Letter Health Consultation

Coeur d'Alene Basin Fish Tissue Analysis and Consumption Advisory

Coeur d'Alene, Idaho

October 10, 2019

Revised January 2020*

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Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

IDAHO DEPARTMENT OF HEALTH & WELFARE
DIVISION OF PUBLIC HEALTH

This publication was made possible by Grant Number 1NU61TS000286-01-00 from the Agency for Toxic Substances and Disease Registry. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Agency for Toxic Substances and Disease Registry, or the Department of Health and Human Services.

*See Appendix E

Summary and Purpose

The Coeur d'Alene Basin including the Coeur d'Alene River and Chain Lakes, South Fork Coeur d'Alene River, Coeur d'Alene Lake, and Spokane River has been impacted by historic mine wastes and associated metals contamination in the Bunker Hill Superfund Site. Fish sampling was completed in 2016 and tissue analyzed to assess concentrations of mercury, lead, arsenic, and cadmium. Concentrations of zinc in fish tissue were also evaluated for ecological monitoring purposes but are not reported here because zinc in fish tissue was not considered a human health risk. This sampling effort updates and expands the previous fish consumption advisory from 2003. Species collected included bass (largemouth and smallmouth bass), panfish (black crappie, yellow perch, and bluegill), brown bullhead, northern pike, kokanee, and trout (rainbow, cutthroat, and brook trout). As part of the Idaho Fish Consumption Advisory Program, the Idaho Department of Health and Welfare assessed tissue concentrations to determine recommended meal limits based on potential human health risks due to the consumption of fish.

Based on tissue concentrations, mercury is the main contaminant of concern in driving fish consumption recommendations. This is especially true for children and pregnant women who are most at risk of adverse health effects of mercury exposure. For the purposes of this assessment, the term "pregnant women" refers to women who are pregnant, considering becoming pregnant, or are nursing. This health assessment includes an updated consumption advisory for site-specific recommended meal limits for northern pike, kokanee, panfish, and bullhead. This assessment also expands the advisory into additional areas of the Coeur d'Alene River and Chain Lakes. For some sites, recommended meal limits for bass are more restrictive than the current statewide bass consumption advisory of less than 8 meals per month for the general adult population and less than 2 meals per month for pregnant women and children.

Project Partners

This fish tissue analysis and consumption advisory project is a collaborative effort among multiple organizations including: United States Environmental Protection Agency (EPA), Idaho Department of Environmental Quality (DEQ), Coeur d'Alene Tribe, Panhandle Health Department (PHD), Idaho Department of Fish and Game (IDFG), Idaho Department of Health and Welfare (IDHW), and the Idaho Fish Consumption Advisory Program (IFCAP).

Sample collection was performed by field crews from the Coeur d'Alene Tribe, IDFG, and DEQ under the *Final Quality Assurance Project Plan (QAPP), Coeur d'Alene Basin Fish Tissue Sampling* (DEQ 2016a). Laboratory analysis was performed at the EPA Region 10 Manchester Environmental Laboratory (MEL) in Port Orchard, Washington. DEQ served as the project coordinator to complete the QAPP, sample collection, transport samples to the laboratory, data management, and quality assurance/quality control reviews. The Idaho Department of Health and Welfare analyzed tissue concentrations to determine recommended meal limits based on possible human health risks from consumption of fish.

Background and Statement of Issues

The Bunker Hill Mining and Metallurgical Complex Superfund Site, referred to as the Bunker Hill Superfund Site (BHSS), is located in the Coeur d'Alene Basin, and was listed on the National Priorities List (NPL) in 1983. The site includes areas contaminated by mine wastes in the Coeur d'Alene River corridor, adjacent floodplains, downstream water bodies, tributaries, and fill areas, as well as the 21-square-mile area referred to as the "Box" that surrounds the historic smelting operations at the Bunker Hill complex. BHSS has three operable units (OU): Operable Unit 1 (OU1), the populated areas of the Box, Operable Unit 2 (OU2), the non-populated areas of the Box, and Operable Unit 3 (OU3), the areas of mining-related contamination outside the Box in the broader river basin.

The Upper Basin is contained within a steep mountain canyon of the South Fork Coeur d'Alene River and adjacent tributary gulches. This area is the heart of the Coeur d'Alene Mining District, a major producer of silver, lead, zinc, and other metals beginning in the late 1880s. Historic mining practices resulted in the widespread metals contamination that is a concern for both human health and the environment. Residual contaminant sources include mine adit discharge, tailings ponds, tailings piles, waste rock piles, and interspersed floodplain tailings along the South Fork Coeur d'Alene River and tributary streams. Erosion of mine waste by precipitation and stream flow continually re-distributes sediment laden with metals, which poses a threat to human health. Metals of human health concern from fish evaluated in this assessment included arsenic, lead, cadmium, and mercury (USEPA 1991, 1992, 2002a). Uptake of metals by fish may pose a risk for human health due to consumption of contaminated tissue. Both recreational fishing and subsistence fishing are common by populations within and near the BHSS, such as members of the Coeur d'Alene Tribe. Generating fish consumption advisories will provide guidance for populations consuming fish and protect human health.

Past Sampling and Consumption Advisories

The selected remedy identified in the OU3 Record of Decision (EPA 2002a) includes educational resources and health advisories to manage the potential for metals exposure through consumption of fish. In 2002, sampling from Coeur d'Alene Lake was performed to include kokanee, largemouth bass, and bullhead. Results from this investigation completed by IDHW, via a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), and the Coeur d'Alene Tribe to issue a health advisory (EPA 2002b, EPA 2003, ATSDR 2003) and recommend fish consumption guidelines for Coeur d'Alene Lake, most recently published in the Idaho Fish Consumption Guide (IDHW 2008). There is also a statewide advisory for bass consumption based on mercury concentrations (IDHW 2008). The current statewide bass advisory recommends limiting consumption of bass species to less than 8 meals per month for the general adult population and less than 2 meals per month for pregnant women and children.

Recently, a need to collect more comprehensive and current fish tissue data was identified because there are no specific fish consumption advisories for the Coeur d'Alene River, chain lakes, South Fork Coeur d'Alene River, and Spokane River (within Idaho) and the 2002 fish tissue metals concentration data for Coeur d'Alene Lake did not include species like northern

pike. Previous evaluations of fish tissue from Coeur d'Alene Lake included some whole fish analysis (gutted carcass) and a limited number of fillets samples (ATSDR 2003).

Planning for fish tissue sample collection under the project QAPP (DEQ 2016a) included a review of historical data to determine locations and species. Metals for analysis were identified from the OU3 ROD, where the selected indicator metals for fish consumption are cadmium, lead, and mercury. Although not identified in the OU3 ROD as an indicator metal, arsenic was also analyzed. Total arsenic was analyzed in all samples and inorganic arsenic was analyzed in a select subset of samples.

Fish Sampling and Tissue Analysis Methods

Fish collection

Fish tissue sampling was conducted throughout the Coeur d'Alene Basin based on the presence of contaminants in the water bodies, frequency of fishing activities, amount of fish for consumption, public interest, and the needs of the OU3 selected remedy. The Basin was divided into four areas: 1) South Fork Coeur d'Alene River (Upper Basin), 2) Coeur d'Alene River and Chain Lakes (Lower Basin), 3) Spokane River (below Post Falls Dam), and 4) Coeur d'Alene Lake. The areas were further subdivided to evaluate variability in tissue concentrations. These areas have known contaminants present and have fisheries needing investigation for protection of human health. Sampling locations are identified in Table 1 and shown in Appendix A. Sample collection included multiple locations that geographically represent large water bodies, similar to locations sampled for the past Coeur d'Alene Lake health advisory (EPA 2002b, EPA 2003, ATSDR 2003), and include high use fishery areas with species that are exposed to contaminants.

Species selection and groupings

Target fish species or species groups have been selected based on fish species present in each water body, fish harvested for consumption, fish life histories, and known data gaps. Fish species of similar life history were grouped together. Target species are abundant enough to provide a fishery and provide adequate sample size for chemical analysis. According to IDFG and the Coeur d'Alene Tribe, these species are consumed in the area by recreational or subsistence anglers. Species selected are those exposed to contaminants and likely to pose health risks for human consumers. Samples collected included adult fish representative of those likely to be harvested for consumption. Smaller fish were collected in the South Fork Coeur d'Alene River than are typically harvested for consumption in other parts of the Basin; however, these were the only fish collected.

Target species or groups for each sampling location are identified in Table 1. The panfish group included black crappie, bluegill, and yellow perch. The bass group included both largemouth and smallmouth bass. The Idaho Fish Consumption Advisory Program (IFCAP) protocol recommends 10 fish per target species or group to reach an approximately 90% confidence that an advisory will be correctly issued. The QAPP followed protocol recommendations (DEQ 2016a). Collection of 10 fish per target species/group was attempted for the locations identified in Table 1. Deviations from collection of 10 fish per target species are described in Appendix A.

Table 1. Summary of Coeur d'Alene Basin sampling zones and target species

Area	Location	Target Species/Groups
South Fork Coeur d'Alene River (Upper Basin)	Zone 1, Upper	Trout (Eastern brook, rainbow, cutthroat)
	Zone 2, Lower	Trout (Eastern brook, cutthroat)
Coeur d'Alene River and Chain Lakes (Lower Basin)	Zone 3, Coeur d'Alene River and Killarney Lake	Panfish*
		Northern pike
		Bass†
		Bullhead
	Zone 4, Swan Lake	Panfish*
		Northern pike
		Bass†
		Bullhead
	Zone 5, Thompson Lake and Anderson Lake	Panfish*
		Northern pike
		Bass†
		Bullhead
Spokane River	Zone 6, Spokane River below Post Falls dam	Bass†
		Trout
Coeur d'Alene Lake	Zone 7, Northern Lake	Panfish*
		Northern pike
		Bass†
		Kokanee
	Zone 8, Central Lake	Panfish*
		Northern pike
		Bass†
		Kokanee
	Zone 9A, Southern Lake, Northern Deeper Section	Panfish*
		Northern pike
		Bass†
	Zone 9B, Southern Lake, Southern Shallow Section	Panfish*
		Northern pike
		Bass†

* Panfish included black crappie, bluegill, and yellow perch.
† Bass included both large and smallmouth bass.

Fish field sampling and tissue analysis

Protocols used to obtain project samples are described in the QAPP (DEQ 2016a). The field project managers selected sampling methods appropriate for waters being sampled. Sampling methods included large water electrofishing, stream electrofishing, large water gill netting, and midwater trawl netting (kokanee). Upon collection using any method, eligible fish that were still alive were killed using percussion over the head. For this study, 'eligible' means fish of target species and of legal harvest size (as outlined by IDFG regulations for specific species) (DEQ

2016a). Details of the tissue preparation and analytical methods for metals are described in Appendix A. All samples, except kokanee, were processed to retain a fillet for each fish without the skin or belly flap included, and any bones imbedded in the fillet were removed. Kokanee were prepared as whole fish samples (excluding scales, all entrails, head, tail, and all fins). Sample processing was designed to reflect the most likely human consumption scenarios for relevant species.

Analysis of Tissue Concentrations

Derivation of screening values

According to the IFCAP protocol (IDHW 2011) and QAPP (DEQ 2016a), geometric mean tissue concentrations were calculated for each metal, site, and species grouping and compared to screening values (Table 2). These chemical specific health-based screening values were used to determine if concentrations of metals in fish tissue may exceed levels associated with the adverse health effects. For total arsenic, cadmium, and mercury the chemical-specific EPA Reference Dose (RfD) was used to derive screening values for chronic noncancer health effects (Table 2) (EPA 2018). Derivation of carcinogenic screening values for arsenic (total and inorganic) is described below. The RfD is an estimate of a daily oral exposure for a chronic duration (up to a lifetime of exposure) that is likely to be without appreciable risk of adverse health effects during a lifetime. RfDs are derived from health effects studies and account for uncertainty in the data used to derive them. RfDs can be considered protective of human health because they generally assume a continuous daily exposure.

Table 2. Screening values and reference doses used for this assessment

Metal	Screening Value (mg/kg)	EPA Reference Dose (mg/kg-d)
Arsenic	1.2 (Total arsenic chronic noncancer) 0.26 (Total arsenic cancer) 0.026 (Inorganic arsenic cancer)	0.0003
Cadmium	4.0	0.001
Lead	0.063	Evaluate using Integrated Exposure Uptake Biokinetic (IEUBK) Model
Mercury	0.4	0.0001

Arsenic

Arsenic is classified as a known human carcinogen (ATSDR 2016). Chronic exposure via ingestion of arsenic can cause darkening and malformations of the skin and increase the risk of skin, bladder, and lung cancer (ATSDR 2016). The chronic noncancer screening level for arsenic is 1.2 mg/kg derived from the EPA oral RfD (USEPA 2018). Consuming fish with tissue concentrations below this level would not be expected to cause adverse noncancer health effects. Inorganic arsenic is considered to be the more toxic form and associated with long term health effects. Fish tissue contains both organic and inorganic arsenic. The U.S. EPA carcinogen screening value for inorganic arsenic in fish tissue is 0.026 mg/kg. This carcinogen screening value assumes a 70-year exposure for a 70 kg individual consuming 17.5 grams of fish/day (recreational fisher exposure consumption), with an acceptable risk level set at 1 excess cancer case in 100,000 exposures ($1x10^{-5}$) (USEPA 2000).

Due to analytical limitations and costs of measuring inorganic arsenic, all tissue samples were first analyzed for total arsenic. It has been assumed that roughly 10 percent of the total arsenic found in fish tissue will be in the inorganic form (CDPHE 2015). Studies performed by DEQ which quantified arsenic levels in fish tissue (both organic and inorganic) in Idaho's water bodies and waterways support that assumption. In Idaho lakes and reservoirs, inorganic arsenic accounted for roughly 2 percent of total arsenic (mean total arsenic = 0.21 ppm; mean inorganic arsenic = 0.005 ppm) (DEQ 2008). In Idaho rivers and streams the percentage of inorganic arsenic in fish was low enough to not be quantifiable (mean total arsenic = 0.073 ppm) (DEQ 2010). Therefore, the screening value 0.26 mg/kg of total arsenic was used to determine the additional analysis of inorganic arsenic. If tissue samples were above or near the total arsenic screening value, a subset (30 individual samples from the whole data set) would be analyzed for inorganic arsenic (DEQ 2016a). The subset of samples was selected using fish with the highest total arsenic concentrations. Results of samples measured for inorganic arsenic are included in Appendix C.

Cadmium

Chronic ingestion of elevated cadmium is associated with kidney damage and low level chronic exposure may cause damage to bones (ATSDR 2012). Cadmium is classified by EPA as a probable human carcinogen based on studies of inhalation exposure. However, this exposure route is not of concern for fish consumption. Evidence of carcinogenicity from oral exposure has not been unequivocally established (ATSDR 2012). The screening value derived of 4.0 mg/kg cadmium is based on the EPA oral RfD of 0.001 mg/kg/day for chronic noncarcinogenic exposure (USEPA 2018).

Lead

Exposure to lead is of greatest concern for children due to adverse impacts on neurological development. Lead may also cause anemia or kidney damage in both children and adults (ATSDR 2007). In general, especially for children, the primary route for lead exposure is through contaminated soil or dust ingestion and not typically fish consumption. Usually, lead in fish does not accumulate in fillet (muscle) tissue but may be present at higher concentrations in bones or organs such as the liver (Schmitt 2004). Lead has been measured in fish species used for human consumption and may still contribute to overall exposure (Castro-Gonzalez 2008). Fish species that are more likely to interact with contaminated sediments or consume detritus (e.g., bullhead) may have higher concentrations of lead in tissues (Czarnezki 1985, ATSDR 2003).

According to the Centers for Disease Control and Prevention (CDC), there is no safe blood lead level and exposures in children should be reduced or eliminated. The screening value for assessment of lead in fish tissue was set at the method detection limit of 0.063 mg/kg because there is no exposure threshold. If the geometric mean of samples exceeded this value, tissue concentrations were evaluated for children's exposures using the Integrated Exposure Uptake Biokinetic (IEUBK) model (USEPA 2007). The IEUBK model determines the probability of exceeding a blood lead level of 5 µg/dL (CDC reference level) for children under 7 years old.

The IEUBK model was used to assess increases in children's blood lead levels due to consumption of contaminated fish. Because lead exposure from contaminated soils and dust is also a concern for populations in the Coeur d'Alene Basin, site-specific scenarios of lead

exposure were generated using soil and indoor dust lead concentrations measured in these communities. IEUBK modeling scenarios included exposure to a combination of lead in fish tissue and from site-specific soil and dust lead concentrations. Model inputs for each scenario are described in Appendix D.

Mercury

Chronic exposure to mercury can impair brain and nervous system and brain development. Children and pregnant women are considered the most sensitive populations to mercury exposure. Methyl mercury is typically the form of mercury found in fish tissue. Methyl mercury can more easily pass into the developing brain of young children and may interfere with the development process. The EPA Reference Dose (RfD) for oral exposure to methyl mercury is 0.0001 mg/kg/day (USEPA 2018). ATSDR has developed a chronic oral minimal risk level (MRL) for methyl mercury (0.0003 mg/kg/day). EPA's methylmercury RfD is based on a benchmark dose analysis of developmental and neurological impairment. The EPA RfD was used in this assessment for the derivation of screening levels and recommended meal limits because it provides a more conservative assessment of exposure.

Calculation of consumption limits

Recommended meals per month were calculated according to the equations in Appendix B using the EPA RfD for each chemical (Table 2). Meal limits were calculated for the general adult population, pregnant women, and children. Pregnant women are also considered to include breastfeeding women and women who are considering becoming pregnant. Typical meal sizes were assumed to be 8 oz for adults and 4 oz for children. This is consistent with previous consumption advisories issued by IDHW and is considered to be a standard serving size. Body weights for each population were used as established in the IFCAP protocol guidance (IFCAP 2011) (Table 3). An exposure duration of 30 years for adults and 12 years for children was used. For arsenic, meals per month were derived using the carcinogen equation which assumes an acceptable cancer risk level of 10^{-5} or 1 additional cancer case out of 100,000 people. This falls within the EPA's acceptable cancer risk level of 10^{-4} to 10^{-6}. The risk level is also used by DEQ to set water quality criteria to protect human health (IDAPA 58.01.02.210.05.b.ii). The cancer slope factor of 1.5 mg/kg-d^{-1} for arsenic was used for the carcinogen equation (EPA 2018).

Table 3. Body weights and fish meal sizes used in the derivation of recommended meals per month

Population Group	Body weight	Meal size
General Adult Population	80 kg (176 lbs)	8 oz (227 g)
Pregnant Woman	70 kg (154 lbs)	8 oz (227 g)
Child	20 kg (44 lbs)	4 oz (113 g)

Results and Discussion

Results of this fish tissue analysis significantly expand the previous sampling and consumption advisory established in 2003 for only Coeur d'Alene Lake. Additional sites and species sampled provide additional data on metals in fish from a wider range of water bodies throughout the

Basin. Ranges of tissue concentrations (Table C1) and geometric mean tissue concentrations (Table C2) for all species and sites are provided in Appendix C.

Arsenic

This assessment used two screening values for total arsenic, which includes both organic and inorganic forms of arsenic. There was also a third screening value for cancer risks from inorganic arsenic. Total arsenic in fish tissue did not exceed the chronic noncancer screening value of 1.2 mg/kg in any samples. The highest geometric mean tissue concentration of 0.225 mg/kg was approximately 5 times lower than this screening level. The geometric mean total arsenic for all groups did not exceed the total arsenic cancer 0.26 mg/kg screening value. Arsenic in fish tissue is not expected to cause chronic adverse health effects to human consumers.

Individual tissue concentrations ranged from 0.022 to 0.590 mg/kg total arsenic. A subset of 30 samples were analyzed for inorganic arsenic according to the QAPP (DEQ 2016b). The highest individual sample total arsenic concentrations were in South Fork Coeur d'Alene River Upper (Zone 1) trout and Coeur d'Alene Lake northern zone bass and northern pike. Tissue from these samples as well as kokanee collected from the northern and central sections of Coeur d'Alene Lake (Zones 7 and 8) were analyzed for inorganic arsenic. For these 30 samples, individual tissue concentrations of inorganic arsenic ranged from 0.008 to 0.024 mg/kg and did not exceed the inorganic arsenic cancer screening value of 0.026 mg/kg. The assumption for derivation of the total arsenic screening value was that 10 percent of total arsenic would be in the inorganic form. For the subset of 30 samples analyzed for inorganic arsenic, about 9 percent of total arsenic was in the inorganic form which supports the initial screening value derivation. Exposure to arsenic is not expected to be a health risk for fish consumers (low likelihood of excess cancer cases).

Cadmium

Cadmium is not expected to be a health concern for fish consumers because fish tissue concentrations did not exceed the cadmium screening value of 4.0 mg/kg for any samples. The highest geometric mean concentration was 0.150 mg/kg in trout from the South Fork Coeur d'Alene River Lower Zone (Zone 2). This concentration is approximately 26 times lower than the screening value. Individual tissue concentrations of cadmium ranged from 0.017 to 0.370 mg/kg.

Lead

Fish tissue from two sites had geometric mean lead concentrations greater than the 0.063 mg/kg screening value. This included bullhead from the Coeur d'Alene River and Killarney Lake (Zone 3) (geometric mean: 0.112 mg/kg) and trout from the South Fork Coeur d'Alene River (Zone 2) (geometric mean: 0.072 mg/kg). The highest detected individual lead concentration was 0.510 mg/kg in bullhead from the Coeur d'Alene River and Killarney Lake (Zone 3).

Lead exposure in children was evaluated using the IEUBK model for a general fish consumption scenario and a site-specific exposure scenario using measured lead soil and dust concentrations from communities in the BHSS Box. The target risk level is less than 5 percent probability of exceeding 5 µg/dL blood lead level (BLL).

Results from the IEUBK analysis indicated that lead exposure from fish is unlikely to contribute to elevated blood lead levels above the target risk level (Table D2). Exposure to lead in dust and soil is a more significant contributor to elevated BLLs in children than fish consumption. Scenario 1 assumed a high fish consumption rate (50% of meat diet is fish), the default 95th percentile Idaho soil lead concentration (32.7 mg/kg), and the maximum geometric mean lead fish tissue concentration (0.112 mg/kg in bullhead). This scenario assessed how BLLs for each age group were impacted when consuming fish tissue with elevated lead and exposed to only soil with background lead levels. For this exposure scenario, BLLs did not exceed the target risk level of 5 percent probability over 5 µg/dL blood lead (Table D2). Therefore, lead exposure from fish consumption is not likely to impact blood lead levels above acceptable levels of risk.

For Scenario 2 which incorporated a site-specific exposure scenario using the maximum mean soil and household dust concentrations (soil lead: 270 mg/kg) from the community of Pinehurst which is located in BHSS Box (Table D1). This scenario was analyzed for both a high fish consumption scenario (50 percent of meat diet is fish) and a more average fish consumption scenario (10 percent of meat diet is fish). The model results indicated that at elevated soil lead concentrations, the risk of elevated BLLs exceeded the 5 percent probability for all age groups for both fish consumption scenarios (Table D2). Although geometric mean BLLs did not exceed 5 µg/dL for any age group. Therefore, soil and dust ingestion are a much greater contributor to elevated BLLs in children. Additionally, children that may be exposed to soil or dust with higher soil lead concentrations would be expected to have an increased risk of elevated BLLs. In this scenario removing fish from the diet would eliminate the health benefits of consuming fish but would not be expected to significantly reduce BLLs. Reducing exposure to lead contaminated soil and dust would have the greatest impact on reducing lead exposure for children. These scenarios can also be considered a protective estimate of children's lead exposure because the modeling assumed that the only fish consumed had the highest lead levels measured in this assessment.

Mercury

For mercury, no geometric mean concentration exceeded the screening value of 0.4 mg/kg. However, individual fish samples did exceed this value. Individual tissue concentrations ranged from 0.023 to 0.941 mg/kg. The highest mercury levels were primarily seen in bass from multiple sites. This is generally consistent with other Idaho water bodies and the current statewide bass consumption advisory. Additionally, northern pike from most sites had mercury concentrations greater than 0.1 mg/kg which was higher than other species except for bass. Typically, piscivorous fish like bass or pike are expected to have elevated mercury concentrations due to mercury bioaccumulation. Higher mercury concentrations may also be associated with larger fish that have accumulated greater mercury over time. For waterbodies in Idaho, mercury has been the main contaminant of concern for generating consumption advisories. Sources of mercury in Idaho water bodies have been attributed to regional atmospheric deposition of mercury from industrial sources or coal burning (DEQ 2008, 2010).

Recommended consumption limits

The purpose of these fish consumption recommendations is to inform the public which fish may be contaminated, which are safe, and which fish should be consumed in limited quantities for

certain populations. The meals per month recommendations are not regulatory but are provided as a precautionary message to protect public health and sensitive populations such as children and pregnant women.

Recommended consumption limits (meals per month) were first derived individually for mercury and arsenic for all sites and species (Appendix C, Table C3) because these contaminants were present at concentrations that were near or exceeded screening levels. The lowest calculated meals per month of these contaminants was then selected for the consumption advisory. Species and water bodies with less than 8 recommended meals per month for at least one of the population groups are listed in Table C4 (Appendix C). According to IFCAP protocol (IFCAP 2011), less than 8 meals per month is below the American Heart Association (AHA) recommendation of consuming 2 meals per week for health benefits. The AHA considers a meal to be 3.5 oz of fish. This analysis considered a meal to be 8 oz for adults and 4 oz for children. Based on the derivations for recommended meals per month, mercury is of the greatest human health concern of the contaminants measured in this assessment. Meals per month recommendations derived based on mercury would therefore be protective of exposure for the other contaminants. The current statewide bass advisory recommends that children and pregnant women consume no more than 2 meals per month of bass and the general adult population consume no more than 8 meals per month of bass. For sites in this assessment meal recommendations were provided for bass if they were more restrictive than the current advisory for a population group (Table 4 and Table C4).

To increase ease of use and comprehension by the public, meal recommendations for some sites were combined to create simplified recommendations (Table 4). These combinations were based on similar sites within the Basin where people would be likely to fish. For example, Zone 9a and 9b of Lake Coeur d'Alene were combined into one Southern Lake Zone because fish likely travel within this zone and there were no apparent differences in contaminant concentrations in fish from each initial sampling zone. The Zones within the Coeur d'Alene River and Chain Lakes (Zones 3-5) were combined based on likely fishing patterns and similar meal recommendation limits. The Chain Lakes advisory was applied to all the Chain Lakes listed in Table 4 besides those lakes sampled (Anderson, Killarney, Swan and Thompson Lakes). Because meal recommendations for some fish were similar across multiple zones, one meal recommendation was generated for each population group. When more than one site was combined, the smallest meal recommendation was selected to be protective of human health. No kokanee were harvested from the Southern Zones (9a and 9b), but meal recommendations were applied to all of Lake Coeur d'Alene to be protective of health and to be consistent with the previous fish consumption advisory. No consumption advisories were necessary for trout from South Fork Coeur d'Alene River (Zone 1 and 2) or the Spokane River (Zone 6) because contaminant concentrations were not expected to cause adverse health effects for typical fish consumers.

Table 4. Combined meals per month recommendations

Species Group*	Location	Consumption Advisory (meals per month)		
		General Population (8 oz. meal)	**Pregnant Women** (8 oz. meal)	**Children** (4 oz. meal)
Bass	Coeur d'Alene River and Chain Lakes†	4	2	2
	Northern Coeur d'Alene Lake‡	4	2	2
	Central Coeur d'Alene Lake	2	2	1
	Southern Coeur d'Alene Lake	3	2	1
Bullhead	Coeur d'Alene River and Chain Lakes†	12	11	6
Kokanee* (whole)	All Coeur d'Alene Lake‡	13	11	6
Northern pike	Coeur d'Alene River and Chain Lakes†	5	5	2
	All Coeur d'Alene Lake‡	5	4	2
Panfish	Coeur d'Alene River and Chain Lakes†	7	6	3
	All Coeur d'Alene Lake‡	11	9	5

* Kokanee recommendations are based on whole fish consumption and all other species refer to fillet samples.
† Chain Lakes advisory includes Thompson Lake, Anderson Lake, Blue Lake, Black Lake, Swan Lake, Cave Lake, Medicine Lake, Killarney Lake, and Bull Run Lake. The Coeur d'Alene River advisory includes the length of river from Enaville downstream to Coeur d'Alene Lake.
‡ Northern section of Coeur d'Alene Lake includes the Spokane River above the Post Falls Dam.

Limitations and uncertainty

Metal concentrations in fish throughout the Basin are variable and consumption of fish may result in higher or lower exposure to metals than estimated in this assessment. Concentrations of some metals in fish can vary depending on fish size. Fish of larger size may have accumulated higher levels of mercury, which may have introduced additional variability into the mean concentrations. Fish size was not accounted for in the derivation of consumption recommendations, but all fish collected for analysis were representative of sizes that would typically be consumed. The fish tissue sampling protocol and IFCAP guidance are designed to generate an adequate number of samples to provide accurate recommendations protective of human health (IFCAP 2011). For some species fewer than the target 10 fish per species were collected or the full range of possible fish sizes was not sampled. Meal limits derived from these geometric mean concentrations may not capture the full range of tissue concentrations but still allow for the generation of meal limit recommendations. Additionally, fish consumers may be exposed to several metals from fish tissue at once, but health risks were evaluated for contaminants individually. The cumulative risk of cancer from exposure to multiple metals was not evaluated because arsenic was the only carcinogenic contaminant measured in this study and concentrations were below screening levels. Use of the IEUBK model has associated uncertainty in generating blood lead level estimates (USEPA 2007). These estimates are meant to be interpreted using site-specific exposure information. Lead in fish may be stored in greater quantities in bone or organs so consuming whole fish may result in higher exposure than consuming fillet tissue (Schmitt 2004). The recommended meal limits generated in this assessment are intended to serve as general guidance for the public while recognizing the health benefits of eating fish.

Meal limits were calculated using specific population estimates of body mass of fish consumers and contaminant dose may vary depending on body mass. Additionally, meal limits were calculated using EPA RfDs assuming a continuous daily exposure for 30 years for adults and can be considered a conservative estimate of exposure. Conservative estimates of exposure are used in generating meal limits, so the consumption of fish at or below meal limits can be considered generally protective of adverse health effects for fish consumers. The recommendations provided in this document are for the general population. Although the Coeur d'Alene Tribe has been consulted, this assessment may not fully characterize health risks associated with a subsistence fish consumption scenario.

Comparison to previous sampling efforts

Previous fish tissue sampling in 2002 in Coeur d'Alene Lake assessed metals in bullhead, kokanee, and bass (ATSDR 2003). The 2002 sampling effort was limited in site location and species collected compared to the 2016 sampling effort, limiting comparisons of metal concentrations in fish through time. Meals per month recommendations issued in 2003 are provided in Table 5. Table C5 (Appendix C) provides a summary of tissue concentrations from the 2002 sampling in Coeur d'Alene Lake (ATSDR 2003). In 2002 bass, kokanee, and bullhead were evaluated for both fillet and gutted whole fish samples. In 2016, only kokanee were evaluated as whole fish samples. In 2016 bullhead were not collected from Coeur d'Alene Lake. In general, for kokanee (whole fish) tissue concentrations were similar for both sampling periods. Specific conclusions about trends in concentrations cannot be accurately determined with limited comparable data.

Table 5. 2003 Lake Coeur d'Alene meals per month recommendations (ATSDR 2003)

Species	Sample Type	Location	Consumption Advisory (meals per month)		
			General Population (8 oz. meal)	Pregnant Women (8 oz. meal)	Children (4 oz. meal)
Bass	Gutted Whole Fish	North	13	5	3
		Center	15	6	3
		South	11	9	5
	Fillet	Whole Lake	26	5	3
Bullhead	Gutted Whole Fish	North	20	4	3
		Center	8	2	0
		South	33	13	8
	Fillet	North	69	24	14
		Center	14	13	7
		South	61	15	9
Kokanee	Gutted Whole Fish	Whole Lake	12	10	6
	Fillet		20	10	6

Children's health considerations

Children are often more sensitive to the effects of contaminant exposure due to differences in their physiology, metabolism, and behaviors compared to adults. Exposure to contaminants during critical periods of growth and development can cause adverse health effects later in life. Lead and mercury are of particular concern due to their known impacts on brain and nervous system development. Meal limits were calculated for children given their smaller body size to address these potential health concerns. Exposure to these contaminants can also occur during fetal development. Pregnant women, nursing women, or women considering becoming pregnant should consider limiting exposure according to recommended meal limits to reduce potential impacts to developing children. Choosing smaller sized fish for consumption may also reduce exposure to mercury. Additionally, for lead, site-specific exposure scenarios for children living in communities near the Bunker Hill Superfund Site were addressed using the IEUBK model.

Benefits of fish consumption

It is important to consider the benefits of eating fish as part of a balanced diet because fish consumption is associated with beneficial health effects. Fish are an excellent protein and nutrient source and are associated with reduced risk of coronary heart disease. The American Heart Association recommends two meals of fish per week as part of a healthy diet. The goal of the derivation of this fish consumption advisory was to generate recommended meal limits and provide fish consumers with information to balance the potential health risks and benefits of fish consumption.

Conclusions

This assessment updates the consumption advisory for the Coeur d'Alene Basin and provides recommended meal limits for the public for waterbodies throughout the Basin. For the fish species sampled in this assessment, mercury is the main contaminant of human health concern driving the meal limit recommendations. Bass had the highest concentrations of mercury across all waterbodies and these results are generally consistent with the statewide bass advisory and other consumption advisories issued in Idaho. Mercury poses the greatest health risk to children and pregnant women due to its developmental and neurological effects and the concentrations present in fish tissue. IDHW recommends that fish consumers, especially those from sensitive populations, follow recommended meal limits to reduce potential health risks from exposure to mercury.

Concentrations of cadmium, arsenic, and lead in fish are not expected to cause adverse health effects for the general population when following meal recommendations. Lead exposure from consuming fish is not expected to cause adverse health risks to children. For children living in communities near the Bunker Hill Superfund Site, potential exposure to lead in soil and dust is predicted to contribute significantly more to elevated blood lead levels than consuming fish even under the high fish consumption scenarios as described in this assessment. Preventing exposure to contaminated soils would reduce adverse health risks more than avoiding fish consumption, which has known health benefits.

Recommendations and Actions

- To minimize health risks from exposure to metals from consuming fish, IDHW recommends that the public follow the updated meal recommendations for fish species consumed from the water bodies addressed in this assessment (Table 4).
- IDHW will update the current Idaho fish consumption advisory public guidance document (IDHW 2008) with the suggested meal limits derived in this assessment and provide meal recommendations that are understandable by the public.
- IFCAP members should coordinate public outreach for the updated advisory information. Updated advisory information should be incorporated into resources used by anglers such as the Idaho Department of Fish and Game Angler's Guide and fishing regulations guidance.
- IDHW will work the Coeur d'Alene Tribe to issue a joint Fish Consumption Advisory using the meal recommendations in this assessment.
- IDHW in coordination with IFCAP may re-evaluate and update fish consumption advisories if new information or tissue data becomes available.

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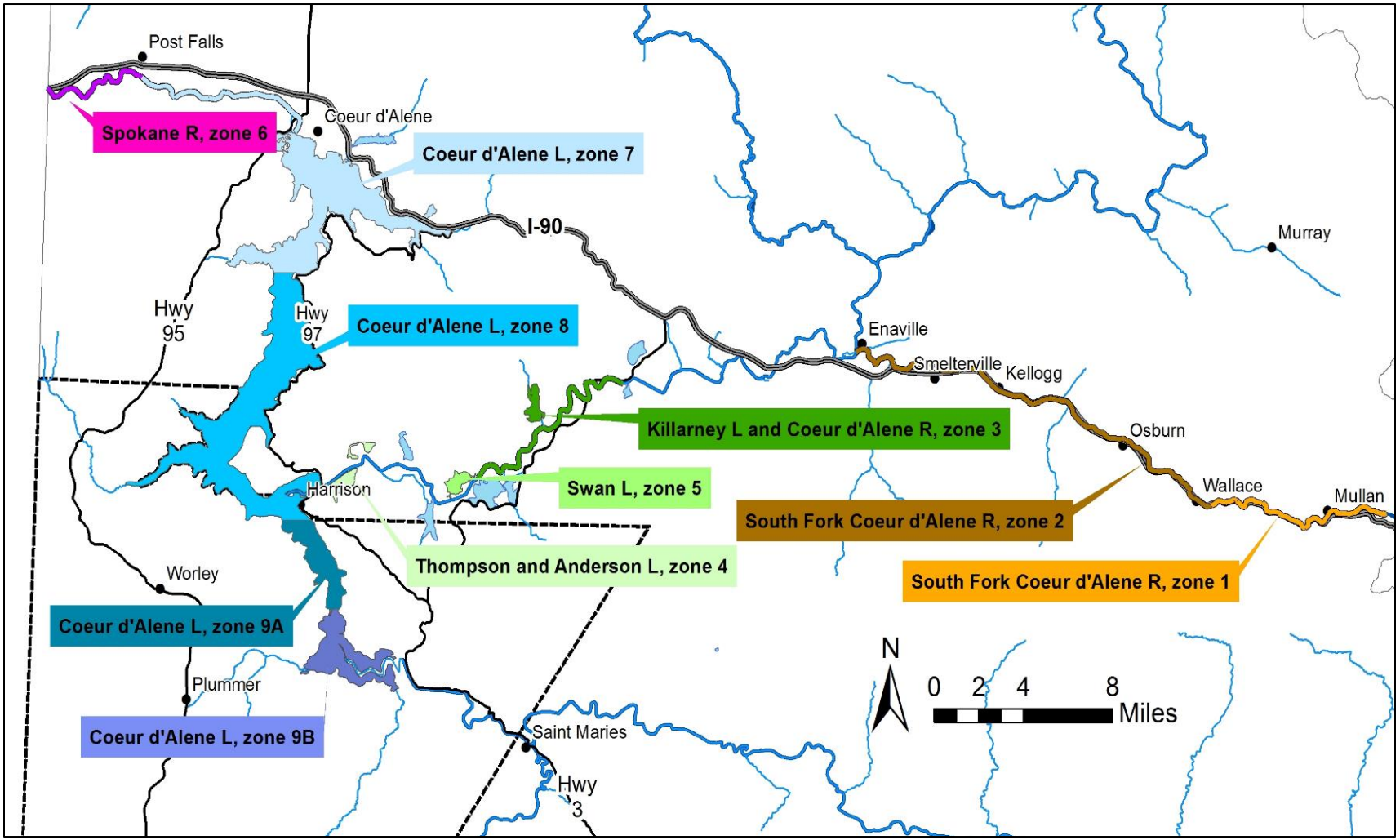
Appendix A: Fish sampling and tissue analysis methods

Figure A1. Fish sampling zones throughout the Coeur d'Alene Basin.



A1. Deviations from targeted collection of fish as outlined in the QAPP (DEQ 2016a)

Deviations from collection of 10 fish per target species included:

- Upper Basin, South Fork Coeur d'Alene River, Zones 1 and 2:
  - Collection of 10 brook trout and 10 mountain whitefish was planned for each zone.
  - For both zones, no mountain whitefish were harvested.
  - For both zones, 10 brook trout could not be harvested; therefore,
    - Zone 1 collection included: 6 eastern brook trout, 1 rainbow trout, and 4 cutthroat trout. 11 samples collected.
    - Zone 2 collection included: 8 eastern brook trout and 1 cutthroat trout. Only 9 of 10 samples collected.
    - Harvesting of cutthroat trout was not planned but was a result of an electrofishing accidental mortality.
- Spokane River, Zone 6:
  - Only 4 of 10 samples collected for rainbow trout.
- Coeur d'Alene Lake, Southern Lake, Zone 9:
  - Originally, only one set of samples was initially planned for the southern part of the lake. However, the *QAPP Addendum, Sample Plan Alteration Form #1* (DEQ 2016b) was prepared to divide Zone 9 into two sections (northern deeper section and southern shallow section) because the Coeur d'Alene Tribe identified that results from sediment, water, zooplankton, and aquatic macrophyte analyses indicate that indicator metals are more prevalent in the northern than in the southern stratum, and corroborate the potential for a similar measurable difference in fish tissue.
  - Kokanee collection was planned for the northern section of the southern part of the lake; however, no kokanee samples were harvested.
  - For the northern deeper section: 9 of 10 samples collected for panfish.

A2. Details of fish tissue preparation and analytical methods

Following sample collection, all fish were wrapped separately in foil and frozen prior to shipment. The frozen samples were transported by vehicle to the EPA Region 10 Manchester Environmental Laboratory in Port Orchard, Washington. The laboratory prepared the fish samples per procedures identified in Appendix C of the QAPP (DEQ 2016a). Details of analytical methods are provided in the QAPP (DEQ 2016a).

Appendix B: Derivation of meals per month recommendations

Meals per month equation for noncarcinogenic chemicals (mercury, cadmium):

$$Meals\ /\ Month = \frac{\frac{RfD \times BW}{Conc} \times 30.44 days / mo}{MS}$$

Meals per month equation for carcinogenic chemicals (arsenic), assuming a lifetime of 70 years:

$$Meals / Month = \frac{\frac{TR \times BW}{q_1^* \times Conc} \times 70 \times 30.44 days / mo}{ED \times MS}$$

Where:

RfD = Chemical specific reference dose (mg/kg/day). Source U.S. EPA IRIS (USEPA 2018)

BW = Body weight (kilograms, kg)
For general adult population: 80 kg (176 lbs)
For pregnant women: 70 kg (154 lbs)
For children: 20 kg (44 lbs)

MS = Meal size (grams, g)
For adults (general population and pregnant women): 227 g (8 ounces)
For children: 113 g (4 ounces)

Conc = Chemical concentration measured in fish tissue (mg/kg wet weight)

TR = Target cancer risk: 10^{-5} or 1 additional cancer case out of 100,000 people.

q_1^* = Cancer slope factor: 1.5 mg/kg-d^-1 Source: U.S. EPA IRIS (USEPA 2018)

ED = Exposure duration (years)

For adults: 30 years

For children: 12 years

Appendix C: Fish Tissue Concentrations and Meals Limits

Table C1. Range of tissue concentrations for each site and species grouping. Shaded cells contain samples greater than the screening value. *N* represents number of samples analyzed and number in parenthesis indicates samples analyzed for inorganic arsenic.

Area	Location	Species Group	N	Concentration Range (mg/kg ww)				
				Arsenic (Total)	Arsenic (Inorganic)	Cadmium	Lead	Mercury
South Fork Coeur d'Alene River (Upper Basin)	Zone 1, Upper	Trout	11 (11)	0.060 - 0.590	0.008 - 0.025	0.027 - 0.031	0.013 - 0.016	0.040 - 0.074
	Zone 2, Lower	Trout	9	0.052 - 0.062		0.060 - 0.370	0.030 - 0.180	0.021 - 0.029
Coeur d'Alene River and Chain Lakes (Lower Basin)	Zone 3, Coeur d'Alene River and Killarney Lake	Bass	10	0.049 - 0.090		0.024 - 0.031	0.012 - 0.020	0.102 - 0.941
		Bullhead	10	0.044 - 0.140		0.022 - 0.030	0.040 - 0.510	0.043 - 0.171
		Northern pike	10	0.051 - 0.068		0.025 - 0.035	0.013 - 0.020	0.087- 0.272
		Panfish	10	0.050 - 0.060		0.024 - 0.060	0.012 - 0.390	0.049 - 0.193
	Zone 4, Swan Lake	Bass	10	0.038 - 0.060		0.019 - 0.021	0.009 - 0.020	0.108 - 0.753
		Bullhead	10	0.047 - 0.130		0.021 - 0.026	0.012 - 0.030	0.038 - 0.141
		Northern pike	10	0.048 - 0.060		0.024 - 0.030	0.010 - 0.015	0.103 - 0.253
		Panfish	10	0.037 - 0.040		0.018 - 0.020	0.010 - 0.070	0.063 - 0.458
	Zone 5, Thompson Lake and Anderson Lake	Bass	10	0.039 - 0.056		0.019 - 0.028	0.010 - 0.014	0.078 - 0.472
		Bullhead	10	0.049 - 0.100		0.023 - 0.025	0.010 - 0.080	0.027 - 0.133
		Northern pike	10	0.050 - 0.070		0.028 - 0.032	0.013 - 0.016	0.043 - 0.161
		Panfish	10	0.039 - 0.041		0.018 - 0.020	0.009 - 0.030	0.033 - 0.126
Spokane River	Zone 6, Spokane River	Bass	10	0.047 - 0.060		0.024 - 0.028	0.010 - 0.014	0.045 - 0.274
		Trout	4	0.060 - 0.068		0.030 - 0.034	0.015 - 0.017	0.043 - 0.087
Coeur d'Alene Lake	Zone 7, Northern Lake	Bass	10 (9)	0.100 - 0.330	0.018 - 0.024	0.023 - 0.030	0.012 - 0.015	0.121 - 0.569
		Kokanee	10 (2)	0.076 - 0.140	0.012	0.070 - 0.210	0.021 - 0.060	0.053 - 0.118
		Northern pike	10 (5)	0.045 - 0.450	0.021 - 0.023	0.022 - 0.037	0.011 - 0.018	0.056 - 0.479
		Panfish	10	0.036 - 0.050		0.018 - 0.021	0.009 - 0.011	0.035 - 0.111
	Zone 8, Central Lake	Bass	10	0.070 - 0.120		0.027 - 0.030	0.013 - 0.15	0.225 - 0.798
		Kokanee	10 (3)	0.070 - 0.170	0.012 - 0.014	0.060 - 0.200	0.020 - 0.050	0.047 - 0.110
		Northern pike	10	0.054 - 0.170		0.027 - 0.030	0.013 - 0.015	0.069 - 0.261
		Panfish	10	0.049 - 0.090		0.024 - 0.060	0.012 - 0.020	0.023 - 0.097
	Zone 9A, Southern Lake, Northern Deeper Section	Bass	10	0.022 - 0.031		0.025 - 0.030	0.011 - 0.015	0.085 - 0.578
		Northern pike	10	0.051 - 0.063		0.025 - 0.031	0.013 - 0.016	0.085 - 0.709
		Panfish	9	0.049 - 0.060		0.017 - 0.028	0.008 - 0.014	0.061 - 0.254
	Zone 9B, Southern Lake, Southern Shallow Section	Bass	10	0.025 - 0.030		0.022 - 0.031	0.012 - 0.015	0.184 - 0.534
		Northern pike	10	0.057 - 0.066		0.028 - 0.033	0.014 - 0.016	0.123 - 0.265
		Panfish	10	0.047 - 0.060		0.022 - 0.024	0.011 - 0.012	0.036 - 0.094

Table C2. Geometric mean tissue concentrations for each site and species grouping. Shaded cells exceeded chemical health screening value. *N* represents number of samples analyzed and number in parenthesis indicates samples analyzed for inorganic arsenic.

Area	Location	Species Group	N	Geometric Mean (mg/kg ww)				
				Arsenic Total	Arsenic Inorganic	Cadmium	Lead	Mercury
South Fork Coeur d'Alene River (Upper Basin)	Zone 1, Upper	Trout	11 (11)	0.225	0.010	0.029	0.015	0.048
	Zone 2, Lower	Trout	9	0.058		0.150	0.072	0.025
Coeur d'Alene River and Chain Lakes (Lower Basin)	Zone 3, Coeur d'Alene River and Killarney Lake	Bass	10	0.058		0.027	0.014	0.245
		Bullhead	10	0.079		0.026	0.112	0.085
		Northern pike	10	0.054		0.027	0.014	0.188
		Panfish	10	0.054		0.031	0.032	0.092
	Zone 4, Swan Lake	Bass	10	0.043		0.020	0.011	0.248
		Bullhead	10	0.071		0.024	0.024	0.072
		Northern pike	10	0.052		0.026	0.013	0.157
		Panfish	10	0.039		0.019	0.022	0.144
	Zone 5, Thompson Lake and Anderson Lake	Bass	10	0.049		0.023	0.012	0.164
		Bullhead	10	0.063		0.024	0.024	0.045
		Northern pike	10	0.059		0.029	0.014	0.099
		Panfish	10	0.040		0.019	0.014	0.069
Spokane River	Zone 6, Spokane River	Bass	10	0.054		0.026	0.013	0.081
		Trout	4	0.065		0.032	0.016	0.059
Coeur d'Alene Lake	Zone 7, Northern Lake	Bass	10 (9)	0.186	0.021	0.027	0.013	0.250
		Kokanee	10 (2)	0.112	0.012	0.115	0.040	0.079
		Northern pike	10 (5)	0.097	0.022	0.027	0.014	0.121
		Panfish	10	0.040		0.020	0.010	0.065
	Zone 8, Central Lake	Bass	10	0.086		0.029	0.014	0.364
		Kokanee	10 (3)	0.117	0.013	0.107	0.032	0.076
		Northern pike	10	0.065		0.029	0.014	0.137
		Panfish	10	0.056		0.032	0.015	0.058
	Zone 9A, Southern Lake, Northern Deeper Section	Bass	10	0.026		0.028	0.013	0.197
		Northern pike	10	0.058		0.028	0.014	0.186
		Panfish	9	0.054		0.024	0.012	0.097
	Zone 9B, Southern Lake, Southern Shallow Section	Bass	10	0.028		0.026	0.014	0.310
		Northern pike	10	0.061		0.031	0.015	0.211
		Panfish	10	0.053		0.023	0.012	0.071

Table C3. Recommended meals consumed per month for general adult population (GP), pregnant women (PW), and children for arsenic and mercury. Cadmium levels were below health screening values. Meal recommendations based on 8 oz serving for adults and 4 oz serving for children.

Area	Location	Species Group	Meals/Month Recommendations (8 oz Adult/4 oz Child)								
			Total Arsenic			Inorganic Arsenic			Mercury		
			GP	PW	Child	GP	PW	Child	GP	PW	Child
South Fork Coeur d'Alene River (Upper Basin)	Zone 1, Upper	Trout	14.4	12.6	7.2	16.3	14.3	8.2	22.3	19.5	11.2
	Zone 2, Lower	Trout	55.8	48.8	27.9				42.4	37.1	21.2
Coeur d'Alene River and Chain Lakes (Lower Basin)	Zone 3, Coeur d'Alene River and Killarney Lake	Bass	55.2	48.3	27.6				4.4	3.8	2.2
		Bullhead	40.8	35.7	20.4				12.7	11.1	6.4
		Northern pike	59.4	52.0	29.7				5.7	5.0	2.9
		Panfish	60.1	52.6	30.1				11.7	10.2	5.8
	Zone 4, Swan Lake	Bass	74.8	65.4	37.4				4.3	3.8	2.2
		Bullhead	45.6	39.9	22.8				15.0	13.1	7.5
		Northern pike	61.7	54.0	30.8				6.8	6.0	3.4
		Panfish	83.0	72.6	41.5				7.5	6.6	3.7
	Zone 5, Thompson Lake and Anderson Lake	Bass	66.4	58.1	33.2				6.5	5.7	3.3
		Bullhead	51.1	44.7	25.6				23.9	20.9	12.0
		Northern pike	54.7	47.9	27.4				10.9	9.5	5.4
		Panfish	80.1	70.1	40.1				15.6	13.7	7.8
Spokane River	Zone 6, Spokane River	Bass	59.5	52.1	29.8				13.3	11.7	6.7
		Trout	49.9	43.7	25.0				18.1	15.8	9.0
Coeur d'Alene Lake	Zone 7, Northern Lake	Bass	17.4	15.2	8.7	7.9	6.9	3.9	4.3	3.8	2.2
		Kokanee	28.9	25.3	14.5	13.9	12.2	7.0	13.6	11.9	6.8
		Northern pike	33.3	29.1	16.6	7.7	6.7	3.8	8.9	7.8	4.4
		Panfish	80.0	70.0	40.0				16.4	14.4	8.2
	Zone 8, Central Lake	Bass	37.4	32.8	18.7				3.0	2.6	1.5
		Kokanee	27.6	24.1	13.8	13.0	11.4	6.5	14.2	12.5	7.1
		Northern pike	49.5	43.3	24.8				7.9	6.9	3.9
		Panfish	57.4	50.2	28.7				18.4	16.1	9.2
	Zone 9A, Southern Lake, Northern Deeper Section	Bass	124.4	108.8	62.2				5.5	4.8	2.7
		Northern pike	55.6	48.6	27.8				5.8	5.1	2.9
		Panfish	60.0	52.5	30.0				11.1	9.7	5.5
	Zone 9B, Southern Lake, Southern Shallow Section	Bass	116.7	102.1	58.3				3.5	3.0	1.7
		Northern pike	52.5	46.0	26.3				5.1	4.5	2.6
		Panfish	60.8	53.2	30.4				15.2	13.3	7.6

Table C4. Consumption recommendations for species with less than 8 meals/month for the general adult population (GP), pregnant women (PW), or children. Meal recommendations based on 8 oz serving for adults and 4 oz serving for children.

Area	Location	Species Group	Meals/month		
			GP	PW	Child
Coeur d'Alene River and Chain Lakes (Lower Basin)	Zone 3, Coeur d'Alene River and Killarney Lake	Bass	4	3	2
		Bullhead	12	11	6
		Northern pike	5	5	2
		Panfish	11	10	5
	Zone 4, Swan Lake	Bass	4	3	2
		Bullhead	15	13	7
		Northern pike	6	5	3
		Panfish	7	6	3
	Zone 5, Thompson Lake and Anderson Lake	Bass	6	5	3
		Northern pike	10	9	5
		Panfish	15	13	7
Spokane River (below Post Falls Dam)	Zone 6, Spokane River (below Post Falls Dam)	Bass	13	11	6
Coeur d'Alene Lake and Spokane River (above Post Falls Dam)	Zone 7, Northern Lake and Spokane River (above Post Falls Dam)	Bass	4	3	2
		Kokanee	13	11	6
		Northern pike	8	7	4
	Zone 8, Central Lake	Bass	2	2	1
		Kokanee	14	12	7
		Northern pike	7	6	3
	Zone 9A, Southern Lake, Northern Deeper Section	Bass	5	4	2
		Northern pike	5	5	2
		Panfish	11	9	5
	Zone 9B, Southern Lake, Southern Shallow Section	Bass	3	3	1
		Northern pike	5	4	2
		Panfish	15	13	7

Table C5. Tissue concentrations from fish collected in Coeur d'Alene Lake during the 2002 sampling effort (ATSDR 2003).

Area	Location	Species	Concentration (mg/kg)			
			Arsenic	Cadmium	Lead	Mercury
Coeur d'Alene Lake	Zone 7, Northern Lake	Bullhead	0.024	0.006	0.029	0.038
	Zone 8, Central Lake	Bass (fillet)	0.064	0.015	0.02	0.188
		Bullhead	0.116	0.016	0.232	0.065
	Zone 9, Southern Lake	Bullhead	0.028	0.005	0.026	0.063
	Entire Lake	Kokanee (fillet)	0.083	0.018	0.02	0.092
		Kokanee (whole)	0.145	0.139	0.115	0.075

Appendix D: IEUBK Model Analysis

Model Version: IEUBKwin32 Version 1.1 Build 11 (USEPA 2007)

Model Inputs

Scenario 1:

Soil background: Idaho 95th percentile background soil lead: 32.7 mg/kg (USEPA 2010)

Fish tissue: 0.112 mg/kg lead – Highest geometric mean concentration measured in bullhead from Coeur d'Alene River and Killarney Lake (Zone 3, Table C2)

High fish consumption scenario: 50% of daily meat diet is fish

Scenario 2:

270 mg/kg – Highest mean soil from BHSS Box communities (Pinehurst, Table D1)

Fish tissue: 0.112 mg/kg lead – Highest geometric mean concentration measured in bullhead from Coeur d'Alene River and Killarney Lake (Zone 3, Table C2)

2a: Typical fish consumption scenario: 10% daily meat diet is fish

2b: High fish consumption scenario: 50% of daily meat diet is fish

Model defaults for air and water exposure and bioavailability were used for both scenarios.

Table D1. Lead soil and dust concentrations measured in communities in the Bunker Hill Superfund Site Box or Basin.

Basin Communities	Soil Lead Geometric Mean (mg/kg)[1]	Vacuum Dust Lead Geometric Mean (mg/kg)
Mullan	1791	229
Burke/Ninemile	211	264
Wallace	166	184
Silverton	192	132
Osburn	221	161
Side Gulches	170	278
Kingston	113	205
Lower Basin	56	117
Box Communities	**Soil Lead Geometric Mean[2]**	**Vacuum Dust Lead Geometric Mean**
Kellogg	131	288
Page	184	160
Pinehurst	270	195
Smelterville	129	202
Wardner	144	248

1 USEPA. 2015. Fourth Five-Year Review Report for Bunker Hill Superfund Site Shoshone and Kootenai Counties, Idaho. November 16, 2015. Source data for Figure 5-3 (Source data prepared by TerraGraphics).

2 USEPA. 2010. Five-Year Review Report; 2010 Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site Operable Units 1, 2, and 3 Idaho and Washington. November 18, 2010. Table 3-3 on page 3-9 is based on data through 2004, with the exception of Wardner, which is based on data available through 2009.

Model Results

Table D2. Results of IEUBK model analysis for predicting increases in children's blood lead level (BLL) above 5 ug/dL based on fish consumption scenarios. Recommended threshold is less than 5 percent exceeding 5 ug/dL. Highest geometric mean lead concentration was for bullhead in CDA River (Zone 3, 0.112 mg/kg) was used as dietary intake. Idaho 95th percentile soil lead concentration used for Scenario 1, and 270 mg/kg soil lead for the site-specific Scenario 2.

	Scenario 1: Soil lead 32.7 mg/kg		**Scenario 2: Soil lead 270 mg/kg**			
	High Exposure (50% Fish Diet)		**Typical Exposure (10% Fish Diet)**		**High Exposure (50% Fish Diet)**	
Age Group (months)	**BLL Geomean (µg/dL)**	**% Above 5 µg/dL**	**BLL Geomean (µg/dL)**	**% Above 5 µg/dL**	**BLL Geomean (µg/dL)**	**% Above 5 µg/dL**
6 to 11	1.43	0.38	3.8	27.1	3.9	29.0
12 to 23	1.66	0.94	4.3	38.0	4.5	41.7
24 to 35	1.62	0.83	4.0	32.4	4.3	37.1
36 to 47	1.56	0.67	3.8	28.5	4.1	33.4
48 to 59	1.60	0.39	3.2	16.6	3.4	21.3
60 to 71	1.34	0.25	2.7	9.3	3.0	13.3
72 to 84	1.29	0.19	2.4	5.8	2.7	9.2

Appendix E: Revisions January 2020

Samples of Northern pike and panfish collected in Zone 9A and 9B were incorrectly labeled as being collected from the other section of Zone 9 (northern deeper or southern shallow section) in the October 2019 report. Tables 4, C1, C2, C3, C4 were corrected to reflect the correct samples for each Zone.

The consumption advisory in Table 4 was clarified as applying to all the Chain Lakes including Thompson Lake, Anderson Lake, Blue Lake, Black Lake, Swan Lake, Cave Lake, Medicine Lake, Killarney Lake, and Bull Run Lake.