40.0	3.352074	1.693812	4.799097	96.7091
35.0	2.939379	1.693812	4.799097	97.9007
30.0	2.794409	1.693812	4.606492	95.8608
25.0	2.783301	1.693812	4.606492	95.0204
20.0	2.586206			
15.0	2.30261			
10.0	1.846012			
5.0	1.693812			
1.0	1.693812			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LB

```
Depth     Stem   Leaves
1           1. | 6
2           2* | 4
4            . | 78
5           3* | 4
(1)          . | 5
5           4* |
5            . | 678
2           5* | 3
1            . | 8
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time	4 8/13/02 11:48:24 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of PS

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
13	2.929679	1.261076	0.3497596	0.758886	5.09666	4.337774

Counts Section of PS

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	13	18	13	38.08583	130.663	19.08376

Means Section of PS

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	2.929679	3.245938	2.62342	2.257785	38.08583	
Std Error	0.3497596				4.546875	
95% LCL	2.167619	1.746916			28.17904	
95% UCL	3.69174	3.96241			47.99262	
T-Value	8.3763					
Prob Level	0.000002					
Count	13		13	13		

Variation Section of PS

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	1.590313	1.261076	1.287593	0.3497596	2.151377	4.337774
Std Error	0.4542956	0.2547312		7.064974E-02		
95% LCL	0.8177585	0.9043		0.2508077		
95% UCL	4.333486	2.081703		0.5773605		

Skewness and Kurtosis Section of PS

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-6.441444E-02	2.060853	-7.313965E-02	-0.7797883	0.4304485	0.3180306
Std Error	0.4169786	0.3556602			8.122438E-02	

Trimmed Section of PS

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	2.929891	2.933091	2.941117	2.974201	3.008003	3.16473
Trim-Std Dev	1.100911	0.9512092	0.8583814	0.7070594	0.5025095	0.5214295
Count	11.7	10.4	9.1	6.5	3.9	1.3

Mean-Deviation Section of PS

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	1.056635	1.032308	1.467981	-0.1145682	4.441074
Std Error	0.2098346		0.4193498	0.7357668	2.122388

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 5 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

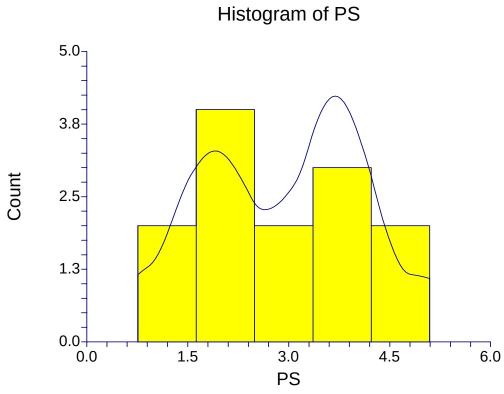
Quartile Section of PS

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.047834	1.786484	3.245938	3.937861	4.767019
95% LCL		0.758886	1.746916	3.245938	
95% UCL		3.245938	3.96241	5.09666	

Normality Test Section of PS

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9755729	0.950753			Accept Normality
Anderson-Darling	0.2011372	0.881755			Accept Normality
Martinez-Iglewicz	0.9801376		1.328902	1.637564	Accept Normality
Kolmogorov-Smirnov	0.1169452		0.215	0.234	Accept Normality
D'Agostino Skewness	-0.1249	0.900628	1.645	1.960	Accept Normality
D'Agostino Kurtosis	-0.6172	0.537092	1.645	1.960	Accept Normality
D'Agostino Omnibus	0.3965	0.820145	4.605	5.991	Accept Normality

Plots Section of PS



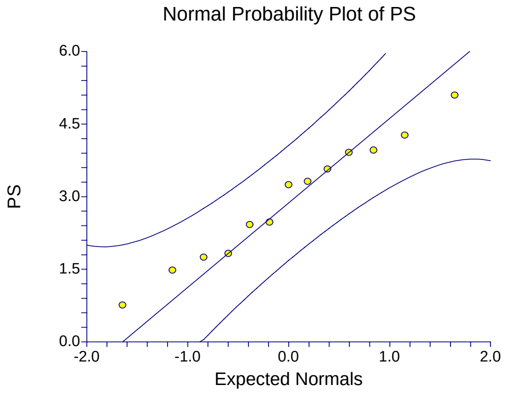


Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 6 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of PS

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	5.09666			
95.0	5.09666			
90.0	4.767019			
85.0	4.241542			
80.0	4.024439			
75.0	3.937861	3.245938	5.09666	95.1953
70.0	3.844789	2.473762	5.09666	97.2088
65.0	3.604954	2.423074	4.272557	95.7848
60.0	3.416866	1.826053	4.272557	97.9582
55.0	3.293802	1.826053	3.96241	95.2750
50.0	3.245938	1.746916	3.96241	97.7539
45.0	2.705415	1.481257	3.913313	97.4754
40.0	2.453487	1.481257	3.570692	95.5290
35.0	2.363372	0.758886	3.314315	95.0102
30.0	1.945457	0.758886	3.314315	97.2088
25.0	1.786484	0.758886	3.245938	95.1953
20.0	1.693784			
15.0	1.507823			
10.0	1.047834			
5.0	0.758886			
1.0	0.758886			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of PS

```
Depth     Stem   Leaves
1            .|  7
2           1*|  4
4            .|  78
6           2*|  44
6            .|
(2)         3*|  23
5            .|  599
2           4*|  2
1            .|
1           5*|  0
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 16 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of All_YP

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
14	8.15096	7.045194	1.882907	1.557206	24.9	23.34279

Counts Section of All_YP

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	14	17	14	114.1134	1575.386	645.2519

Means Section of All_YP

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	8.15096	5.68	6.069	4.639834	114.1134	
Std Error	1.882907				26.3607	
95% LCL	4.083186	3.154507			57.1646	
95% UCL	12.21873	8.85			171.0623	
T-Value	4.3289					
Prob Level	0.000818					
Count	14		14	14		

Variation Section of All_YP

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	49.63476	7.045194	7.181855	1.882907	6.287863	23.34279
Std Error	22.54134	2.262413		0.6046552		
95% LCL	26.08596	5.107441		1.365021		
95% UCL	128.8249	11.35011		3.033444		

Skewness and Kurtosis Section of All_YP

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	1.458749	3.887458	1.639966	1.901927	0.8643392	0.7816503
Std Error	0.6546837	2.455356			0.1034617	

Trimmed Section of All_YP

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	7.586778	6.982154	6.365203	5.901636	5.859188	5.68
Trim-Std Dev	5.977225	4.646457	2.832568	1.370405	0.7792423	0.1496663
Count	12.6	11.2	9.8	7	4.2	1.4

Mean-Deviation Section of All_YP

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	5.123042	4.439774	46.08942	456.4387	8257.874
Std Error	1.130015		20.93125	165.309	3293.39

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time	17 8/13/02 11:48:24 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

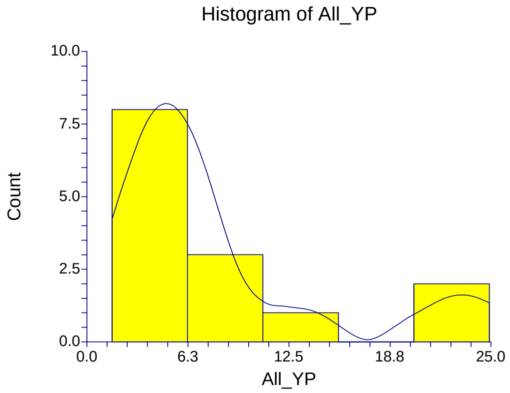
Quartile Section of All_YP

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.848742	3.653421	5.68	9.941284	23.2
95% LCL		1.557206	3.154507	5.6	
95% UCL		5.76	8.85	24.9	

Normality Test Section of All_YP

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.7844409	0.003225			Reject Normality
Anderson-Darling	1.273792	0.002611			Reject Normality
Martinez-Iglewicz	4.319716		1.305415	1.57245	Reject Normality
Kolmogorov-Smirnov	0.2791714		0.208	0.226	Reject Normality
D'Agostino Skewness	2.5821	0.009821	1.645	1.960	Reject Normality
D'Agostino Kurtosis	1.5220	0.128009	1.645	1.960	Accept Normality
D'Agostino Omnibus	8.9835	0.011201	4.605	5.991	Reject Normality

Plots Section of All_YP



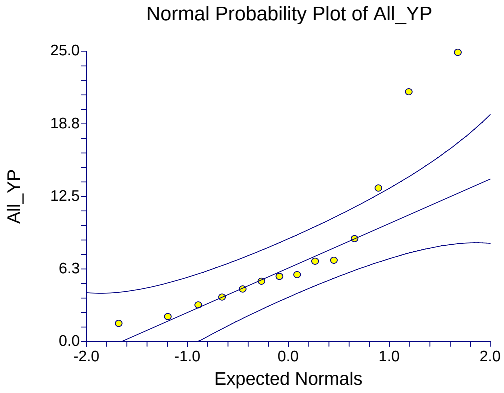


Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 18 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of All_YP

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	24.9			
95.0	24.9			
90.0	23.2			
85.0	19.42878			
80.0	13.21514	5.6	24.9	95.3622
75.0	9.941284	5.6	24.9	97.1873
70.0	7.925	5.186589	24.9	98.4929
65.0	6.9775	5.186589	21.5	95.5137
60.0	6.91	4.52	21.5	97.4393
55.0	6.0475	3.819726	13.21514	97.1563
50.0	5.68	3.154507	8.85	96.4844
45.0	5.496647	3.154507	8.85	97.1563
40.0	5.186589	2.140278	7	97.4393
35.0	4.686647	1.557206	6.91	97.3253
30.0	4.169863	1.557206	5.76	96.1749
25.0	3.653421	1.557206	5.76	97.1873
20.0	3.154507	1.557206	5.76	95.3622
15.0	2.393835			
10.0	1.848742			
5.0	1.557206			
1.0	1.557206			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of All_YP

```
Depth    Stem  Leaves
1          0* | 1
4           T | 233
(4)         F | 4555
6           S | 67
4           . | 8
3          1* |
3           T | 3
High          | 21, 24
```

Unit = 1 Example: 1 |2 Represents 12

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Page/Date/Time 19 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of LN_All_BB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
22	1.258629	0.7505796	0.1600241	-0.2435886	2.564949	2.808538

Counts Section of LN_All_BB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	22	9	22	27.68985	46.68202	11.83076

Means Section of LN_All_BB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	1.258629	1.481127	1.052199	0.8123583	27.68985	
Std Error	0.1600241				3.52053	
95% LCL	0.925841	0.5472702			20.3685	
95% UCL	1.591418	1.61542			35.01119	
T-Value	7.8652					
Prob Level	0.000000					
Count	22		21	22		

Variation Section of LN_All_BB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.5633697	0.7505796	0.7595651	0.1600241	1.184174	2.808538
Std Error	0.1360367	0.1281576		0.0273233		
95% LCL	0.3334594	0.5774594		0.1231148		
95% UCL	1.150528	1.072627		0.2286848		

Skewness and Kurtosis Section of LN_All_BB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.3880854	2.282768	-0.417079	-0.5800606	0.5963467	0.3901615
Std Error	0.3275374	0.5641177			0.1196934	

Trimmed Section of LN_All_BB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.269079	1.279859	1.3051	1.368867	1.425972	1.475878
Trim-Std Dev	0.63741	0.5613422	0.4826191	0.2779101	0.1479486	0.0653934
Count	19.8	17.6	15.4	11	6.6	2.2

Mean-Deviation Section of LN_All_BB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.5996878	0.5778787	0.537762	-0.1530426	0.660149
Std Error	9.619223E-02		0.1298532	0.1142257	0.2390441

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 20 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

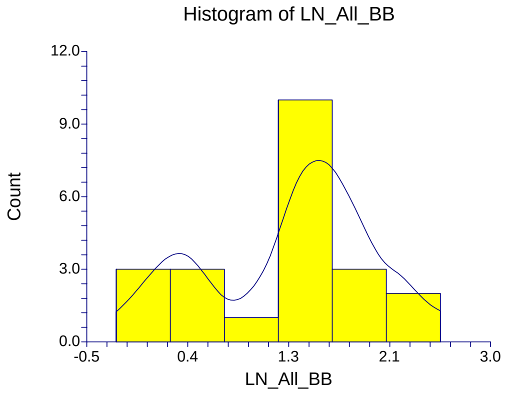
Quartile Section of LN_All_BB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.145408	0.5150002	1.481127	1.699175	2.193264
95% LCL		0.1392218	0.5472702	1.541159	
95% UCL		1.305627	1.61542	2.267994	

Normality Test Section of LN_All_BB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9503977	0.321628			Accept Normality
Anderson-Darling	0.5338745	0.172031			Accept Normality
Martinez-Iglewicz	1.012009		1.19765	1.318967	Accept Normality
Kolmogorov-Smirnov	0.1068083		0.169	0.184	Accept Normality
D'Agostino Skewness	-0.8892	0.373921	1.645	1.960	Accept Normality
D'Agostino Kurtosis	-0.5523	0.580774	1.645	1.960	Accept Normality
D'Agostino Omnibus	1.0956	0.578227	4.605	5.991	Accept Normality

Plots Section of LN_All_BB


Histogram of LN_All_BB

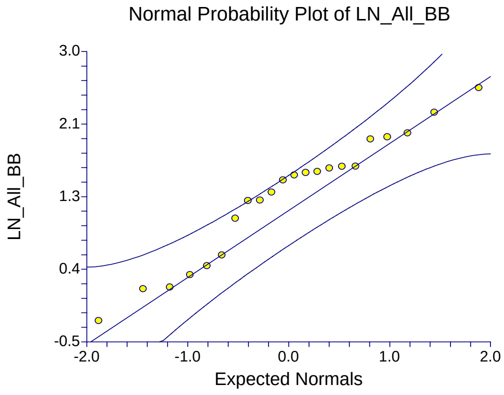

Normal Probability Plot of LN_All_BB

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 21 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of LN_All_BB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	2.564949			
95.0	2.520406			
90.0	2.193264			
85.0	1.997477	1.595339	2.564949	96.0610
80.0	1.955208	1.553925	2.564949	97.2480
75.0	1.699175	1.541159	2.267994	95.5626
70.0	1.615619	1.451532	2.018895	96.5299
65.0	1.593268	1.305627	1.971299	95.7513
60.0	1.551372	1.20896	1.944481	95.1952
55.0	1.530506	1.202972	1.944481	96.7366
50.0	1.481127	0.5472702	1.61542	96.5310
45.0	1.356693	0.4181904	1.595339	96.7366
40.0	1.228294	0.3086891	1.553925	97.0971
35.0	1.203272	0.1598424	1.541159	97.5925
30.0	0.9453141	0.1392218	1.451532	95.7178
25.0	0.5150002	0.1392218	1.305627	95.5626
20.0	0.3743899	-0.2435886	1.20896	97.2480
15.0	0.2268234	-0.2435886	1.202972	96.0610
10.0	0.145408			
5.0	-0.1861671			
1.0	-0.2435886			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_All_BB

```
Depth     Stem  Leaves
1          -0*| 2
5           0*| 1134
7            .| 59
11          1*| 2234
11           .| 55556699
3           2*| 02
1            .| 5
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 7 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of LN_LB

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
11	1.283234	0.3822248	0.1152451	0.5269816	1.764416	1.237434

Counts Section of LN_LB

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	11	20	11	14.11557	19.57453	1.460958

Means Section of LN_LB

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	1.283234	1.280542	1.219679	1.142011	14.11557	
Std Error	0.1152451				1.267696	
95% LCL	1.026452	0.8980494			11.29097	
95% UCL	1.540016	1.574138			16.94017	
T-Value	11.1348					
Prob Level	0.000001					
Count	11		11	11		

Variation Section of LN_LB

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.1460958	0.3822248	0.3918847	0.1152451	0.5504999	1.237434
Std Error	5.073997E-02	9.386773E-02		2.830219E-02		
95% LCL	7.132478E-02	0.267067		8.052373E-02		
95% UCL	0.4499447	0.6707792		0.2022475		

Skewness and Kurtosis Section of LN_LB

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.5463649	2.326837	-0.6367026	-0.2886053	0.2978607	0.239782
Std Error	0.4495891	0.6486849			6.765687E-02	

Trimmed Section of LN_LB

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.298515	1.314453	1.318668	1.328354	1.347761	1.290369
Trim-Std Dev	0.3379959	0.2817048	0.2600905	0.2275031	0.1729961	0.1729055
Count	9.9	8.8	7.7	5.5	3.3	1.1

Mean-Deviation Section of LN_LB

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.3072956	0.3070509	0.1328144	-2.644542E-02	4.104461E-02
Std Error	6.908049E-02		4.612724E-02	2.449028E-02	2.274341E-02

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 8 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

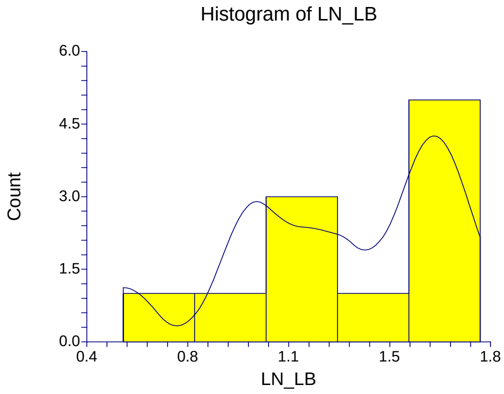
Quartile Section of LN_LB

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.6011952	1.023638	1.280542	1.574138	1.745902
95% LCL		0.5269816	0.8980494	1.249798	
95% UCL		1.527467	1.574138	1.764416	

Normality Test Section of LN_LB

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.937646	0.493232			Accept Normality
Anderson-Darling	0.3259602	0.521272			Accept Normality
Martinez-Iglewicz	1.033918		1.390037	1.823783	Accept Normality
Kolmogorov-Smirnov	0.1095952		0.231	0.251	Accept Normality
D'Agostino Skewness	-0.9920	0.321220	1.645	1.960	Accept Normality
D'Agostino Kurtosis	-0.0456	0.963604	1.645	1.960	Accept Normality
D'Agostino Omnibus	0.9861	0.610775	4.605	5.991	Accept Normality

Plots Section of LN_LB


Histogram of LN_LB

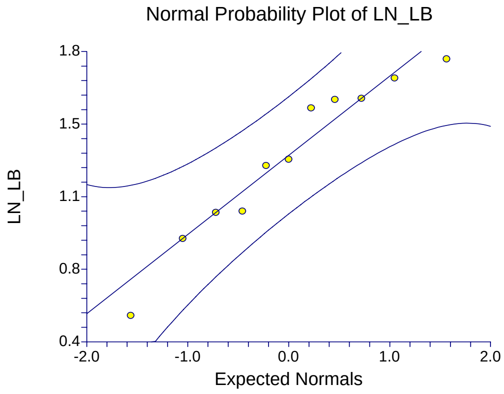

Normal Probability Plot of LN_LB

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 9 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of LN_LB

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	1.764416			
95.0	1.764416			
90.0	1.745902			
85.0	1.690361			
80.0	1.632763			
75.0	1.574138	1.249798	1.764416	95.0204
70.0	1.570712	1.249798	1.764416	95.8608
65.0	1.560236	1.030267	1.764416	97.9007
60.0	1.535659	1.023638	1.671847	96.3842
55.0	1.428697	1.023638	1.671847	97.1266
50.0	1.280542	0.8980494	1.574138	96.1426
45.0	1.262096	0.5269816	1.574138	98.3804
40.0	1.205892	0.5269816	1.568428	96.7091
35.0	1.074173	0.5269816	1.568428	97.9007
30.0	1.027615	0.5269816	1.527467	95.8608
25.0	1.023638	0.5269816	1.527467	95.0204
20.0	0.9482847			
15.0	0.8238358			
10.0	0.6011952			
5.0	0.5269816			
1.0	0.5269816			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_LB

```
Depth      Stem   Leaves
1             F |  5
1             S |
2             . |  8
4            1* |  00
(2)           T |  22
5             F |  555
2             S |  67
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time	10 8/13/02 11:48:24 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of LN_PS

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
13	0.9644787	0.5303746	0.1470995	-0.2759037	1.628585	1.904489

Counts Section of LN_PS

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	13	18	13	12.53822	15.46842	3.375567

Means Section of LN_PS

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	0.9644787	1.177404	0.9859673	1.32121	12.53822	
Std Error	0.1470995				1.912293	
95% LCL	0.6439764	0.557852			8.371695	
95% UCL	1.284981	1.376852			16.70475	
T-Value	6.5566					
Prob Level	0.000027					
Count	13		12	13		

Variation Section of LN_PS

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.2812973	0.5303746	0.541527	0.1470995	0.790614	1.904489
Std Error	0.1167164	0.1556088		4.315811E-02		
95% LCL	0.1446465	0.3803242		0.105483		
95% UCL	0.7665144	0.8755081		0.2428222		

Skewness and Kurtosis Section of LN_PS

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.9394383	3.238083	-1.066689	1.018162	0.5499081	0.3413814
Std Error	0.440395	1.157135			0.1762213	

Trimmed Section of LN_PS

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	0.996494	1.022309	1.03656	1.063707	1.09036	1.148464
Trim-Std Dev	0.440565	0.3560751	0.3166829	0.2555512	0.1734477	0.182999
Count	11.7	10.4	9.1	6.5	3.9	1.3

Mean-Deviation Section of LN_PS

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.4183229	0.401944	0.259659	-0.1243006	0.2183206
Std Error	8.825079E-02		0.1077382	8.491881E-02	0.1345029

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time	11 8/13/02 11:48:24 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Quartile Section of LN_PS

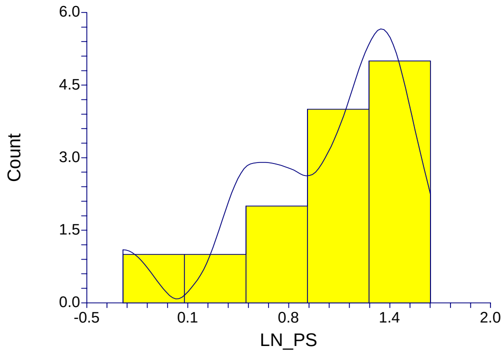
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	-8.385805E-03	0.5800044	1.177404	1.370618	1.558036
95% LCL		-0.2759037	0.557852	1.177404	
95% UCL		1.177404	1.376852	1.628585	

Normality Test Section of LN_PS

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9164348	0.224460			Accept Normality
Anderson-Darling	0.4389729	0.293292			Accept Normality
Martinez-Iglewicz	1.330294		1.328902	1.637564	Accept Normality
Kolmogorov-Smirnov	0.1174988		0.215	0.234	Accept Normality
D'Agostino Skewness	-1.7329	0.083108	1.645	1.960	Accept Normality
D'Agostino Kurtosis	0.9915	0.321448	1.645	1.960	Accept Normality
D'Agostino Omnibus	3.9861	0.136279	4.605	5.991	Accept Normality

Plots Section of LN_PS

Histogram of LN_PS



Normal Probability Plot of LN_PS

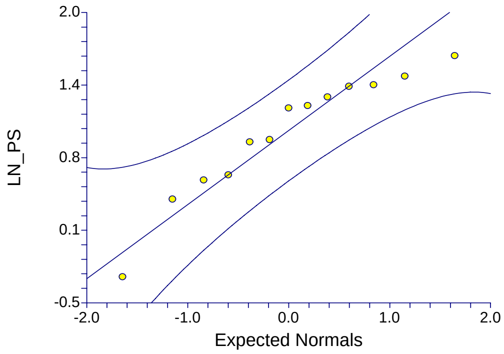


Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 12 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of LN_PS

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	1.628585			
95.0	1.628585			
90.0	1.558036			
85.0	1.444677			
80.0	1.391924			
75.0	1.370618	1.177404	1.628585	95.1953
70.0	1.346059	0.9057401	1.628585	97.2088
65.0	1.281922	0.885037	1.452212	95.7848
60.0	1.228054	0.6021568	1.452212	97.9582
55.0	1.191997	0.6021568	1.376852	95.2750
50.0	1.177404	0.557852	1.376852	97.7539
45.0	0.9872394	0.392891	1.364384	97.4754
40.0	0.8974589	0.392891	1.272759	95.5290
35.0	0.8567489	-0.2759037	1.198251	95.0102
30.0	0.6587328	-0.2759037	1.198251	97.2088
25.0	0.5800044	-0.2759037	1.177404	95.1953
20.0	0.5248598			
15.0	0.4093871			
10.0	-8.385805E-03			
5.0	-0.2759037			
1.0	-0.2759037			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_PS

```
Depth   Stem  Leaves
1        -0* | 2
1         0* |
2          T | 3
3          F | 5
4          S | 6
6          . | 89
(2)       1* | 11
5          T | 233
2          F | 4
1          S | 6
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time 22 8/13/02 11:48:24 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Summary Section of LN_All_YP

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
14	1.803194	0.7882679	0.2106735	0.4428932	3.214868	2.771975

Counts Section of LN_All_YP

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
31	14	17	14	25.24471	53.59887	8.077761

Means Section of LN_All_YP

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	1.803194	1.736852	1.613648	1.382728	25.24471	
Std Error	0.2106735				2.949428	
95% LCL	1.348061	1.148832			18.87286	
95% UCL	2.258326	2.180418			31.61657	
T-Value	8.5592					
Prob Level	0.000001					
Count	14		14	14		

Variation Section of LN_All_YP

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.6213662	0.7882679	0.8035584	0.2106735	0.9883117	2.771975
Std Error	0.2049597	0.1838568		4.913779E-02		
95% LCL	0.3265641	0.5714579		0.1527285		
95% UCL	1.61273	1.269933		0.3394039		

Skewness and Kurtosis Section of LN_All_YP

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	0.2131581	2.523245	0.2396383	-0.1133884	0.437151	0.3332928
Std Error	0.312867	0.7104543			7.996649E-02	

Trimmed Section of LN_All_YP

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.80034	1.790657	1.773974	1.752496	1.761474	1.736852
Trim-Std Dev	0.6814911	0.5564498	0.4040432	0.2303188	0.1300689	2.635144E-02
Count	12.6	11.2	9.8	7	4.2	1.4

Mean-Deviation Section of LN_All_YP

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.5863454	0.5788803	0.5769829	9.342137E-02	0.8400116
Std Error	0.1264343		0.1903197	0.1299284	0.3538316

Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic
Rising Pond

Descriptive Statistics Report

Page/Date/Time	23 8/13/02 11:48:24 AM
Database	L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Quartile Section of LN_All_YP

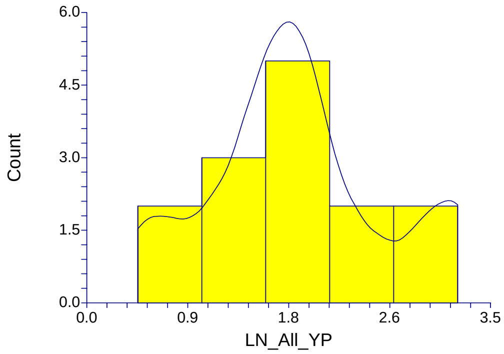
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.6019145	1.292342	1.736852	2.280654	3.14146
95% LCL		0.4428932	1.148832	1.722767	
95% UCL		1.750937	2.180418	3.214868	

Normality Test Section of LN_All_YP

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9709221	0.888747			Accept Normality
Anderson-Darling	0.2173726	0.842360			Accept Normality
Martinez-Iglewicz	1.003277		1.305415	1.57245	Accept Normality
Kolmogorov-Smirnov	0.1424496		0.208	0.226	Accept Normality
D'Agostino Skewness	0.4221	0.672962	1.645	1.960	Accept Normality
D'Agostino Kurtosis	0.1144	0.908890	1.645	1.960	Accept Normality
D'Agostino Omnibus	0.1913	0.908804	4.605	5.991	Accept Normality

Plots Section of LN_All_YP

Histogram of LN_All_YP



Normal Probability Plot of LN_All_YP

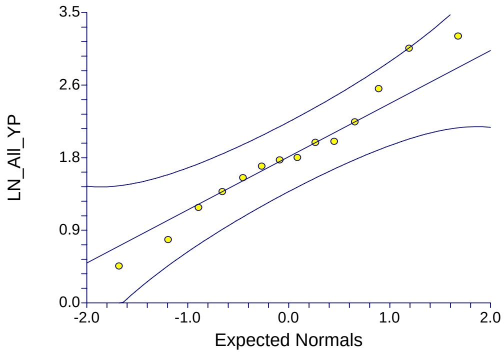


Exhibit C.5-5

Species-Specific Total PCB Shapiro-Wilk Test Statistic Rising Pond

Descriptive Statistics Report

Page/Date/Time 24 8/13/02 11:48:25 AM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Percentile Section of LN_All_YP

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	3.214868			
95.0	3.214868			
90.0	3.14146			
85.0	2.94638			
80.0	2.581363	1.722767	3.214868	95.3622
75.0	2.280654	1.722767	3.214868	97.1873
70.0	2.063164	1.646076	3.214868	98.4929
65.0	1.942675	1.646076	3.068053	95.5137
60.0	1.93297	1.508512	3.068053	97.4393
55.0	1.796445	1.340179	2.581363	97.1563
50.0	1.736852	1.148832	2.180418	96.4844
45.0	1.703594	1.148832	2.180418	97.1563
40.0	1.646076	0.7609357	1.94591	97.4393
35.0	1.542903	0.4428932	1.93297	97.3253
30.0	1.424345	0.4428932	1.750937	96.1749
25.0	1.292342	0.4428932	1.750937	97.1873
20.0	1.148832	0.4428932	1.750937	95.3622
15.0	0.8579099			
10.0	0.6019145			
5.0	0.4428932			
1.0	0.4428932			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_All_YP

```
Depth     Stem  Leaves
1           0* | 4
2            . | 7
4           1* | 13
(6)          . | 567799
4           2* | 1
3            . | 5
2           3* | 02
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 1 7/30/02 8:31:22 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_LB	11	1.283234	0.3822248	0.1152451	1.026452	1.540016
LN_PS	13	0.9644787	0.5303746	0.1470995	0.6439764	1.284981

Note: T-alpha (LN_LB) = 2.2281, T-alpha (LN_PS) = 2.1788

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	22	0.318755	0.4688732	0.1920848	-7.960447E-02	0.7171145
Unequal	21.52	0.318755	0.653753	0.1868681	-6.928532E-02	0.7067953

Note: T-alpha (Equal) = 2.0739, T-alpha (Unequal) = 2.0765

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1.6594	0.111215	Accept Ho	0.354843	0.149490
Difference < 0	1.6594	0.944393	Accept Ho	0.000567	0.000050
Difference > 0	1.6594	0.055607	Accept Ho	0.485366	0.221364

Difference: (LN_LB)-(LN_PS)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1.7058	0.102442	Accept Ho	0.370795	0.159005
Difference < 0	1.7058	0.948779	Accept Ho	0.000485	0.000042
Difference > 0	1.7058	0.051221	Accept Ho	0.502791	0.233790

Difference: (LN_LB)-(LN_PS)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_LB)	-0.9920	0.321220	Cannot reject normality
Kurtosis Normality (LN_LB)	-0.0456	0.963604	Cannot reject normality
Omnibus Normality (LN_LB)	0.9861	0.610775	Cannot reject normality
Skewness Normality (LN_PS)	-1.7329	0.083108	Cannot reject normality
Kurtosis Normality (LN_PS)	0.9915	0.321448	Cannot reject normality
Omnibus Normality (LN_PS)	3.9861	0.136279	Cannot reject normality
Variance-Ratio Equal-Variance Test	1.9254	0.294498	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.5157	0.480218	Cannot reject equal variances

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 2 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
LN_LB	98	164	137.5	17.26026
LN_PS	45	136	162.5	17.26026

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**
Diff<>0	0.133883	Accept Ho	1.5353	0.124706	Accept Ho	1.5064	0.131977	Accept Ho
Diff<0	0.933058	Accept Ho	1.5353	0.937647	Accept Ho	1.5643	0.941125	Accept Ho
Diff>0	0.066942	Accept Ho	1.5353	0.062353	Accept Ho	1.5064	0.065989	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.377622	0.5195	.050	Accept Ho	0.2787
D(1)<D(2)	0.000000	0.5195	.025	Accept Ho	
D(1)>D(2)	0.377622	0.5195	.025	Accept Ho	

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time	3 7/30/02 8:31:24 AM
Database	L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_LB	11	1.283234	0.3822248	0.1152451	1.026452	1.540016
LN_All_BB	22	1.258629	0.7505796	0.1600241	0.925841	1.591418

Note: T-alpha (LN_LB) = 2.2281, T-alpha (LN_All_BB) = 2.0796

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	31	2.460427E-02	0.6548017	0.2418015	-0.4685532	0.5177618
Unequal	30.95	2.460427E-02	0.8422977	0.1972033	-0.3776213	0.4268299

Note: T-alpha (Equal) = 2.0395, T-alpha (Unequal) = 2.0396

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.1018	0.919607	Accept Ho	0.051115	0.010348
Difference < 0	0.1018	0.540196	Accept Ho	0.040544	0.007680
Difference > 0	0.1018	0.459804	Accept Ho	0.061137	0.012910

Difference: (LN_LB)-(LN_All_BB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.1248	0.901516	Accept Ho	0.051677	0.010523
Difference < 0	0.1248	0.549242	Accept Ho	0.038620	0.007226
Difference > 0	0.1248	0.450758	Accept Ho	0.063906	0.013661

Difference: (LN_LB)-(LN_All_BB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_LB)	-0.9920	0.321220	Cannot reject normality
Kurtosis Normality (LN_LB)	-0.0456	0.963604	Cannot reject normality
Omnibus Normality (LN_LB)	0.9861	0.610775	Cannot reject normality
Skewness Normality (LN_All_BB)	-0.8892	0.373921	Cannot reject normality
Kurtosis Normality (LN_All_BB)	-0.5523	0.580774	Cannot reject normality
Omnibus Normality (LN_All_BB)	1.0956	0.578227	Cannot reject normality
Variance-Ratio Equal-Variance Test	3.8562	0.020470	Reject equal variances
Modified-Levene Equal-Variance Test	2.7804	0.105496	Cannot reject equal variances

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 4 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
LN_LB	117	183	187	26.18524
LN_All_BB	125	378	374	26.18524

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			-0.1528	0.878589	Accept Ho	-0.1337	0.893669	Accept Ho
Diff<0			-0.1528	0.439295	Accept Ho	-0.1337	0.446834	Accept Ho
Diff>0			-0.1528	0.560705	Accept Ho	-0.1719	0.568223	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.227273	0.4714	.050	Accept Ho	0.8300
D(1)<D(2)	0.227273	0.4714	.025	Accept Ho	
D(1)>D(2)	0.227273	0.4714	.025	Accept Ho	

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 5 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_LB	11	1.283234	0.3822248	0.1152451	1.026452	1.540016
LN_All_YP	14	1.803194	0.7882679	0.2106735	1.348061	2.258326

Note: T-alpha (LN_LB) = 2.2281, T-alpha (LN_All_YP) = 2.1604

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	23	-0.5199601	0.643993	0.2594722	-1.056719	1.679893E-02
Unequal	19.66	-0.5199601	0.8760491	0.2401348	-1.021435	-1.848545E-02

Note: T-alpha (Equal) = 2.0687, T-alpha (Unequal) = 2.0883

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.0039	0.056995	Accept Ho	0.484120	0.237555
Difference < 0	-2.0039	0.028497	Reject Ho	0.617757	0.330165
Difference > 0	-2.0039	0.971503	Accept Ho	0.000164	0.000012

Difference: (LN_LB)-(LN_All_YP)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.1653	0.042853	Reject Ho	0.539448	0.277460
Difference < 0	-2.1653	0.021427	Reject Ho	0.671834	0.378589
Difference > 0	-2.1653	0.978573	Accept Ho	0.000092	0.000007

Difference: (LN_LB)-(LN_All_YP)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_LB)	-0.9920	0.321220	Cannot reject normality
Kurtosis Normality (LN_LB)	-0.0456	0.963604	Cannot reject normality
Omnibus Normality (LN_LB)	0.9861	0.610775	Cannot reject normality
Skewness Normality (LN_All_YP)	0.4221	0.672962	Cannot reject normality
Kurtosis Normality (LN_All_YP)	0.1144	0.908890	Cannot reject normality
Omnibus Normality (LN_All_YP)	0.1913	0.908804	Cannot reject normality
Variance-Ratio Equal-Variance Test	4.2531	0.022388	Reject equal variances
Modified-Levene Equal-Variance Test	2.7038	0.113709	Cannot reject equal variances

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 6 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
LN_LB	42	108	143	18.26654
LN_All_YP	112	217	182	18.26654

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**
Diff<>0	0.057951	Accept Ho	-1.9161	0.055356	Accept Ho	-1.8887	0.058932	Accept Ho
Diff<0	0.028976	Reject Ho	-1.9161	0.027678	Reject Ho	-1.8887	0.029466	Reject Ho
Diff>0	0.971024	Accept Ho	-1.9161	0.972322	Accept Ho	-1.9434	0.974019	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.480519	0.5116	.050	Accept Ho	0.0802
D(1)<D(2)	0.480519	0.5116	.025	Accept Ho	
D(1)>D(2)	0.071429	0.5116	.025	Accept Ho	

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 7 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_PS	13	0.9644787	0.5303746	0.1470995	0.6439764	1.284981
LN_All_BB	22	1.258629	0.7505796	0.1600241	0.925841	1.591418

Note: T-alpha (LN_PS) = 2.1788, T-alpha (LN_All_BB) = 2.0796

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	33	-0.2941507	0.678821	0.2374686	-0.7772843	0.1889828
Unequal	31.78	-0.2941507	0.9190577	0.2173614	-0.737023	0.1487215

Note: T-alpha (Equal) = 2.0345, T-alpha (Unequal) = 2.0375

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1.2387	0.224198	Accept Ho	0.225263	0.081113
Difference < 0	-1.2387	0.112099	Accept Ho	0.333032	0.127606
Difference > 0	-1.2387	0.887901	Accept Ho	0.002127	0.000219

Difference: (LN_PS)-(LN_All_BB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1.3533	0.185515	Accept Ho	0.259214	0.098257
Difference < 0	-1.3533	0.092758	Accept Ho	0.374327	0.151509
Difference > 0	-1.3533	0.907242	Accept Ho	0.001489	0.000145

Difference: (LN_PS)-(LN_All_BB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_PS)	-1.7329	0.083108	Cannot reject normality
Kurtosis Normality (LN_PS)	0.9915	0.321448	Cannot reject normality
Omnibus Normality (LN_PS)	3.9861	0.136279	Cannot reject normality
Skewness Normality (LN_All_BB)	-0.8892	0.373921	Cannot reject normality
Kurtosis Normality (LN_All_BB)	-0.5523	0.580774	Cannot reject normality
Omnibus Normality (LN_All_BB)	1.0956	0.578227	Cannot reject normality
Variance-Ratio Equal-Variance Test	2.0028	0.186739	Cannot reject equal variances
Modified-Levene Equal-Variance Test	1.1222	0.297138	Cannot reject equal variances

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 8 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
LN_PS	99	190	234	29.29164
LN_All_BB	187	440	396	29.29164

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			-1.5021	0.133062	Accept Ho	-1.4851	0.137526	Accept Ho
Diff<0			-1.5021	0.066531	Accept Ho	-1.4851	0.068763	Accept Ho
Diff>0			-1.5021	0.933469	Accept Ho	-1.5192	0.935645	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.423077	0.4481	.050	Accept Ho	0.0736
D(1)<D(2)	0.423077	0.4481	.025	Accept Ho	
D(1)>D(2)	0.118881	0.4481	.025	Accept Ho	

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time 9 7/30/02 8:31:24 AM
Database L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_PS	13	0.9644787	0.5303746	0.1470995	0.6439764	1.284981
LN_All_YP	14	1.803194	0.7882679	0.2106735	1.348061	2.258326

Note: T-alpha (LN_PS) = 2.1788, T-alpha (LN_All_YP) = 2.1604

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	25	-0.8387151	0.6768553	0.2607006	-1.375638	-0.3017922
Unequal	22.88	-0.8387151	0.9500861	0.2569466	-1.37041	-0.3070204

Note: T-alpha (Equal) = 2.0595, T-alpha (Unequal) = 2.0693

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-3.2172	0.003563	Reject Ho	0.871059	0.665249
Difference < 0	-3.2172	0.001781	Reject Ho	0.931015	0.762630
Difference > 0	-3.2172	0.998219	Accept Ho	0.000001	0.000000

Difference: (LN_PS)-(LN_All_YP)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-3.2642	0.003428	Reject Ho	0.877877	0.673758
Difference < 0	-3.2642	0.001714	Reject Ho	0.935805	0.771068
Difference > 0	-3.2642	0.998286	Accept Ho	0.000001	0.000000

Difference: (LN_PS)-(LN_All_YP)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_PS)	-1.7329	0.083108	Cannot reject normality
Kurtosis Normality (LN_PS)	0.9915	0.321448	Cannot reject normality
Omnibus Normality (LN_PS)	3.9861	0.136279	Cannot reject normality
Skewness Normality (LN_All_YP)	0.4221	0.672962	Cannot reject normality
Kurtosis Normality (LN_All_YP)	0.1144	0.908890	Cannot reject normality
Omnibus Normality (LN_All_YP)	0.1913	0.908804	Cannot reject normality
Variance-Ratio Equal-Variance Test	2.2089	0.175395	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.9931	0.328546	Cannot reject equal variances

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

```
                                   Two-Sample Test Report
Page/Date/Time     10    7/30/02 8:31:24 AM
Database           L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

                           Mann         W            Mean         Std Dev
Variable                   Whitney U    Sum Ranks    of W         of W
LN_PS                      32           123          182          20.60744
LN_All_YP                  150          255          196          20.60744
Number Sets of Ties = 0,   Multiplicity Factor = 0

              Exact Probability         Approximation Without Correction Approximation With Correction
Alternative   Prob        Decision                  Prob        Decision                  Prob        Decision
Hypothesis    Level       (5%)         Z-Value      Level       (5%)         Z-Value      Level       (5%)
Diff<>0       0.003303    Reject Ho    -2.8630      0.004196    Reject Ho    -2.8388      0.004529    Reject Ho
Diff<0        0.001652    Reject Ho    -2.8630      0.002098    Reject Ho    -2.8388      0.002264    Reject Ho
Diff>0        0.998348    Accept Ho    -2.8630      0.997902    Accept Ho    -2.8873      0.998057    Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative   Dmn               Reject Ho if      Test Alpha        Decision          Prob
Hypothesis    Criterion Value   Greater Than      Level             (Test Alpha)      Level
D(1)<>D(2)    0.642857          0.4908            .050              Reject Ho         0.0023
D(1)<D(2)     0.642857          0.4908            .025              Reject Ho
D(1)>D(2)     0.000000          0.4908            .025              Accept Ho
```

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

Two-Sample Test Report

Page/Date/Time	11 7/30/02 8:31:24 AM
Database	L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_All_BB	22	1.258629	0.7505796	0.1600241	0.925841	1.591418
LN_All_YP	14	1.803194	0.7882679	0.2106735	1.348061	2.258326

Note: T-alpha (LN_All_BB) = 2.0796, T-alpha (LN_All_YP) = 2.1604

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	34	-0.5445644	0.765209	0.261611	-1.076222	-1.290691E-02
Unequal	26.80	-0.5445644	1.088456	0.2645581	-1.087578	-1.55097E-03

Note: T-alpha (Equal) = 2.0322, T-alpha (Unequal) = 2.0525

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.0816	0.044980	Reject Ho	0.525010	0.275954
Difference < 0	-2.0816	0.022490	Reject Ho	0.653588	0.371715
Difference > 0	-2.0816	0.977510	Accept Ho	0.000114	0.000007

Difference: (LN_All_BB)-(LN_All_YP)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.0584	0.049394	Reject Ho	0.509792	0.260024
Difference < 0	-2.0584	0.024697	Reject Ho	0.641009	0.355200
Difference > 0	-2.0584	0.975303	Accept Ho	0.000130	0.000009

Difference: (LN_All_BB)-(LN_All_YP)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_All_BB)	-0.8892	0.373921	Cannot reject normality
Kurtosis Normality (LN_All_BB)	-0.5523	0.580774	Cannot reject normality
Omnibus Normality (LN_All_BB)	1.0956	0.578227	Cannot reject normality
Skewness Normality (LN_All_YP)	0.4221	0.672962	Cannot reject normality
Kurtosis Normality (LN_All_YP)	0.1144	0.908890	Cannot reject normality
Omnibus Normality (LN_All_YP)	0.1913	0.908804	Cannot reject normality
Variance-Ratio Equal-Variance Test	1.1029	0.846799	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.0000	0.995495	Cannot reject equal variances

Exhibit C.5-6

Species-Specific Total PCB t-Tests
Rising Pond

```
                                        Two-Sample Test Report
Page/Date/Time    12    7/30/02 8:31:24 AM
Database          L:\GEPITTS - FISH INGESTION\FISH CONCENTRATIONS\NCSS\RP PCBS.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

                          Mann         W            Mean         Std Dev
Variable                  Whitney U    Sum Ranks    of W         of W
LN_All_BB                 97           350          407          30.81666
LN_All_YP                 211          316          259          30.81666
Number Sets of Ties = 0,   Multiplicity Factor = 0

             Exact Probability         Approximation Without Correction    Approximation With Correction
Alternative  Prob        Decision                 Prob        Decision                 Prob        Decision
Hypothesis   Level       (5%)          Z-Value    Level       (5%)         Z-Value    Level       (5%)
Diff<>0                                1.8496     0.064364    Accept Ho    1.8334     0.066740    Accept Ho
Diff<0                                 1.8496     0.032182    Reject Ho    1.8334     0.033370    Reject Ho
Diff>0                                 1.8496     0.967818    Accept Ho    1.8659     0.968970    Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative    Dmn               Reject Ho if     Test Alpha     Decision        Prob
Hypothesis     Criterion Value   Greater Than     Level          (Test Alpha)    Level
D(1)<>D(2)     0.415584          0.4385           .050           Accept Ho       0.0754
D(1)<D(2)      0.415584          0.4385           .025           Accept Ho
D(1)>D(2)      0.000000          0.4385           .025           Accept Ho
```

Exhibit C.5-7

Total PCB by Species Box Plot
Rising Pond

Page/Date/Time 1 8/13/02 12:08:16 PM
Database L:\GEPitts - Fish Ingestion\Fish Concentrations\NCSS\RP PCBs.S0

Box Plot Section

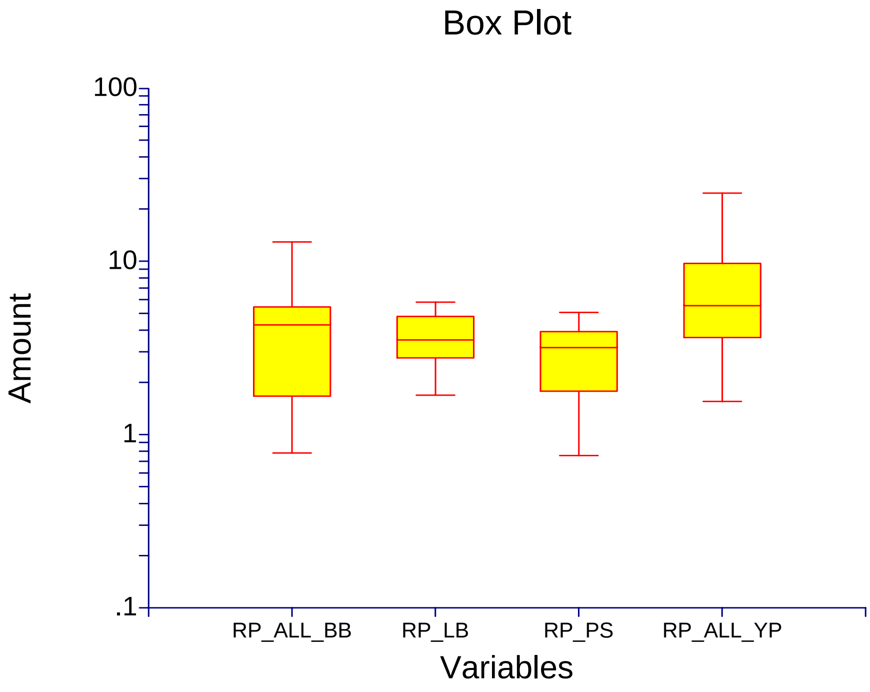


Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time	1 3/31/03 8:53:31 AM
Database	L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Summary Section of SMB_C_98_2000

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
20	0.97465	0.5088544	0.1137833	0.259	1.9	1.641

Counts Section of SMB_C_98_2000

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
60	20	40	20	19.493	23.91858	4.919723

Means Section of SMB_C_98_2000

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	0.97465	0.8	0.837939	0.704231	19.493	
Std Error	0.1137833				2.275666	
95% LCL	0.7364988	0.569			14.72998	
95% UCL	1.212801	1.32			24.25602	
T-Value	8.5658					
Prob Level	0.000000					
Count	20		20	20		

Variation Section of SMB_C_98_2000

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.2589328	0.5088544	0.515591	0.1137833	0.88625	1.641
Std Error	5.012525E-02	6.965432E-02		1.557518E-02		
95% LCL	0.1497526	0.3869789		0.0865311		
95% UCL	0.5523733	0.7432182		0.1661887		

Skewness and Kurtosis Section of SMB_C_98_2000

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	0.2787005	1.749496	0.3018263	-1.258011	0.5220893	0.5441875
Std Error	0.3590095	0.3161702			6.442041E-02	

Trimmed Section of SMB_C_98_2000

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	0.963	0.9565	0.9524286	0.9195	0.8916667	0.8
Trim-Std Dev	0.4568982	0.4166788	0.3716917	0.2933391	0.234812	4.242641E-02
Count	18	16	14	10	6	2

Mean-Deviation Section of SMB_C_98_2000

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.449815	0.43535	0.2459861	3.400194E-02	0.1058605
Std Error	6.837708E-02		4.761899E-02	4.260147E-02	3.447154E-02

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time	2 3/31/03 8:53:32 AM
Database	L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

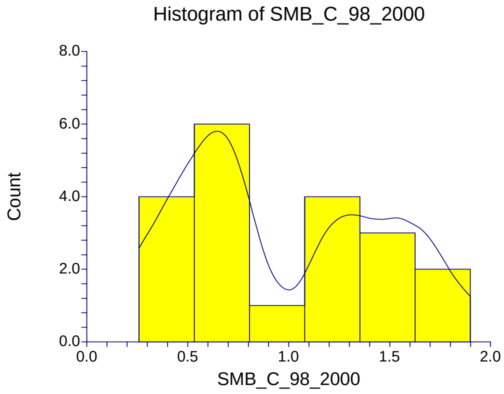
Quartile Section of SMB_C_98_2000

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.332	0.57625	0.8	1.4625	1.692
95% LCL		0.259	0.569	0.83	
95% UCL		0.73	1.32	1.7	

Normality Test Section of SMB_C_98_2000

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9317454	0.166825			Accept Normality
Anderson-Darling	0.5459419	0.160462			Accept Normality
Martinez-Iglewicz	0.9930949		1.216194	1.357297	Accept Normality
Kolmogorov-Smirnov	0.1618967		0.176	0.192	Accept Normality
D'Agostino Skewness	0.6217	0.534145	1.645	1.960	Accept Normality
D'Agostino Kurtosis	-1.8515	0.064093	1.645	1.960	Accept Normality
D'Agostino Omnibus	3.8147	0.148476	4.605	5.991	Accept Normality

Plots Section of SMB_C_98_2000


Histogram of SMB_C_98_2000

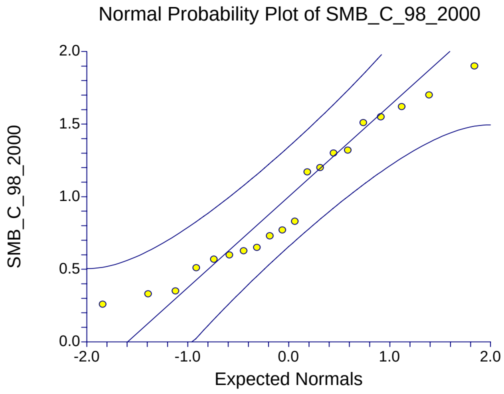

Normal Probability Plot of SMB_C_98_2000

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 3 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Percentile Section of SMB_C_98_2000

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	1.9			
95.0	1.89			
90.0	1.692			
85.0	1.6095	1.2	1.9	95.5319
80.0	1.542	1.2	1.9	95.6328
75.0	1.4625	0.83	1.7	96.1823
70.0	1.314	0.77	1.7	97.5218
65.0	1.265	0.73	1.62	96.8303
60.0	1.188	0.65	1.55	96.3010
55.0	1.017	0.598	1.51	97.4703
50.0	0.8	0.569	1.32	97.3396
45.0	0.748	0.569	1.3	95.9722
40.0	0.682	0.35	1.2	97.5360
35.0	0.63505	0.35	1.17	96.8303
30.0	0.6067	0.33	0.83	97.5218
25.0	0.57625	0.259	0.73	95.5904
20.0	0.5218	0.259	0.65	95.6328
15.0	0.374	0.259	0.65	95.5319
10.0	0.332			
5.0	0.26255			
1.0	0.259			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of SMB_C_98_2000

```
Depth     Stem  Leaves
3            T|  233
6            F|  555
10           S|  6677
10           .|  8
9           1*|  1
8            T|  233
5            F|  55
3            S|  67
1            .|  9
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 4 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Summary Section of SMB_BB_98_2000

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
20	0.96055	0.3887587	8.692908E-02	0.36	1.99	1.63

Counts Section of SMB_BB_98_2000

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
60	20	40	18	19.211	21.32466	2.871533

Means Section of SMB_BB_98_2000

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	0.96055	0.831	0.8911344	0.8252732	19.211	
Std Error	8.692908E-02				1.738582	
95% LCL	0.7786053	0.654			15.57211	
95% UCL	1.142495	1.1			22.84989	
T-Value	11.0498					
Prob Level	0.000000					
Count	20		20	20		

Variation Section of SMB_BB_98_2000

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.1511333	0.3887587	0.3939053	8.692908E-02	0.57475	1.63
Std Error	5.435031E-02	9.885687E-02		2.210507E-02		
95% LCL	8.740729E-02	0.2956472		6.610873E-02		
95% UCL	0.3224081	0.5678099		0.1269661		

Skewness and Kurtosis Section of SMB_BB_98_2000

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	0.9196979	3.586506	0.9960119	1.137307	0.4047251	0.3555355
Std Error	0.4141943	1.032533			5.999215E-02	

Trimmed Section of SMB_BB_98_2000

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	0.9367222	0.9250625	0.9132143	0.8881	0.8738334	0.831
Trim-Std Dev	0.2911322	0.2555398	0.2191414	0.1423263	0.1169588	5.515433E-02
Count	18	16	14	10	6	2

Mean-Deviation Section of SMB_BB_98_2000

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.304505	0.29545	0.1435767	5.003466E-02	7.393315E-02
Std Error	5.223927E-02		5.163279E-02	3.505895E-02	4.589576E-02

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 5 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

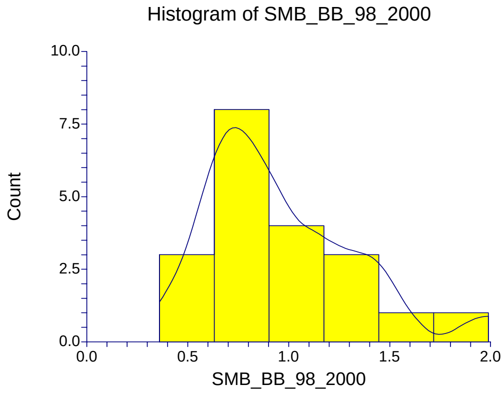
Quartile Section of SMB_BB_98_2000

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.5636	0.67525	0.831	1.25	1.492
95% LCL		0.36	0.654	0.87	
95% UCL		0.78	1.1	1.5	

Normality Test Section of SMB_BB_98_2000

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9335024	0.180299			Accept Normality
Anderson-Darling	0.5091571	0.198149			Accept Normality
Martinez-Iglewicz	1.263088		1.216194	1.357297	Accept Normality
Kolmogorov-Smirnov	0.1676958		0.176	0.192	Accept Normality
D'Agostino Skewness	1.9224	0.054549	1.645	1.960	Accept Normality
D'Agostino Kurtosis	1.2119	0.225551	1.645	1.960	Accept Normality
D'Agostino Omnibus	5.1645	0.075604	4.605	5.991	Accept Normality

Plots Section of SMB_BB_98_2000



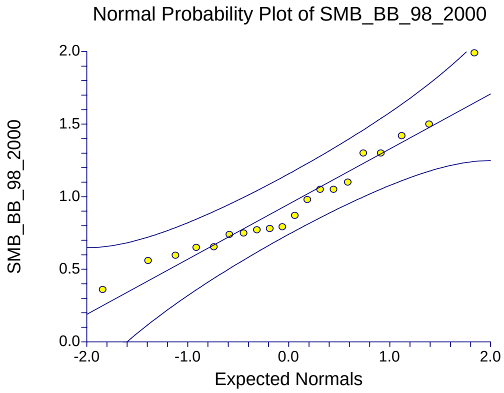


Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 6 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Percentile Section of SMB_BB_98_2000

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	1.99			
95.0	1.9655			
90.0	1.492			
85.0	1.402	1.05	1.99	95.5319
80.0	1.3	1.05	1.99	95.6328
75.0	1.25	0.87	1.5	96.1823
70.0	1.085	0.792	1.5	97.5218
65.0	1.05	0.78	1.42	96.8303
60.0	1.022	0.771	1.3	96.3010
55.0	0.9305	0.739	1.3	97.4703
50.0	0.831	0.654	1.1	97.3396
45.0	0.7854	0.654	1.05	95.9722
40.0	0.7746	0.596	1.05	97.5360
35.0	0.7567	0.596	0.98	96.8303
30.0	0.742	0.56	0.87	97.5218
25.0	0.67525	0.36	0.78	95.5904
20.0	0.6508	0.36	0.771	95.6328
15.0	0.6041	0.36	0.771	95.5319
10.0	0.5636			
5.0	0.37			
1.0	0.36			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of SMB_BB_98_2000

Depth	Stem	Leaves
1	T |	3
3	F |	55
10	S |	6677777
10	. |	89
8	1* |	001
5	T |	33
3	F |	45
High	|	19

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 7 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Summary Section of SMB_LL_98_2000

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
20	0.67145	0.3200631	7.156828E-02	0.225	1.3	1.075

Counts Section of SMB_LL_98_2000

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
60	20	40	19	13.429	10.96327	1.946367

Means Section of SMB_LL_98_2000

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	0.67145	0.688	0.5937761	0.5181373	13.429	0.93
Std Error	7.156828E-02				1.431365	
95% LCL	0.5216559	0.361			10.43312	
95% UCL	0.8212441	0.93			16.42488	
T-Value	9.3820					
Prob Level	0.000000					
Count	20		20	20		2

Variation Section of SMB_LL_98_2000

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.1024404	0.3200631	0.3243003	7.156828E-02	0.56275	1.075
Std Error	2.217746E-02	4.899608E-02		1.095586E-02		
95% LCL	5.924594E-02	0.2434049		5.442699E-02		
95% UCL	0.2185329	0.467475		0.1045306		

Skewness and Kurtosis Section of SMB_LL_98_2000

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	0.2564512	1.937371	0.2777309	-1.013036	0.4766745	0.3923692
Std Error	0.3419816	0.2972105			6.132745E-02	

Trimmed Section of SMB_LL_98_2000

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	0.6613333	0.65525	0.6552857	0.6558	0.6538333	0.688
Trim-Std Dev	0.2818147	0.2478713	0.2337574	0.1997392	0.1307921	2.545584E-02
Count	18	16	14	10	6	2

Mean-Deviation Section of SMB_LL_98_2000

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.26995	0.26995	9.731834E-02	7.785686E-03	1.834857E-02
Std Error	4.300833E-02		2.106859E-02	1.094574E-02	7.223375E-03

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time	8 3/31/03 8:53:33 AM
Database	L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

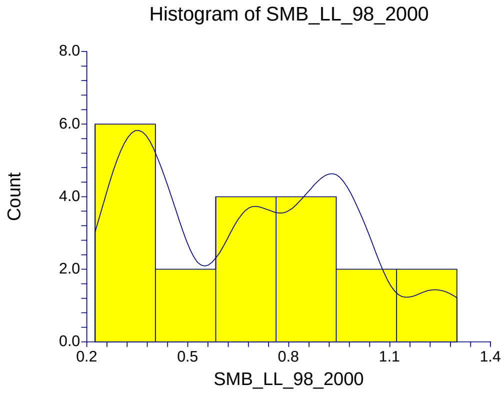
Quartile Section of SMB_LL_98_2000

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.258	0.36725	0.688	0.93	1.151
95% LCL		0.225	0.361	0.706	
95% UCL		0.61	0.93	1.17	

Normality Test Section of SMB_LL_98_2000

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9375544	0.215488			Accept Normality
Anderson-Darling	0.4932155	0.216867			Accept Normality
Martinez-Iglewicz	0.9791771		1.216194	1.357297	Accept Normality
Kolmogorov-Smirnov	0.1848712		0.176	0.192	Accept Normality
D'Agostino Skewness	0.5727	0.566830	1.645	1.960	Accept Normality
D'Agostino Kurtosis	-1.2843	0.199032	1.645	1.960	Accept Normality
D'Agostino Omnibus	1.9775	0.372046	4.605	5.991	Accept Normality

Plots Section of SMB_LL_98_2000



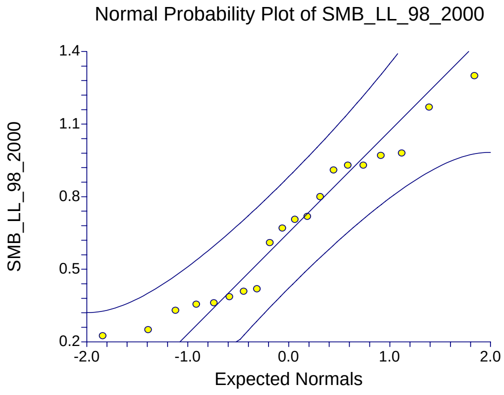


Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 9 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Percentile Section of SMB_LL_98_2000

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	1.3			
95.0	1.2935			
90.0	1.151			
85.0	0.9785	0.8	1.3	95.5319
80.0	0.962	0.8	1.3	95.6328
75.0	0.93	0.706	1.17	96.1823
70.0	0.924	0.67	1.17	97.5218
65.0	0.8715	0.61	0.98	96.8303
60.0	0.7672	0.419	0.97	96.3010
55.0	0.7126	0.386	0.93	97.4703
50.0	0.688	0.361	0.93	97.3396
45.0	0.637	0.361	0.91	95.9722
40.0	0.4954	0.33	0.8	97.5360
35.0	0.4125	0.33	0.718	96.8303
30.0	0.3929	0.25	0.706	97.5218
25.0	0.36725	0.225	0.61	95.5904
20.0	0.3562	0.225	0.419	95.6328
15.0	0.33375	0.225	0.419	95.5319
10.0	0.258			
5.0	0.22625			
1.0	0.225			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of SMB_LL_98_2000

Depth	Stem	Leaves
2	2 |	25
6	3 |	3568
8	4 |	01
8	5 |	
10	6 |	17
10	7 |	01
8	8 |	0
7	9 |	13378
2	10 |	
2	11 |	7
1	12 |	
1	13 |	0

Unit = .01 Example: 1 |2 Represents 0.12

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 10 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Summary Section of SMB_LZ_98_2000

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
20	0.5989	0.617094	0.1379864	0.112	2.9	2.788

Counts Section of SMB_LZ_98_2000

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
60	20	40	20	11.978	14.40892	7.235296

Means Section of SMB_LZ_98_2000

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	0.5989	0.451	0.4335577	0.333528	11.978	
Std Error	0.1379864				2.759728	
95% LCL	0.3100911	0.223			6.201822	
95% UCL	0.8877089	0.71			17.75418	
T-Value	4.3403					
Prob Level	0.000353					
Count	20		20	20		

Variation Section of SMB_LZ_98_2000

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.380805	0.617094	0.6252636	0.1379864	0.504	2.788
Std Error	0.2677213	0.3067726		6.859643E-02		
95% LCL	0.2202369	0.4692941		0.1049373		
95% UCL	0.8123598	0.90131		0.2015391		

Skewness and Kurtosis Section of SMB_LZ_98_2000

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	2.766275	10.88531	2.995813	10.65438	1.030379	0.7725055
Std Error	0.8508512	7.242428			0.1930118	

Trimmed Section of SMB_LZ_98_2000

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	0.4981111	0.4695625	0.4635	0.4525	0.4513333	0.451
Trim-Std Dev	0.2990487	0.2228817	0.2035794	0.1626716	9.026775E-02	2.687006E-02
Count	18	16	14	10	6	2

Mean-Deviation Section of SMB_LZ_98_2000

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.37127	0.3484	0.3617648	0.6019145	1.424602
Std Error	8.292173E-02		0.2543352	0.4691712	1.09139

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 11 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

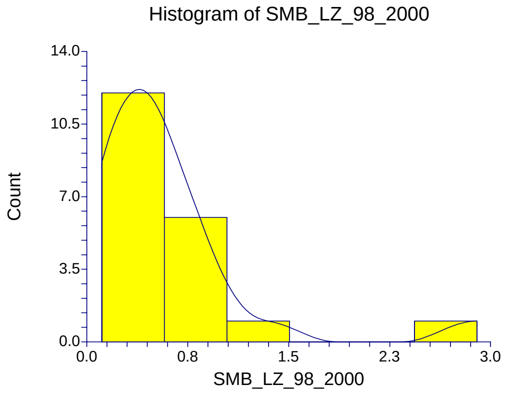
Quartile Section of SMB_LZ_98_2000

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.1571	0.22475	0.451	0.72875	1.253
95% LCL		0.112	0.223	0.47	
95% UCL		0.36	0.71	1.3	

Normality Test Section of SMB_LZ_98_2000

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.6605026	0.000013			Reject Normality
Anderson-Darling	2.043263	0.000034			Reject Normality
Martinez-Iglewicz	4.658338		1.216194	1.357297	Reject Normality
Kolmogorov-Smirnov	0.2540172		0.176	0.192	Reject Normality
D'Agostino Skewness	4.3623	0.000013	1.645	1.960	Reject Normality
D'Agostino Kurtosis	3.8646	0.000111	1.645	1.960	Reject Normality
D'Agostino Omnibus	33.9653	0.000000	4.605	5.991	Reject Normality

Plots Section of SMB_LZ_98_2000


Histogram of SMB_LZ_98_2000

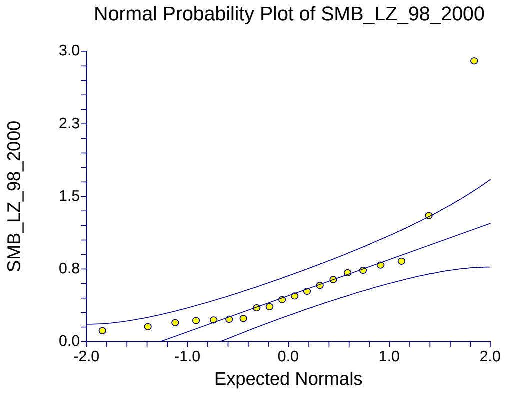

Normal Probability Plot of SMB_LZ_98_2000

Exhibit C.5-8

Smallmouth Bass Location-Specific tPCB Shapiro-Wilk Test Statistic Connecticut

Descriptive Statistics Report

Page/Date/Time 12 3/31/03 8:53:33 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Percentile Section of SMB_LZ_98_2000

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	2.9			
95.0	2.82			
90.0	1.253			
85.0	0.824	0.58	2.9	95.5319
80.0	0.779	0.58	2.9	95.6328
75.0	0.72875	0.47	1.3	96.1823
70.0	0.689	0.432	1.3	97.5218
65.0	0.619	0.36	0.83	96.8303
60.0	0.5552	0.348	0.79	96.3010
55.0	0.4964	0.23	0.735	97.4703
50.0	0.451	0.223	0.71	97.3396
45.0	0.3924	0.223	0.64	95.9722
40.0	0.3528	0.194	0.58	97.5360
35.0	0.27585	0.194	0.518	96.8303
30.0	0.2321	0.153	0.47	97.5218
25.0	0.22475	0.112	0.36	95.5904
20.0	0.2174	0.112	0.348	95.6328
15.0	0.1973	0.112	0.348	95.5319
10.0	0.1571			
5.0	0.11405			
1.0	0.112			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of SMB_LZ_98_2000

```
Depth      Stem  Leaves
3            0* |  111
9             T |  222233
(4)           F |  4455
7             S |  6777
3             . |  8
2            1* |
2             T |  3
High            |  29
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests
Connecticut

Two-Sample Test Report

Page/Date/Time 1 12/27/02 11:09:35 AM
Database L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
SMB_C_98_2000	20	0.97465	0.5088544	0.1137833	0.7364988	1.212801
SMB_BB_98_2000	20	0.96055	0.3887587	8.692908E-02	0.7786053	1.142495

Note: T-alpha (SMB_C_98_2000) = 2.0930, T-alpha (SMB_BB_98_2000) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	38	0.0141	0.4528057	0.1431897	-0.2757725	0.3039725
Unequal	35.54	0.0141	0.640364	0.1431897	-0.2764318	0.3046318

Note: T-alpha (Equal) = 2.0244, T-alpha (Unequal) = 2.0290

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.0985	0.922076	Accept Ho	0.051057	0.010332
Difference < 0	0.0985	0.538962	Accept Ho	0.040790	0.007730
Difference > 0	0.0985	0.461038	Accept Ho	0.060796	0.012830

Difference: (SMB_C_98_2000)-(SMB_BB_98_2000)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.0985	0.922112	Accept Ho	0.051053	0.010330
Difference < 0	0.0985	0.538944	Accept Ho	0.040801	0.007735
Difference > 0	0.0985	0.461056	Accept Ho	0.060782	0.012823

Difference: (SMB_C_98_2000)-(SMB_BB_98_2000)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (SMB_C_98_2000)	0.6217	0.534145	Cannot reject normality
Kurtosis Normality (SMB_C_98_2000)	-1.8515	0.064093	Cannot reject normality
Omnibus Normality (SMB_C_98_2000)	3.8147	0.148476	Cannot reject normality
Skewness Normality (SMB_BB_98_2000)	1.9224	0.054549	Cannot reject normality
Kurtosis Normality (SMB_BB_98_2000)	1.2119	0.225551	Cannot reject normality
Omnibus Normality (SMB_BB_98_2000)	5.1645	0.075604	Cannot reject normality
Variance-Ratio Equal-Variance Test	1.7133	0.249606	Cannot reject equal variances
Modified-Levene Equal-Variance Test	2.3238	0.135691	Cannot reject equal variances

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests Connecticut

Two-Sample Test Report

Page/Date/Time	2 12/27/02 11:09:35 AM
Database	L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
SMB_C_98_2000	192.5	402.5	410	36.95805
SMB_BB_98_2000	207.5	417.5	410	36.95805

Number Sets of Ties = 3, Multiplicity Factor = 36

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			-0.2029	0.839188	Accept Ho	-0.1894	0.849776	Accept Ho
Diff<0			-0.2029	0.419594	Accept Ho	-0.1894	0.424888	Accept Ho
Diff>0			-0.2029	0.580406	Accept Ho	-0.2165	0.585686	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.200000	0.4071	.050	Accept Ho	0.8320
D(1)<D(2)	0.200000	0.4071	.025	Accept Ho	
D(1)>D(2)	0.200000	0.4071	.025	Accept Ho	

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests
Connecticut

Two-Sample Test Report

Page/Date/Time 3 12/27/02 11:09:36 AM
Database L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
SMB_C_98_2000	20	0.97465	0.5088544	0.1137833	0.7364988	1.212801
SMB_LL_98_2000	20	0.67145	0.3200631	7.156828E-02	0.5216559	0.8212441

Note: T-alpha (SMB_C_98_2000) = 2.0930, T-alpha (SMB_LL_98_2000) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	38	0.3032	0.4250724	0.1344197	3.108154E-02	0.5753185
Unequal	32.00	0.3032	0.6011432	0.1344197	2.939574E-02	0.5770043

Note: T-alpha (Equal) = 2.0244, T-alpha (Unequal) = 2.0369

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.2556	0.029933	Reject Ho	0.594236	0.337941
Difference < 0	2.2556	0.985033	Accept Ho	0.000056	0.000003
Difference > 0	2.2556	0.014967	Reject Ho	0.715768	0.440013

Difference: (SMB_C_98_2000)-(SMB_LL_98_2000)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.2556	0.031064	Reject Ho	0.590053	0.331317
Difference < 0	2.2556	0.984468	Accept Ho	0.000058	0.000004
Difference > 0	2.2556	0.015532	Reject Ho	0.713169	0.434106

Difference: (SMB_C_98_2000)-(SMB_LL_98_2000)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (SMB_C_98_2000)	0.6217	0.534145	Cannot reject normality
Kurtosis Normality (SMB_C_98_2000)	-1.8515	0.064093	Cannot reject normality
Omnibus Normality (SMB_C_98_2000)	3.8147	0.148476	Cannot reject normality
Skewness Normality (SMB_LL_98_2000)	0.5727	0.566830	Cannot reject normality
Kurtosis Normality (SMB_LL_98_2000)	-1.2843	0.199032	Cannot reject normality
Omnibus Normality (SMB_LL_98_2000)	1.9775	0.372046	Cannot reject normality
Variance-Ratio Equal-Variance Test	2.5276	0.049887	Reject equal variances
Modified-Levene Equal-Variance Test	4.6543	0.037363	Reject equal variances

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests Connecticut

Two-Sample Test Report

Page/Date/Time 4 12/27/02 11:09:36 AM
Database L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
SMB_C_98_2000	263.5	473.5	410	36.96152
SMB_LL_98_2000	136.5	346.5	410	36.96152

Number Sets of Ties = 4, Multiplicity Factor = 24

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			1.7180	0.085796	Accept Ho	1.7045	0.088292	Accept Ho
Diff<0			1.7180	0.957102	Accept Ho	1.7315	0.958321	Accept Ho
Diff>0			1.7180	0.042898	Reject Ho	1.7045	0.044146	Reject Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.350000	0.4071	.050	Accept Ho	0.1745
D(1)<D(2)	0.000000	0.4071	.025	Accept Ho	
D(1)>D(2)	0.350000	0.4071	.025	Accept Ho	

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests
Connecticut

Two-Sample Test Report

Page/Date/Time 5 12/27/02 11:09:36 AM
Database L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
SMB_C_98_2000	20	0.97465	0.5088544	0.1137833	0.7364988	1.212801
SMB_LZ_98_2000	20	0.5989	0.617094	0.1379864	0.3100911	0.8877089

Note: T-alpha (SMB_C_98_2000) = 2.0930, T-alpha (SMB_LZ_98_2000) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	38	0.37575	0.5655695	0.1788488	1.368955E-02	0.7378104
Unequal	36.67	0.37575	0.7998361	0.1788488	1.325755E-02	0.7382424

Note: T-alpha (Equal) = 2.0244, T-alpha (Unequal) = 2.0268

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.1009	0.042335	Reject Ho	0.534982	0.285728
Difference < 0	2.1009	0.978833	Accept Ho	0.000104	0.000007
Difference > 0	2.1009	0.021167	Reject Ho	0.662189	0.382086

Difference: (SMB_C_98_2000)-(SMB_LZ_98_2000)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.1009	0.042581	Reject Ho	0.534213	0.284617
Difference < 0	2.1009	0.978709	Accept Ho	0.000104	0.000007
Difference > 0	2.1009	0.021291	Reject Ho	0.661687	0.381058

Difference: (SMB_C_98_2000)-(SMB_LZ_98_2000)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (SMB_C_98_2000)	0.6217	0.534145	Cannot reject normality
Kurtosis Normality (SMB_C_98_2000)	-1.8515	0.064093	Cannot reject normality
Omnibus Normality (SMB_C_98_2000)	3.8147	0.148476	Cannot reject normality
Skewness Normality (SMB_LZ_98_2000)	4.3623	0.000013	Reject normality
Kurtosis Normality (SMB_LZ_98_2000)	3.8646	0.000111	Reject normality
Omnibus Normality (SMB_LZ_98_2000)	33.9653	0.000000	Reject normality
Variance-Ratio Equal-Variance Test	1.4707	0.408149	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.4113	0.525141	Cannot reject equal variances

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests Connecticut

Two-Sample Test Report

Page/Date/Time	6 12/27/02 11:09:36 AM
Database	L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
SMB_C_98_2000	302	512	410	36.96499
SMB_LZ_98_2000	98	308	410	36.96499

Number Sets of Ties = 2,   Multiplicity Factor = 12

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**	**Z-Value**	**Prob Level**	**Decision (5%)**
Diff<>0			2.7594	0.005791	Reject Ho	2.7458	0.006036	Reject Ho
Diff<0			2.7594	0.997104	Accept Ho	2.7729	0.997222	Accept Ho
Diff>0			2.7594	0.002896	Reject Ho	2.7458	0.003018	Reject Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.400000	0.4071	.050	Accept Ho	0.0811
D(1)<D(2)	0.050000	0.4071	.025	Accept Ho	
D(1)>D(2)	0.400000	0.4071	.025	Accept Ho	

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests Connecticut

Two-Sample Test Report

Page/Date/Time	7 12/27/02 11:09:36 AM
Database	L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
SMB_BB_98_2000	20	0.96055	0.3887587	8.692908E-02	0.7786053	1.142495
SMB_LL_98_2000	20	0.67145	0.3200631	7.156828E-02	0.5216559	0.8212441

Note: T-alpha (SMB_BB_98_2000) = 2.0930, T-alpha (SMB_LL_98_2000) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	38	0.2891	0.3560714	0.1125997	0.0611539	0.5170461
Unequal	36.65	0.2891	0.503561	0.1125997	6.087755E-02	0.5173224

Note: T-alpha (Equal) = 2.0244, T-alpha (Unequal) = 2.0268

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.5675	0.014302	Reject Ho	0.706168	0.452196
Difference < 0	2.5675	0.992849	Accept Ho	0.000015	0.000001
Difference > 0	2.5675	0.007151	Reject Ho	0.809621	0.559451

Difference: (SMB_BB_98_2000)-(SMB_LL_98_2000)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.5675	0.014461	Reject Ho	0.705332	0.450571
Difference < 0	2.5675	0.992769	Accept Ho	0.000015	0.000001
Difference > 0	2.5675	0.007231	Reject Ho	0.809154	0.558118

Difference: (SMB_BB_98_2000)-(SMB_LL_98_2000)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (SMB_BB_98_2000)	1.9224	0.054549	Cannot reject normality
Kurtosis Normality (SMB_BB_98_2000)	1.2119	0.225551	Cannot reject normality
Omnibus Normality (SMB_BB_98_2000)	5.1645	0.075604	Cannot reject normality
Skewness Normality (SMB_LL_98_2000)	0.5727	0.566830	Cannot reject normality
Kurtosis Normality (SMB_LL_98_2000)	-1.2843	0.199032	Cannot reject normality
Omnibus Normality (SMB_LL_98_2000)	1.9775	0.372046	Cannot reject normality
Variance-Ratio Equal-Variance Test	1.4753	0.404340	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.1263	0.724221	Cannot reject equal variances

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests Connecticut

Two-Sample Test Report

Page/Date/Time 8 12/27/02 11:09:36 AM
Database L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
SMB_BB_98_2000	281.5	491.5	410	36.95631
SMB_LL_98_2000	118.5	328.5	410	36.95631

Number Sets of Ties = 4, Multiplicity Factor = 42

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			2.2053	0.027433	Reject Ho	2.1918	0.028396	Reject Ho
Diff<0			2.2053	0.986284	Accept Ho	2.2188	0.986751	Accept Ho
Diff>0			2.2053	0.013716	Reject Ho	2.1918	0.014198	Reject Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.350000	0.4071	.050	Accept Ho	0.1745
D(1)<D(2)	0.000000	0.4071	.025	Accept Ho	
D(1)>D(2)	0.350000	0.4071	.025	Accept Ho	

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests
Connecticut

Two-Sample Test Report

Page/Date/Time	9 12/27/02 11:09:36 AM
Database	L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
SMB_BB_98_2000	20	0.96055	0.3887587	8.692908E-02	0.7786053	1.142495
SMB_LZ_98_2000	20	0.5989	0.617094	0.1379864	0.3100911	0.8877089

Note: T-alpha (SMB_BB_98_2000) = 2.0930, T-alpha (SMB_LZ_98_2000) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	38	0.36165	0.515722	0.1630856	3.150043E-02	0.6917996
Unequal	32.03	0.36165	0.729341	0.1630856	2.946732E-02	0.6938327

Note: T-alpha (Equal) = 2.0244, T-alpha (Unequal) = 2.0369

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.2175	0.032640	Reject Ho	0.579796	0.324744
Difference < 0	2.2175	0.983680	Accept Ho	0.000066	0.000004
Difference > 0	2.2175	0.016320	Reject Ho	0.702960	0.425584

Difference: (SMB_BB_98_2000)-(SMB_LZ_98_2000)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.2175	0.033802	Reject Ho	0.575678	0.318380
Difference < 0	2.2175	0.983099	Accept Ho	0.000068	0.000004
Difference > 0	2.2175	0.016901	Reject Ho	0.700369	0.419853

Difference: (SMB_BB_98_2000)-(SMB_LZ_98_2000)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (SMB_BB_98_2000)	1.9224	0.054549	Cannot reject normality
Kurtosis Normality (SMB_BB_98_2000)	1.2119	0.225551	Cannot reject normality
Omnibus Normality (SMB_BB_98_2000)	5.1645	0.075604	Cannot reject normality
Skewness Normality (SMB_LZ_98_2000)	4.3623	0.000013	Reject normality
Kurtosis Normality (SMB_LZ_98_2000)	3.8646	0.000111	Reject normality
Omnibus Normality (SMB_LZ_98_2000)	33.9653	0.000000	Reject normality
Variance-Ratio Equal-Variance Test	2.5197	0.050647	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.1589	0.692438	Cannot reject equal variances

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests Connecticut

Two-Sample Test Report

Page/Date/Time	10 12/27/02 11:09:36 AM
Database	L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
SMB_BB_98_2000	326.5	536.5	410	36.95805
SMB_LZ_98_2000	73.5	283.5	410	36.95805

Number Sets of Ties = 3, Multiplicity Factor = 36

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			3.4228	0.000620	Reject Ho	3.4093	0.000651	Reject Ho
Diff<0			3.4228	0.999690	Accept Ho	3.4363	0.999705	Accept Ho
Diff>0			3.4228	0.000310	Reject Ho	3.4093	0.000326	Reject Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.550000	0.4071	.050	Reject Ho	0.0040
D(1)<D(2)	0.050000	0.4071	.025	Accept Ho	
D(1)>D(2)	0.550000	0.4071	.025	Reject Ho	

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests
Connecticut

Two-Sample Test Report

Page/Date/Time 11 12/27/02 11:09:36 AM
Database L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
SMB_LL_98_2000	20	0.67145	0.3200631	7.156828E-02	0.5216559	0.8212441
SMB_LZ_98_2000	20	0.5989	0.617094	0.1379864	0.3100911	0.8877089

Note: T-alpha (SMB_LL_98_2000) = 2.0930, T-alpha (SMB_LZ_98_2000) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	38	0.07255	0.4915513	0.1554422	-0.2421262	0.3872262
Unequal	28.53	0.07255	0.6951585	0.1554422	-0.2455913	0.3906913

Note: T-alpha (Equal) = 2.0244, T-alpha (Unequal) = 2.0467

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.4667	0.643356	Accept Ho	0.074040	0.017880
Difference < 0	0.4667	0.678322	Accept Ho	0.017716	0.002744
Difference > 0	0.4667	0.321678	Accept Ho	0.117735	0.030333

Difference: (SMB_LL_98_2000)-(SMB_LZ_98_2000)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.4667	0.644235	Accept Ho	0.073632	0.017645
Difference < 0	0.4667	0.677882	Accept Ho	0.017834	0.002788
Difference > 0	0.4667	0.322118	Accept Ho	0.117199	0.029973

Difference: (SMB_LL_98_2000)-(SMB_LZ_98_2000)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (SMB_LL_98_2000)	0.5727	0.566830	Cannot reject normality
Kurtosis Normality (SMB_LL_98_2000)	-1.2843	0.199032	Cannot reject normality
Omnibus Normality (SMB_LL_98_2000)	1.9775	0.372046	Cannot reject normality
Skewness Normality (SMB_LZ_98_2000)	4.3623	0.000013	Reject normality
Kurtosis Normality (SMB_LZ_98_2000)	3.8646	0.000111	Reject normality
Omnibus Normality (SMB_LZ_98_2000)	33.9653	0.000000	Reject normality
Variance-Ratio Equal-Variance Test	3.7173	0.006279	Reject equal variances
Modified-Levene Equal-Variance Test	0.4075	0.527086	Cannot reject equal variances

Exhibit C.5-9

Location-Specific Smallmouth Bass tPCB t-Tests
Connecticut

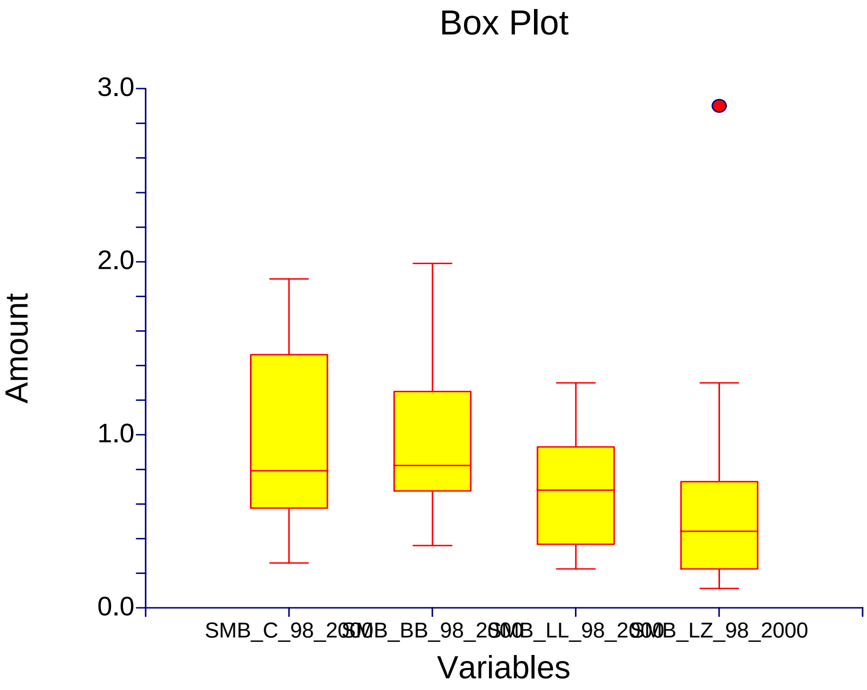
```
                                   Two-Sample Test Report
Page/Date/Time    12   12/27/02 11:09:36 AM
Database          L:\GE Pitts - Fish Ingestion ... ns\CT Data\98 & 2000 data.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

                          Mann         W            Mean         Std Dev
Variable                  Whitney U    Sum Ranks    of W         of W
SMB_LL_98_2000            262.5        472.5        410          36.96499
SMB_LZ_98_2000            137.5        347.5        410          36.96499
Number Sets of Ties = 2,   Multiplicity Factor = 12

             Exact Probability      Approximation Without Correction           Approximation With Correction
Alternative  Prob       Decision               Prob        Decision                      Prob        Decision
Hypothesis   Level      (5%)        Z-Value    Level       (5%)        Z-Value           Level       (5%)
Diff<>0                             1.6908     0.090877    Accept Ho   1.6773            0.093491    Accept Ho
Diff<0                              1.6908     0.954561    Accept Ho   1.7043            0.955839    Accept Ho
Diff>0                              1.6908     0.045439    Reject Ho   1.6773            0.046746    Reject Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative  Dmn              Reject Ho if    Test Alpha    Decision        Prob
Hypothesis   Criterion Value  Greater Than    Level         (Test Alpha)    Level
D(1)<>D(2)   0.300000         0.4071          .050          Accept Ho       0.3356
D(1)<D(2)    0.050000         0.4071          .025          Accept Ho
D(1)>D(2)    0.300000         0.4071          .025          Accept Ho
```

Exhibit C.5-10

Smallmouth Bass tPCBs by Location Box Plot
Connecticut

Page/Date/Time 1 3/31/03 8:55:00 AM
Database L:\GE Pitts - Fish & Waterfo ... ns\CT Data\98 & 2000 data.S0

Box Plot Section



ATTACHMENT C.6

DUCK STATISTICS

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 4 7/8/02 1:19:14 PM
Database

Summary Section of PSA_ML_B

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
5	9.102658	6.704039	2.998137	1.593342	19.34015	17.74681

Counts Section of PSA_ML_B

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
25	5	20	5	45.51329	594.0685	179.7765

Means Section of PSA_ML_B

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	9.102658	7.804711	6.84356	4.645912	45.51329	
Std Error	2.998137				14.99069	
95% LCL	0.7784953				3.892476	
95% UCL	17.42682				87.13411	
T-Value	3.0361					
Prob Level	0.038549					
Count	5		5	5		

Variation Section of PSA_ML_B

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	44.94413	6.704039	7.132065	2.998137	11.69059	17.74681
Std Error	22.1899	2.340474		1.046692		
95% LCL	16.13317	4.016612		1.796283		
95% UCL	371.1182	19.26443		8.615314		

Skewness and Kurtosis Section of PSA_ML_B

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	0.5682168	2.218807	0.8470476	0.8752261	0.7364924	0.5991555
Std Error	0.6300528	1.402495			0.1988071	

Trimmed Section of PSA_ML_B

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	8.951094	8.761637	8.51805	8.154412	7.99899	1.004665
Trim-Std Dev	6.310403	5.73624	4.803472	2.841201	2.857098	
Count	4.5	4	3.5	2.5	1.5	0.5

Mean-Deviation Section of PSA_ML_B

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	4.935825	4.676236	35.95531	122.5063	2868.438
Std Error	1.785602		17.75192	101.0293	1364.054

Descriptive Statistics Report

Page/Date/Time 5 7/8/02 1:19:14 PM

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Database

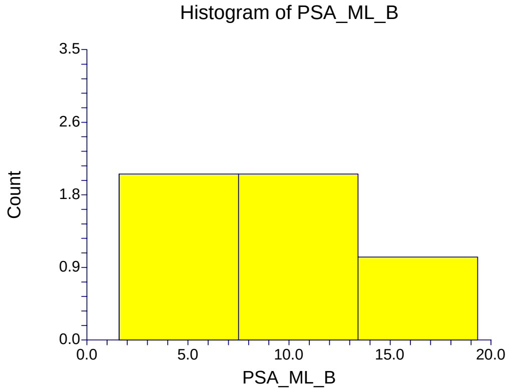
Quartile Section of PSA_ML_B

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.593342	3.581851	7.804711	15.27244	19.34015
95% LCL					
95% UCL					

Normality Test Section of PSA_ML_B

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9626262	0.826143			Accept Normality
Anderson-Darling					
Martinez-Iglewicz	1.189795		1.957019	4.768394	Accept Normality
Kolmogorov-Smirnov	0.1769301		0.319	0.319	Accept Normality
D'Agostino Skewness	0.0000		1.645	1.960	
D'Agostino Kurtosis		1.000000	1.645	1.960	
D'Agostino Omnibus			4.605	5.991	

Plots Section of PSA_ML_B



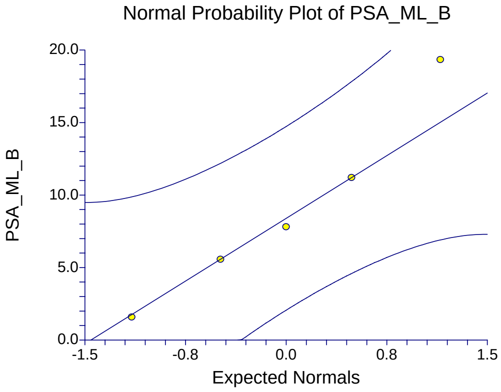


Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 6 7/8/02 1:19:14 PM
Database

Percentile Section of PSA_ML_B

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	19.34015			
95.0	19.34015			
90.0	19.34015			
85.0	19.34015			
80.0	17.71306			
75.0	15.27244			
70.0	12.83182			
65.0	10.86473			
60.0	9.844725			
55.0	8.824718			
50.0	7.804711			
45.0	7.134406			
40.0	6.4641			
35.0	5.793794			
30.0	4.774956			
25.0	3.581851			
20.0	2.388745			
15.0	1.593342			
10.0	1.593342			
5.0	1.593342			
1.0	1.593342			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of PSA_ML_B

Depth	Stem	Leaves
1	0* |	1
(2)	. |	57
2	1* |	1
1	. |	9

Unit = 1 Example: 1 |2 Represents 12

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 7 7/8/02 1:19:15 PM
Database

Summary Section of PSA_WD_B

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
20	6.595052	3.76534	0.8419557	1.059623	17.85441	16.79478

Counts Section of PSA_WD_B

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
25	20	5	20	131.901	1139.272	269.378

Means Section of PSA_WD_B

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	6.595052	5.947101	5.654303	4.621281	131.901	
Std Error	0.8419557				16.83911	
95% LCL	4.832818	3.711664			96.65636	
95% UCL	8.357285	7.402329			167.1457	
T-Value	7.8330					
Prob Level	0.000000					
Count	20		20	20		

Variation Section of PSA_WD_B

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	14.17779	3.76534	3.815189	0.8419557	4.42385	16.79478
Std Error	6.451854	1.211617		0.2709258		
95% LCL	8.199662	2.863505		0.6402992		
95% UCL	30.24504	5.499549		1.229737		

Skewness and Kurtosis Section of PSA_WD_B

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	1.368485	5.141734	1.482038	3.165201	0.5709342	0.4389964
Std Error	0.4280731	1.80426			9.752529E-02	

Trimmed Section of PSA_WD_B

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	6.277056	6.128161	5.966293	5.908755	5.864345	5.947101
Trim-Std Dev	2.545397	2.181508	1.685534	1.036934	0.7692398	8.175498E-02
Count	18	16	14	10	6	2

Mean-Deviation Section of PSA_WD_B

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	2.679872	2.610756	13.4689	67.64539	932.7682
Std Error	0.5059659		6.129261	48.45246	641.9398

Descriptive Statistics Report

Page/Date/Time 8 7/8/02 1:19:15 PM

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Database

Quartile Section of PSA_WD_B

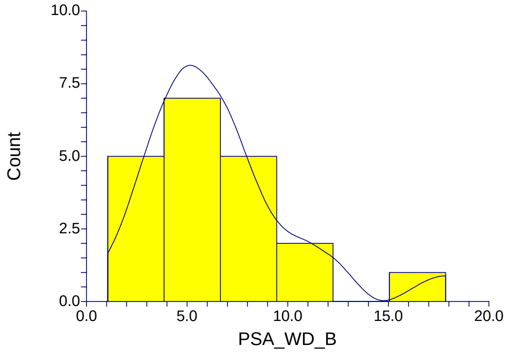
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	3.25522	3.940113	5.947101	8.363963	11.63981
95% LCL		1.059623	3.711664	6.00491	
95% UCL		5.097102	7.402329	11.68524	

Normality Test Section of PSA_WD_B

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.8892464	0.026049			Reject Normality
Anderson-Darling	0.7102375	0.063822			Accept Normality
Martinez-Iglewicz	1.594984		1.216194	1.357297	Reject Normality
Kolmogorov-Smirnov	0.1651188		0.176	0.192	Accept Normality
D'Agostino Skewness	2.6767	0.007434	1.645	1.960	Reject Normality
D'Agostino Kurtosis	2.2440	0.024829	1.645	1.960	Reject Normality
D'Agostino Omnibus	12.2007	0.002242	4.605	5.991	Reject Normality

Plots Section of PSA_WD_B

Histogram of PSA_WD_B



Normal Probability Plot of PSA_WD_B

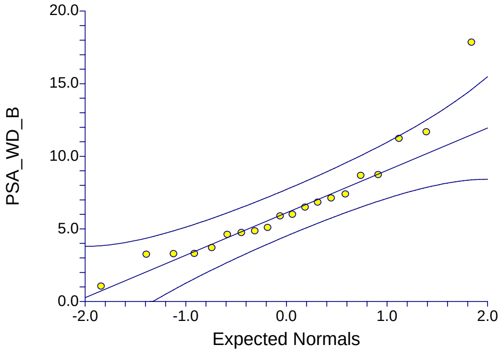


Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 9 7/8/02 1:19:15 PM
Database

Percentile Section of PSA_WD_B

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	17.85441			
95.0	17.54595			
90.0	11.63981			
85.0	10.8569	6.838475	17.85441	95.5319
80.0	8.726827	6.838475	17.85441	95.6328
75.0	8.363963	6.00491	11.68524	96.1823
70.0	7.319383	5.889291	11.68524	97.5218
65.0	7.025263	5.097102	11.23093	96.8303
60.0	6.700697	4.86226	8.737407	96.3010
55.0	6.273926	4.625461	8.684507	97.4703
50.0	5.947101	3.711664	7.402329	97.3396
45.0	5.453587	3.711664	7.125841	95.9722
40.0	4.956197	3.291559	6.838475	97.5360
35.0	4.787891	3.291559	6.49403	96.8303
30.0	4.662177	3.251182	6.00491	97.5218
25.0	3.940113	1.059623	5.097102	95.5904
20.0	3.387911	1.059623	4.86226	95.6328
15.0	3.293871	1.059623	4.86226	95.5319
10.0	3.25522			
5.0	1.169201			
1.0	1.059623			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of PSA_WD_B

```
Depth     Stem   Leaves
1            1|  0
1            2|
5            3|  2237
8            4|  678
10           5|  08
10           6|  048
7            7|  14
5            8|  67
3            9|
3           10|
3           11|  26
High          |  178
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 40 7/8/02 1:19:17 PM
Database

Summary Section of LN_PSA_ML_B

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
5	1.923308	0.9362444	0.4187012	0.4658337	2.962183	2.496349

Counts Section of LN_PSA_ML_B

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
25	5	20	5	9.61654	22.00178	3.506214

Means Section of LN_PSA_ML_B

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	1.923308	2.054728	1.6373	1.260378	9.61654	
Std Error	0.4187012				2.093506	
95% LCL	0.760807				3.804035	
95% UCL	3.085809				15.42904	
T-Value	4.5935					
Prob Level	0.010080					
Count	5		5	5		

Variation Section of LN_PSA_ML_B

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.8765536	0.9362444	0.99602	0.4187012	1.597613	2.496349
Std Error	0.4527442	0.341939		0.1529198		
95% LCL	0.3146482	0.5609351		0.2508578		
95% UCL	7.237986	2.690351		1.203161		

Skewness and Kurtosis Section of LN_PSA_ML_B

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.6339689	2.333886	-0.945065	1.335545	0.4867886	0.3110121
Std Error	0.6309146	1.604688			0.1946023	

Trimmed Section of LN_PSA_ML_B

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.946564	1.975633	2.013008	2.06203	2.058784	1.33151
Trim-Std Dev	0.8787829	0.7944635	0.6558761	0.3495232	0.3495797	
Count	4.5	4	3.5	2.5	1.5	0.5

Mean-Deviation Section of LN_PSA_ML_B

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.6653292	0.6390452	0.7012429	-0.3722808	1.147669
Std Error	0.2493661		0.3621953	0.247986	0.5296699

Descriptive Statistics Report

Page/Date/Time 41 7/8/02 1:19:17 PM

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Database

Quartile Section of LN_PSA_ML_B

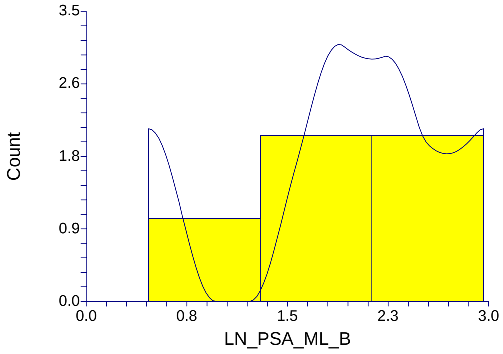
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	0.4658337	1.091647	2.054728	2.68926	2.962183
95% LCL					
95% UCL					

Normality Test Section of LN_PSA_ML_B

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9528925	0.757828			Accept Normality
Anderson-Darling					
Martinez-Iglewicz	1.151573		1.957019	4.768394	Accept Normality
Kolmogorov-Smirnov	0.140232		0.319	0.319	Accept Normality
D'Agostino Skewness	0.0000		1.645	1.960	
D'Agostino Kurtosis		1.000000	1.645	1.960	
D'Agostino Omnibus			4.605	5.991	

Plots Section of LN_PSA_ML_B

Histogram of LN_PSA_ML_B



Normal Probability Plot of LN_PSA_ML_B

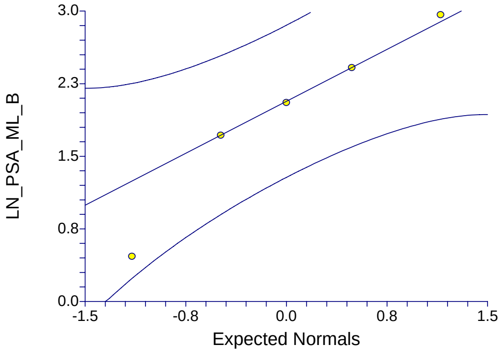


Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 42 7/8/02 1:19:17 PM
Database

Percentile Section of LN_PSA_ML_B

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	2.962183			
95.0	2.962183			
90.0	2.962183			
85.0	2.962183			
80.0	2.853014			
75.0	2.68926			
70.0	2.525506			
65.0	2.380176			
60.0	2.271693			
55.0	2.16321			
50.0	2.054728			
45.0	1.953547			
40.0	1.852367			
35.0	1.751186			
30.0	1.467134			
25.0	1.091647			
20.0	0.7161589			
15.0	0.4658337			
10.0	0.4658337			
5.0	0.4658337			
1.0	0.4658337			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_PSA_ML_B

Depth	Stem	Leaves
Low	|	4
2	1. |	7
(2)	2* |	04
1	. |	9

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 43 7/8/02 1:19:18 PM
Database

Summary Section of LN_PSA_WD_B

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
20	1.732417	0.6005471	0.1342864	5.791318E-02	2.88225	2.824337

Counts Section of LN_PSA_WD_B

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
25	20	5	20	34.64833	66.87784	6.852479

Means Section of LN_PSA_WD_B

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	1.732417	1.782857	1.487941	0.7049457	34.64833	
Std Error	0.1342864				2.685728	
95% LCL	1.451352	1.31148			29.02704	
95% UCL	2.013481	2.001795			40.26963	
T-Value	12.9009					
Prob Level	0.000000					
Count	20		20	20		

Variation Section of LN_PSA_WD_B

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	0.3606568	0.6005471	0.6084975	0.1342864	0.7551	2.824337
Std Error	0.1501457	0.1767872		3.953082E-02		
95% LCL	0.2085843	0.4567102		0.1021235		
95% UCL	0.7693781	0.877142		0.1961349		

Skewness and Kurtosis Section of LN_PSA_WD_B

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.708272	4.466312	-0.7670424	2.284505	0.3466527	0.2420712
Std Error	0.5220529	1.061262			0.0856185	

Trimmed Section of LN_PSA_WD_B

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.761565	1.754427	1.7472	1.762413	1.761556	1.782857
Trim-Std Dev	0.3993455	0.3545376	0.2943648	0.177038	0.1334539	1.374746E-02
Count	18	16	14	10	6	2

Mean-Deviation Section of LN_PSA_WD_B

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	0.4356501	0.4315783	0.3426239	-0.1420452	0.5243055
Std Error	8.069824E-02		0.1426384	0.1579839	0.3511459

Descriptive Statistics Report

Page/Date/Time 44 7/8/02 1:19:18 PM

Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Database

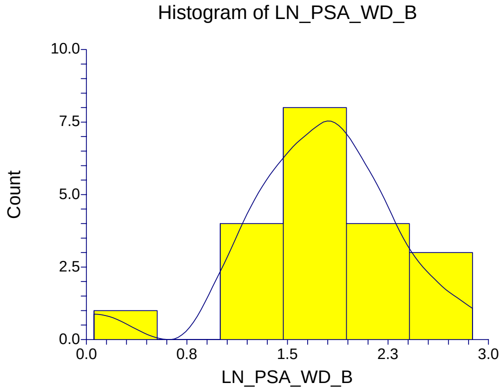
Quartile Section of LN_PSA_WD_B

Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	1.180253	1.366504	1.782857	2.121604	2.454361
95% LCL		5.791318E-02	1.31148	1.792578	
95% UCL		1.628672	2.001795	2.458327	

Normality Test Section of LN_PSA_WD_B

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9466419	0.318973			Accept Normality
Anderson-Darling	0.356318	0.457402			Accept Normality
Martinez-Iglewicz	1.310306		1.216194	1.357297	Accept Normality
Kolmogorov-Smirnov	8.432814E-02		0.176	0.192	Accept Normality
D'Agostino Skewness	-1.5209	0.128273	1.645	1.960	Accept Normality
D'Agostino Kurtosis	1.8660	0.062039	1.645	1.960	Accept Normality
D'Agostino Omnibus	5.7953	0.055152	4.605	5.991	Accept Normality

Plots Section of LN_PSA_WD_B



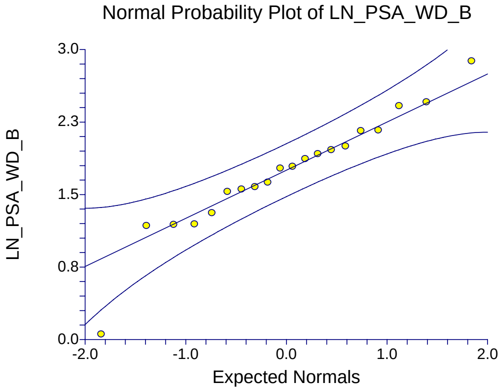


Exhibit C.6-1

Total PCBs Descriptive Statistics and Shapiro-Wilk Test Statistic
Mallard and Wood Duck
Reaches 5 and 6

Descriptive Statistics Report

Page/Date/Time 45 7/8/02 1:19:18 PM
Database

Percentile Section of LN_PSA_WD_B

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99.0	2.88225			
95.0	2.861054			
90.0	2.454361			
85.0	2.381013	1.922565	2.88225	95.5319
80.0	2.166399	1.922565	2.88225	95.6328
75.0	2.121604	1.792578	2.458327	96.1823
70.0	1.990375	1.773136	2.458327	97.5218
65.0	1.949321	1.628672	2.418671	96.8303
60.0	1.901892	1.581503	2.167614	96.3010
55.0	1.835646	1.531576	2.161541	97.4703
50.0	1.782857	1.31148	2.001795	97.3396
45.0	1.693681	1.31148	1.963728	95.9722
40.0	1.600371	1.191361	1.922565	97.5360
35.0	1.566025	1.191361	1.870883	96.8303
30.0	1.539411	1.179019	1.792578	97.5218
25.0	1.366504	5.791318E-02	1.628672	95.5904
20.0	1.219123	5.791318E-02	1.581503	95.6328
15.0	1.192062	5.791318E-02	1.581503	95.5319
10.0	1.180253			
5.0	0.1139685			
1.0	5.791318E-02			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of LN_PSA_WD_B

```
Depth     Stem   Leaves
Low          |   0
4          1*|   111
5           T|   3
8           F|   555
(3)         S|   677
9           .|   899
6          2*|   011
3           T|
3           F|   44
1           S|
1           .|   8
```

Unit = .1 Example: 1 |2 Represents 1.2

Exhibit C.6-2

Species-Specific Total PCB t-Tests
Reaches 5 and 6

Two-Sample Test Report

Page/Date/Time 1 7/12/02 9:59:25 AM
Database L:\GEPitts - Duck Ingestion\Data\Duck Total PCB.S0

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
LN_PSA_ML_B	5	1.923308	0.9362444	0.4187012	0.760807	3.085809
LN_PSA_WD_B	20	1.732417	0.6005471	0.1342864	1.451352	2.013481

Note: T-alpha (LN_PSA_ML_B) = 2.7764, T-alpha (LN_PSA_WD_B) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	23	0.1908913	0.671102	0.335551	-0.5032489	0.8850315
Unequal	4.85	0.1908913	1.1123	0.4397085	-0.9496883	1.331471

Note: T-alpha (Equal) = 2.0687, T-alpha (Unequal) = 2.5939

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.5689	0.574945	Accept Ho	0.084726	0.021309
Difference < 0	0.5689	0.712527	Accept Ho	0.013997	0.002096
Difference > 0	0.5689	0.287473	Accept Ho	0.137292	0.036732

Difference: (LN_PSA_ML_B)-(LN_PSA_WD_B)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0.4341	0.682808	Accept Ho	0.064619	0.013778
Difference < 0	0.4341	0.658596	Accept Ho	0.021454	0.003857
Difference > 0	0.4341	0.341404	Accept Ho	0.102448	0.023079

Difference: (LN_PSA_ML_B)-(LN_PSA_WD_B)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (LN_PSA_ML_B)	0.0000		
Kurtosis Normality (LN_PSA_ML_B)		1.000000	Cannot reject normality
Omnibus Normality (LN_PSA_ML_B)			
Skewness Normality (LN_PSA_WD_B)	-1.5209	0.128273	Cannot reject normality
Kurtosis Normality (LN_PSA_WD_B)	1.8660	0.062039	Cannot reject normality
Omnibus Normality (LN_PSA_WD_B)	5.7953	0.055152	Cannot reject normality
Variance-Ratio Equal-Variance Test	2.4304	0.284991	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0.8374	0.369637	Cannot reject equal variances

Exhibit C.6-2

Species-Specific Total PCB t-Tests
Reaches 5 and 6

Two-Sample Test Report

Page/Date/Time 2 7/12/02 9:59:26 AM
Database L:\GEPitts - Duck Ingestion\Data\Duck Total PCB.S0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
LN_PSA_ML_B	62	77	65	14.7196
LN_PSA_WD_B	38	248	260	14.7196

Number Sets of Ties = 0, Multiplicity Factor = 0

	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0	0.446678	Accept Ho	0.8152	0.414935	Accept Ho	0.7813	0.434643	Accept Ho
Diff<0	0.776661	Accept Ho	0.8152	0.792532	Accept Ho	0.8492	0.802117	Accept Ho
Diff>0	0.223339	Accept Ho	0.8152	0.207468	Accept Ho	0.7813	0.217322	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

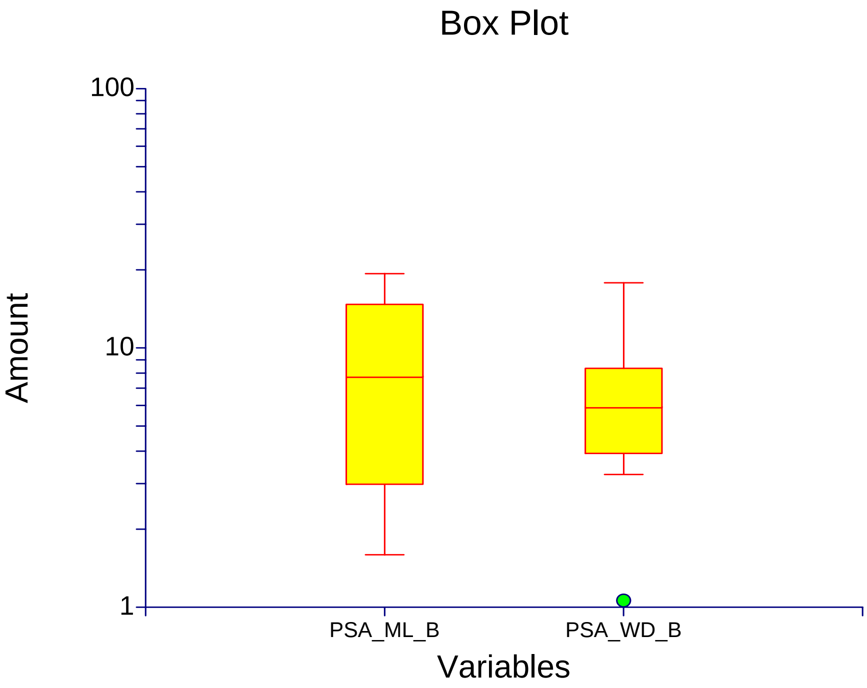
Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.350000	0.6211	.050	Accept Ho	0.6638
D(1)<D(2)	0.150000	0.6211	.025	Accept Ho	
D(1)>D(2)	0.350000	0.6211	.025	Accept Ho	

Exhibit C.6-3

Total PCB by Species Box Plots
Duck Breast
Reaches 5 and 6

Page/Date/Time 1 8/15/02 6:50:23 PM
Database L:\GEPITTS - DUCK INGESTION\DATA\NCSS\DUCK TOTAL PCB.S0

Box Plot Section



ATTACHMENT C.7

USE OF PROBABILITY BOUNDS COMPARED TO 2-DIMENSIONAL MONTE CARLO

ATTACHMENT C.7

USE OF PROBABILITY BOUNDS COMPARED TO 2-DIMENSIONAL MONTE CARLO

INTRODUCTION

Until recently, quantitative risk assessments have been deterministic and deliberately conservative with respect to safeguarding human health. Although these assessments are necessary and useful, the level of conservatism, and thus the margin of safety, is left unquantified. Probabilistic uncertainty analyses are used to estimate both the likelihood of adverse effects and the reliability of those estimates. Such analyses provide a better understanding of risk, promote transparency in the assessment, enhance credibility of the conclusions, and therefore, improve decisionmaking.

EPA guidance on probabilistic uncertainty analyses (EPA, 2001) distinguishes between variability and uncertainty. Variability (also called randomness, aleatory uncertainty, objective uncertainty, or irreducible uncertainty) arises from natural stochasticity, environmental variation across space or through time, genetic heterogeneity among individuals, and other sources of randomness. Variability in a parameter can exist between individuals within a population, across populations, and within an individual over time. Body weight, for example, varies between individuals within a population, across populations, and within a single individual over time.

Uncertainty (also called epistemic uncertainty, subjective uncertainty, or reducible uncertainty) arises from incomplete knowledge about the world. Sources of uncertainty include measurement uncertainty (also referred to as measurement error), small sample sizes, detection limits and other forms of data censoring, ignorance about the details of the mechanisms and processes involved, and other imperfections in scientific understanding.

Variability and uncertainty are fundamentally different. In principle, uncertainty can be reduced by focused empirical effort. Although variability can often be better characterized by further specific study, it is not generally reducible by empirical effort.

Variability can be translated into risk (i.e., probability of some adverse consequence) by the application of an appropriate probabilistic model. The result of applying the model is a characterization of risk, usually as the relationship between the magnitude of some adverse effect and its probability or frequency of occurrence. Uncertainty cannot be translated into probability in the same way, at least without appeal to a subjectivist interpretation of probability, which is considered inappropriate for regulatory purposes. However, it can be used to generate error bounds on the risk assessments.

Variability and uncertainty have to be treated separately, and differently, in environmental risk assessments. One common approach is to perform a two-dimensional Monte Carlo analysis (2DMCA) to simultaneously model variability and uncertainty. Another approach is to perform a probability bounds analysis (PBA). This section compares the use of 2DMCA and PBA to calculate the effects of variability and uncertainty on an exposure distribution. Parallel exposure noncancer risk assessments were constructed for the Reaches 5 and 6 (PSA) adult angler scenario using both 2DMCA and PBA to provide a basis for this comparison.

Although the one-dimensional Monte Carlo analysis (1DMCA) models only variability, the 2DMCA model detailed below simulates both variability, using the same inputs as the 1DMCA, and in addition, incorporates uncertainty regarding the input variables via an uncertainty loop (see EPA, 2001, Section 3.4.1). In both the 2DMCA and PBA models, all variables are treated as independent. The 2DMCA simulations were performed using Crystal Ball (Decisioneering, 2000) with 250 uncertainty iterations and 2,000 variability iterations in each uncertainty loop using Latin hypercube sampling. Limited trials using larger numbers of variability iterations (5,000 and 10,000) showed no appreciable change in the results.

Table 1 summarizes the inputs used in the comparison of the 2DMCA and PBA models, summarizing information presented in Section 6 of Volume I. The variability-loop 2DMCA variables were specified directly from the information in Table 6-2. The uncertainty-loop 2DMCA variables and the PBA inputs were specified using information from Table 6-2 and Table 6-3.

Table 1

Summary of All Inputs for the Comparison of PBA and 2DMCA

Variable	Symbol	Units	Min, Max	Central Estimate	Standard Deviation	Uncertainty Type[a]	Distribution Type[b]
2DMCA model							
tPCB concentration	C_{fish}	mg/kg	10.8, 13.9	-	-	U	Uniform
Fraction ingested	*FI*	unitless	0.01, 1.0	0.48	0.27	V	EDF
Ingestion rate	*EF×IR*	g/day	0.02, 647.5	8.5	13.6	U,V	Mixture
Cooking loss	*LOSS*	unitless	0.16, 1	0.26	0.18	V	Mixture
Bake		unitless	0.05, 0.67	0.22	0.11	V	Lognormal
Broil		unitless	0.02, 1	.2	0.18	V	T-lognormal
Pan fry		unitless	0.04, 0.9	0.24	0.15	V	Lognormal
Deep fry		unitless	0.15, 1	0.44	0.17	V	T-lognormal
Body weight	*BW*	kg	39, 113	72	15	V	Lognormal
PBA model							
tPCB concentration	C_{fish}	mg/kg	10.8, 13.9	[10.8, 13.9]	-	U	Interval
Fraction ingested	*FI*	unitless	0.01, 1	0.48	0.27	U,V	MMMS
Ingestion rate	*EF×IR*	g/day	0.02, 647.5	[5.2, 15.7]	[9.9, 37.7]	U,V	ENV EDF
Cooking loss	*LOSS*	unitless	0, 1	0.26	0.18	U,V	Mixture
Bake		unitless	0, 1	0.22	0.11	U,V	MMMS
Broil		unitless	0, 1	.20	0.18	U,V	MMMS
Pan fry		unitless	0, 1	0.24	0.15	U,V	MMMS
Deep fry		unitless	0, 1	0.44	0.17	U,V	MMMS
Body weight	*BW*	kg	39, 113	0.24	0.15	V	Lognormal

[a] Uncertainty types modeled include uncertainty only (U), variability only (V), and both uncertainty and variability (U,V). When uncertainty and variability are both modeled, they are kept analytically separate.

[b] EDF stands for empirical distribution function; lognormal and uniform are probability distributions; T-lognormal is a truncated lognormal distribution; mixture is a stochastic mixture of probability distributions or p-boxes; interval stands for an interval input; MMMS is a distribution-free p-box formed using the minimum, maximum, mean, and standard deviation; and ENV EDF is an envelope formed around two or more empirical distribution functions.

TREATMENT OF EACH VARIABLE

Concentration (C_{fish})—In 2DMCA, concentration was modeled as an uncertain parameter, with no variability, using a uniform distribution with minimum 10.8 mg/kg and maximum 13.9 mg/kg. The lower limit is the mean measured tPCB concentration in the EPA data set and the upper limit is the computed 95% UCL on the mean. This uncertainty parameterization is discussed in Section 6.6.1.2. In the PBA, an interval was used to model the same uncertainty.

Fraction ingested that is contaminated (*FI*)—This parameter was modeled as containing variability but no uncertainty in the 2DMCA. Its value was drawn from an empirical distribution function mixture. Table 2 gives the values and associated probabilities used to calculate the mixture.

Table 2

Fraction Ingested (Unitless)

Probability	Value of FI
0.05	0.1
0.1	0.2
0.2	0.3
0.35	0.5
0.18	0.97
0.02	1

Although the PBA input for *FI* contained uncertainty, the 2DMCA did not account for this in a parallel manner. In the PBA, the uncertainty is constrained such that the bounds at each probability of exceedance level are defined based on the moments (mean and variance), resulting in bounds around all *FI* input distributions with the specified range, mean, and variance. Using 2DMCA methods, it is difficult to assign uncertainty to each Monte Carlo realization when the uncertainty is a result of incertitude about the *shape* of the distribution rather than about the parameterization of a specified distribution. Although it is possible to arbitrarily assert several different families of distributions that could model the data, the distribution selection weighting in each uncertainty loop is difficult to derive. Generally, there are an infinite number of possible shapes, and the Monte Carlo approach cannot exhaustively search them all.

Ingestion rate (*EF×IR (meal size)*)—Ingestion rate was modeled with both uncertainty and variability. In each uncertainty iteration, an integer value was chosen from the set {1,2,3,4,5,6} by random uniform sampling. This choice identified which of six possible parent distributions for intake rate would be used to model variability in that particular Monte Carlo realization. The six distributions for intake rate correspond directly to the six meal-sharing assumptions listed in Section 6.6.1.5. In theory, this methodology mixes angler survey data equally from each of the distributions corresponding to the various meal-sharing assumptions. A more sophisticated weighting scheme for combining these underlying distributions was not attempted. In the PBA, the intake rate was formed by taking the envelope around the six empirical distributions associated with the various meal-sharing assumptions. This provides the variable with a finite (non-zero) amount of uncertainty, in addition to variability. As is the case with *FI,* the PBA models uncertainty regarding both the shape and parameterization of the ingestion rate distribution because neither of these is known.

Cooking loss (*LOSS*)—Cooking loss was modeled in the 2DMCA with variability and no uncertainty. Like the method used to model ingestion rate, an integer value was chosen from the set {1,2,3,4}. Unlike *EF×IR (meal size),* this selection was not made in the uncertainty loop, but was performed in each variability iteration. The choice corresponds to the selection of the cooking method for that particular Monte Carlo realization (meal) from a menu of baking, broiling, pan-frying, and deep-frying. Based on the information in the angler studies (Section 4.5.2.3), the random sampling scheme was arranged so that baking, broiling, and deep-frying each had selection probabilities of 20%. Pan-frying was assigned a selection probability of 40%. After the cooking method was selected, a value for cooking loss was randomly selected from the empirical distribution for that method (Table 3). This allows for the possibility that individual anglers can use a variety of cooking methods over their lifetimes.

Table 3

Cooking Loss Data from Individual Trials with Different Preparation Methods

Cooking Method			
Bake (p=0.2)	**Broil (p=0.2)**	**Pan fry (p=0.4)**	**Deep fry (p=0.2)**
5	0	46	74
16	53	7.5	31
34	7.5	35	35
7.5	24	31	32
27	12	15	47
20	16	27	
35	47	0	
22	0	27	
13			
39			
18			

Note: All values in percentage of PCB loss. p indicates the probability that a method will be chosen for a given Monte Carlo realization.

This methodology does not attempt to account for any uncertainty about the loss that could occur just within a specific cooking method. In the PBA, the cooking loss variable models both uncertainty and variability. That uncertainty was introduced to account for the fact that the results of the individual studies of cooking loss are themselves uncertain.

Body weight (*BW*) — Body weight was modeled with variability and no uncertainty in both the 2DMCA and in the PBA. The lognormally parameterized distributions for the body weight of men and women were mixed in equal parts. The resulting distribution was sampled to produce variability in the Monte Carlo realizations.

RESULTS OF THE 2DMCA AND PBA COMPARISON

A summary of the results of the two analyses (2DMCA and PBA) for adult angler dose are presented in Table 4. In all cases, the PBA bounds completely enclose all of the 2DMCA realizations. Many of the 2DMCA results have maxima (minima) that are more than a factor of two smaller (larger) than the PBA results.

Table 4

Results of Comparison of 2-D Monte Carlo Simulation and Probability Bounds Analysis for Adult Noncancer Average Daily Exposure to tPCB* Due to Fish Ingestion from Reaches 5 and 6

	Range	Mean	Std.dev.	25th %-ile	50th %-ile
PBA	[0, 2.3E-1]	[1.4E-4, 1.4E-3]	[3.3E-4, 4.7E-3]	[1.1E-7, 2.4E-4]	[4.3E-6, 7.2E-4]
2DMCA	[1.2E-7, 1.3E-1]	[2.9E-4, 1.2E-3]	[6.1E-4, 4.3E-3]	[2.8E-5, 1.0E-4]	[8.3E-5, 3.2E-4]

	75th %-ile	90th %-ile	95th %-ile	99th %-ile
PBA	[3.1E-5, 2.0E-3]	[1.2E-4, 5.0E-3]	[2.4E-4, 9.7E-3]	[5.3E-4, 4.3E-2]
2DMCA	[2.6E-4, 9.4E-4]	[6.3E-4, 2.5E-3]	[1.1E-3, 5.1E-3]	[4.1E-3, 2.7E-2]

* In mg/kg-d.

Figure 1 shows the bounds from the PBA (black lines) and the envelope of all distributions from the 2DMCA (gray lines); 15 of the 250 realizations are shown as narrow black lines. The probability bounds completely enclose all of the 2DMCA results. Of note is the added uncertainty in the PBA. There are three primary causes for the difference between the bounds around all 2DMCA realizations and the probability bounds: (1) there are variables with uncertainty in PBA but which have no uncertainty when modeled in 2DMCA, due primarily to the inability of 2DMCA to address distributional form (shape) uncertainty; (2) tPCB concentration(C_{fish}) was treated as an interval in the PBA and as a uniform distribution in 2DMCA; (3) the breadth of the 2DMCA result is a function of the finite number of iterations used. In contrast, the PBA bounds are comprehensive. Because all variables were treated as independent in both the PBA and the 2DMCA, the bounds do not differ due to differences in dependence assumptions. These three causes all lead to an underestimation of the impact of uncertainty on exposure estimation by 2DMCA.

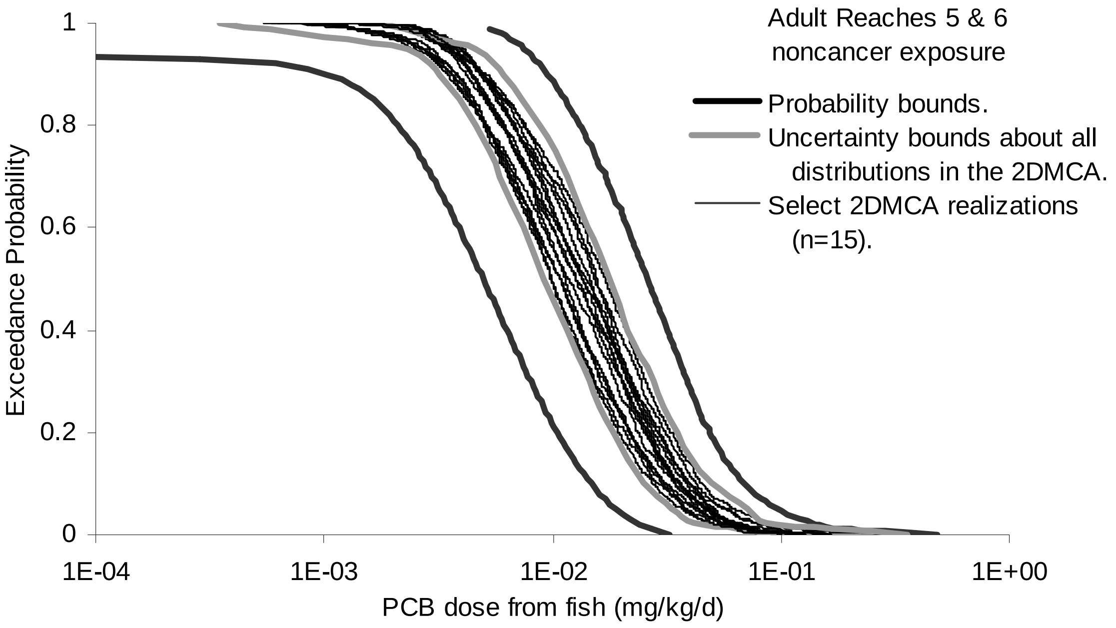


Figure 1 Comparison of 2DMCA and PBA for the 1-D Noncancer Model of Anglers at Reaches 5 and 6

REFERENCES

Decisioneering (Decisioneering, Inc.). 2000. *Crystal Ball 2000 User Manual*. Decisioneering, Inc., Denver, CO. 396 pp.

EPA (U.S. Environmental Protection Agency). 2001. *Risk Assessment Guidance for Superfund (RAGS)*, Volume III - *Part A: Process for Conducting Probabilistic Risk Assessment*. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC. EPA 540-R-02-002. Available on-line at the EPA website http://www.epa.gov/superfund/programs/risk/rags3a/index.htm