ANALYSIS OF HEAVY METALS (Pb, Zn, Cd) IN CULTURALLY SIGNIFICANT PLANTS WITHIN THE GRAND LAKE WATERSHED OF NORTHEASTERN OKLAHOMA

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ABSTRACT—Releases of hazardous substances, including Cd, Pb, and Zn from the Tri-State Mining District, Ottawa County, Oklahoma have caused concern among Tribal members living downstream of this historic mining area regarding contaminant levels present in traditionally gathered plants. Plants and soils from gathering areas located in floodplain habitats were sampled and analyzed for Cd, Pb, and Zn concentrations to investigate this potential health hazard from consumption of culturally significant plants and to identify an exposure pathway from contaminated soils, causing injury to these culturally significant plants. A significant, positive correlation was shown for metal concentrations in plant tissues and soil (Pb: $r = 0.48$, $p = 0.00$; Zn: $r = 0.70$, $p = 0.00$). These results indicate a contamination pathway in which culturally significant plants are exposed to heavy metal concentrations via floodplain soils. Plant metals were compared to the provisional tolerable weekly intakes (PTWI) recommended by the Joint FAO/WHO Expert Committee on Food Additives. In one serving for a child (23 kg), 35% of Cd, 42% for Pb, and 2% for Zn in plant tissue samples exceeded metal concentration for the PTWI. In one serving for an adult (70 kg), 21% Cd, 34% for Pb, and 1% for Zn exceeded metal concentration for the PTWI (Table 5). These results indicate that Tribal consumption of only one serving of culturally important species per week from impacted gathering areas pose serious health risks from exposure of Cd, Pb, and Zn to Tribal members, especially to children. Based on these results, culturally significant plants have been injured as defined by DOI regulations that state "...an injury to a biological resource has resulted from a release of a hazardous substance if the concentration of the substance is sufficient to exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act in edible portions of organisms".. Injured species were found to be widespread across the study area and were collected adjacent to all the water bodies in question in this study; namely, Tar Creek, Elm Creek, Lost Creek, Spring River, and Grand River. Service loss due to [i]njuries to plant species is most likely greater than what is estimated within this study since Tribal members commonly consume multiple servings of multiples species of traditional plants per week. A hypothetical weekly consumption scenario

indicated that an adult Tribal member, 17,054% of their allowable weekly limit intake for Cd, 22,461% for Pb, and 2,320% for Zn. Additionally, a child Tribal member would have consumed 25,952% of their allowable weekly limit for Cd, 34,180% for Pb, and 3,531% for Zn. These calculations highlight the severe magnitude of heavy metal exposure to Tribal members who gather and consume traditional plants within the Grand Lake watershed. The results of this study can be used by Tribes and government entities to make decisions on managing natural resources to protect Tribal traditional lifeways.

Key Words: heavy metals, wild plants, culturally important plants, consumption, Grand Lake watershed, Native American, traditional lifeways.

LIST OF ACRONYMS

Department of the Interior (DOI)

Food and Agricultural Organization of the United Nations (FAO)

Food and Drug Administration (FDA)

Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)

Oklahoma Department of Environmental Quality (ODEQ)

Provisional Tolerable Weekly Intake (PTWI)

Tar Creek Superfund Site (TCSS)

Tri-State Mining District (TSMD)

U.S. Environmental Protection Agency (U.S. EPA)

World Health Organization (WHO)

X-ray Fluorescence (XRF)

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INTRODUCTION

Tribal communities rely on the use of wild plants in order to maintain their traditional lifeways. Gathering of wild plants takes place year round for crafts, ceremonies, food, and medicine. Important seasonal species are canned, dried, or frozen and stored for use throughout the year. As a result of such reliance and uses, Tribal consumption rates of wild plants are typically higher than the general population. Commonly, all meals during any given day are supplemented by wild plants. Each generation has retained this sacred knowledge through songs, stories, and first-hand teachings from Tribal elders (Garvin et al., 2009).

Gathering of wild plants is often necessary for survival of Tribal communities. Poverty and unemployment rates among Tribal communities are the highest for any ethnic group in the U.S, with nearly one in three individuals living below the poverty line. Because they are highly dependent upon their natural resources, Tribal communities are more susceptible to adverse health effects from pollution. In many cases, they have greater exposure risks than the general population as a result of their dietary practices and unique cultures that embrace the environment (Walker, et al., 2012).

In northeastern Oklahoma, heavy metal runoff from historic lead and zinc mining operations has contaminated natural resources, including floodplain areas used by Tribal communities to gather edible wild plants. Historic mining operations within the Tri-State Mining District (TSMD) encompass approximately 1,188 square miles in southeastern Kansas, southwestern Missouri, and northeastern Oklahoma (Brosius and Sawin, 2001). The Oklahoma portion of the TSMD is referred to as the Tar Creek Superfund Site (TCSS). Two major rivers (Spring River and Neosho River) and their watersheds combine to form Grand River and drain the entire TSMD into Grand Lake o' the Cherokees (Grand Lake). Lands and natural resources located downstream of the TMSD and within jurisdictional areas of ten Tribes have and continue to be exposed to upstream heavy metals sources from TMSD, and potentially render certain resources (i.e. wild plants) unsafe for use or consumption within Tribal communities.

In 2010, the Six Treaty Tribes of Oklahoma[1] analyzed heavy metal concentrations of floodplain soils (clay fraction) within their jurisdictional lands located in the Grand Lake watershed. Heavy metal concentrations in floodplain soils that were located approximately 8 miles downstream of the TSMD were as high as 24.9 mg/kg Cd, 250 mg/kg Pb, and 4,400 mg/kg Zn (Garvin et al., 2010). In comparison, background concentrations within soils have previously been established within the Tri-State area as 0.6 mg/kg Cd, 20 mg/kg Pb, and 100 mg/kg Zn (Pope, 2004). The number of transects that exceeded background concentrations are shown in Appendix A. Results of this study determined that heavy metals have contaminated floodplain soils within Tribal jurisdictions that are located as far south as the upper end of Grand Lake.

[1] These are the Cherokee Nation, Eastern Shawnee Tribe of Oklahoma, Miami Tribe of Oklahoma, Ottawa Tribe of Oklahoma, Seneca-Cayuga Tribe of Oklahoma, and Wyandotte Nation of Oklahoma. These Tribes formed the Six Treaty Tribes of Oklahoma in 2009 to address specific Tribal natural resource concerns.

Recent surveys[2] administered by the Six Treaty Tribes of Oklahoma in 2009 and 2011 to Tribal members living within northeastern Oklahoma indicated that gathering culturally significant plants was considered to be very important in maintaining traditional lifeways. It was also indicated that the majority of culturally important species used by Tribal members are gathered from floodplain habitats of the Grand Lake watershed (Garvin et al., 2011). Floodplains are very important gathering locations for Tribal communities because they are easily accessed by boat and support a wide variety of culturally significant plant species, both in quantity and diversity. Results from the recent sediment study and Tribal surveys have raised interrelated concerns regarding the impact of ongoing heavy metals contamination on wild plants within floodplain areas and the potential health risks posed to Tribal communities who gather and consume wild plants from these areas.

As defined by the Department of the Interior (DOI), an injury to a biological resource has resulted from a release of a hazardous substance if the concentration of the substance is sufficient to exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. § 342, in edible portions of organisms. 43 CFR § 11.62(f)(1)(ii). The regulations further specify that [i]njury to biological resources, as such injury is defined in § 11.62(f)(1)(ii), may be determined by using methods acceptable to or used by the Food and Drug Administration or the appropriate State health agency in determining the levels defined in that paragraph. 43 CFR § ``.64(f)(4) Methods that U.S. Food and Drug Administration (FDA) accepts or uses for these purposes include those used by the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives to establish tolerable human intakes of Cd, Pb, and Zn contained in foods. These limits are referred to as the provisional tolerable weekly intake (PTWI) and represent the acceptable human weekly exposure to contaminants within foods (FAO/WHO, 2004).

The methods used by the FAO/WHO to establish tolerable human intakes of Cd, Pb, and Zn contained in foods are methods that the FDA accepts or uses to determine whether concentrations of these metals are sufficient to exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. § 342 in edible portions of organisms (B. Harper, personal communication, March 11, 2014). Injury to culturally important plant species can therefore be determined under 43 CFR § 11.62(f)(1)(ii) by assessing heavy metal concentrations in plant species, using these data to calculate the PTWI for each species, and then comparing the PTWI to approximate serving sizes and the frequency of consumption by Tribal members for each species. Any species that contains higher concentrations than the weekly tolerable limit based on Tribal consumption frequency is injured under 43 CFR § 11.62(f)(1)(ii).

The objectives of this study were to 1) assess the concentrations of Cd, Pb, and Zn in culturally significant plants used by the Six Treaty Tribes of Oklahoma, 2) compare heavy metal concentrations in culturally significant plants to concentrations within floodplain soils to identify

[2] Data from survey can be accessed from the Eastern Shawnee Tribe of Oklahoma Environmental Department. For contact information visit http://www.estoo-nsn.gov/.

metal pathways, 3) calculate PTWI values for culturally significant plants, and 4) identify injured culturally significant plants based on exceedances of the PTWI as provided in 43 CFR § 11.62(f)(1)(ii).

METHODS

Located along the southwestern flank of the Ozark Mountains, the abandoned TSMD encompasses 1,188 square miles in southeastern Kansas, southwestern Missouri, and northeastern Oklahoma. Commercial extraction of lead and zinc bearing ores within the TSMD took place for nearly 120 years (1850-1970), peaking between 1918 and 1941 (Brosius and Sawin, 2001). Mining occurred within a 50-150 ft thick limestone and chert bearing strata known as the Boone Formation or Boone Aquifer. As part of the mining process, the Boone Formation was continuously dewatered to keep the mines from flooding. Mining and milling operations within the TSMD resulted in the accumulation of abandoned mine wastes on the ground surface in the form of fine sediments within flotation/tailing ponds and large piles of gravel-size chert known as chat. Mining activities also created an extensive and interconnected network of underground mine workings. When the mining finally ceased in 1970, the pumps used to dewater the mines were shut off, causing the mines to fill with highly acidic water that contained elevated concentrations of SO_4^-, Pb, Zn, Cd, and Fe (USEPA 2000). Metals located in the mines and in waste materials on the surface have led to contamination of not only the groundwater, but to surface water, sediments, and floodplain soils within the Grand Lake watershed (Davis and Schumacher 1992; Ankley et al. 1996; USEPA 2000; USGS 2009; Garvin et al., 2010).

The study location for this project is the Oklahoma portion of the Grand Lake Watershed (Figure 1). Figure 1 shows the jurisdictional boundaries for all Tribes in the area. The two major rivers that make up the watershed are the Neosho River and Spring River. Two important tributaries of the Neosho River drain upstream mining areas: Elm Creek drains mining areas in Cherokee County, KS and Tar Creek drains the TCSS in Ottawa County, OK. Spring River drains several portions of the Tri-State Mining District in areas of Cherokee County, KS and Jasper and Newton counties, MO. It is joined by several tributaries in Oklahoma including Beaver Creek and Quapaw Creek, both of which drain the TCSS. Where the two rivers join, the Grand River begins. Before the Grand River becomes Grand Lake, it receives mine drainage from Newton County, MO via Lost Creek. Tribal gathering practices frequently occur in riparian habitats since they support a diverse and rich ecosystem of plants and animals that are important for subsistence. As seen in Figure 2, plant tissue sampling sites were chosen in areas previously shown to have heavy metal contamination within floodplain soils of Tribal jurisdictions (Garvin et al., 2010). The latitude and longitude of these sampling locations are shown in Table 1.

Figure 1: Tribal jurisdictions within the Grand Lake watershed.

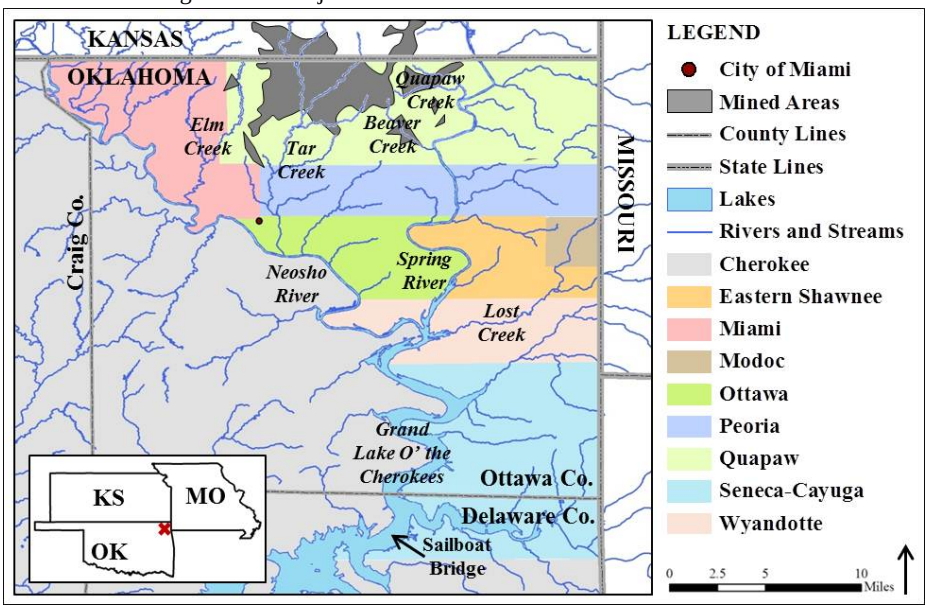
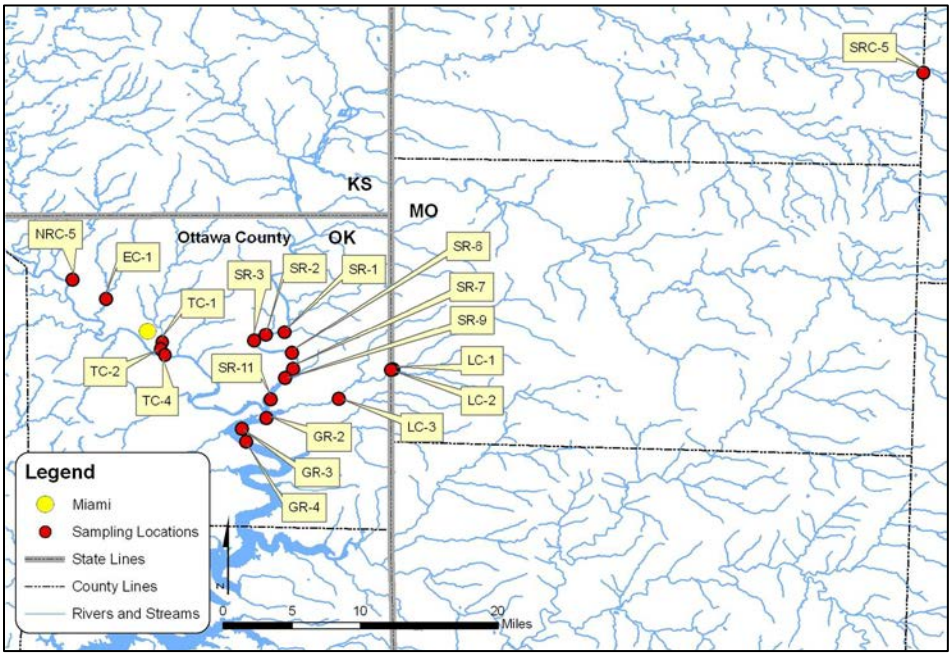


Table 1: Latitude and longitude of sampling locations within the Grand Lake watershed.

Locations of Plant Sampling for Metal Analysis		
Site	Latitude	Longitude
EC-1	36.91372	-94.92095
GR-2	36.7887	-94.75193
GR-3	36.77761	-94.7779
GR-4	36.76384	-94.77348
LC-1	36.83928	-94.61852
LC-2	36.83886	-94.62055
LC-3	36.80857	-94.67572
NRC-5	36.93388	-94.95599
SR-1	36.87832	-94.73316
SR-11	36.808097	-94.747415
SR-2	36.87572	-94.75247
SR-3	36.86954	-94.76492
SR-6	36.85689	-94.72532
SR-7	36.839729	-94.72434
SR-9	36.83047	-94.73242
SRC-5	37.15078	-94.0609
TC-1	36.86779	-94.86174
TC-2	36.860719	-94.863521
TC-4	36.85456	-94.85858

*Elm Creek (EC), Grand River (GR), Lost Creek (LC), Neosho River Control (NRC), Spring River (SR), Spring River Control (SRC), and Tar Creek (TC).

Figure 2: Sampling locations where culturally important plant tissues were collected for heavy metal analysis and coincide with previous floodplain soil sampling (Garvin et al., 2010).



Field and Laboratory Procedures

All field and laboratory procedures followed those approved within the sampling analysis plan (SAP)[3]. The specific plant organ that is used by Tribes was sampled for each species. Roots or rhizomes were dug with a stainless steel trowel and removed from the plant using stainless steel scissors. Leaves, stems, or fruit were also collected from plants using stainless steel scissors. All samples were rinsed thoroughly with deionized water, placed in a resealable plastic bag, and stored at 4 °C until shipment. Sampling equipment was sterilized between each use by scrubbing with Liquinox® and rinsing with deionized water. Concentrations of Cd, Pb, and Zn in plant samples were analyzed by ACZ Laboratories in Steamboat Springs, Colorado. Concentrations were determined using inductively coupled plasma-mass spectrometry (ICP-MS) using EPA Method 6020.

Soil samples analyzed within this study were based on previous collected data from Garvin et al. 2010, and sample collections consisted of the following procedures. Using a stainless steel trowel and bowl, a composite soil sample (15 cm deep) was collected from designated floodplain sites. Samples were refrigerated at 4 °C until shipment. Sampling equipment was sterilized between each use by scrubbing with Liquinox® and rinsing with deionized water. Samples were transferred to white Dixie® bowls, oven dried at 110 °C for 8 hours, and then ground with a mortar and pestle to break the sample apart, but making sure not to pulverize any portion of the sample. The sample was then passed through a 5-, 10-, 35-, 60-, 120-, and 230-mesh sieve to achieve a homogenized sample that was less than 63 µm (clay

[3] The SAP was approved by the Tar Creek Trustee Council and is available online at <http://www.ottawatribe.org/wp-content/uploads/2001/04/CRISAPfinal133.pdf>.

fraction). A portion of the sieved sample was placed in a 31.0 mm polyethylene sample cup so that one-half to two-thirds of the sample cup was full. The sample cup was then covered with a 2.5 µm Mylar film for analysis. The remaining homogenized portions of all samples were stored in Ziploc™ bags. All equipment including mortar, pestle, and sieves were thoroughly sterilized between each use by scrubbing with Liquinox® and rinsing with deionized water. X-ray Fluorescence (XRF) screening was performed at the Cherokee Nation Environmental Office in Tahlequah, Oklahoma by a certified operator (Garvin et al., 2010).

Calculation of Provisional Tolerable Weekly Intakes

Acceptable or tolerable intakes of Cd, Pb, and Zn have been established by the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives (FAO/WHO, 2004). These limits are referred to as the provisional tolerable weekly intake (PTWI) and represent the acceptable human weekly exposure to contaminants within foods. The PTWI is based on the number of mg of contaminant that is consumed per kg of body weight per week. As seen in Table 2, the established PTWI limit of Cd is 0.007 mg/kg/week, Pb is 0.025 mg/kg/week, and Zn is 7 mg/kg/week (FAO/WHO, 2004). This can be further understood that for every kg a person weighs, they may consume 0.007 mg Cd, 0.025 mg Pb, and 7 mg Zn per week. Using the established PTWI limits, the PTWI of any individual can be calculated based on their weight. Thus, a child weighing 23 kg may consume 0.161 mg Cd, 0.575 mg Pb, and 161 mg Zn per week. Similarly, an adult weighing 70 kg may consume 0.49 mg Cd, 1.75 mg Pb, and 490 mg Zn per week.

Table 2: Provisional tolerable weekly intake (PTWI) limits for Cd, Pb, and Zn for children (23 kg) and adults (70 kg).

Additive	Established PTWI limit per kg body weight[a]	PTWI of a 23 kg child	PTWI of a 70kg adult
Cd	0.007	0.161	0.49
Pb	0.025	0.575	1.75
Zn	7	161	490

[a] provisional tolerable weekly intake limit (mg/kg body weight/week) established by the Joint FAO/WHO Expert Committee on Food Additives.

Serving size and frequency of consumption are variables that influence metal exposure. Typical serving sizes of each culturally significant plant species that were sampled within this study are shown in Table 3. These data were used to calculate the percentage of the PTWI that was obtained for heavy metals by consuming one serving of a specific plant species for an average child (23kg) and an average adult (70kg).

Table 3: Species of culturally significant plants sampled for heavy metal concentrations and their approximate serving sizes within Tribal communities (Garvin et al., 2011).

Species	Common name	Plant organ consumed[a]	Child serving size[b] (g)	Adult serving size[c] (g)
Allium stellatum	wild onion	w	25	50
Arisaema dracontium	green dragon	r	25	50
Arisaema triphyllum	jack-in-the-pulpit	r	50	100
Asarum canadense	wild ginger	r	25	50
Asclepias syriaca	common milkweed	l,s	50	100
Asimina triloba	pawpaw	f,l	75	150
Betula nigra	river birch	s	75	150
Carya illinoinensis	pecan	f	60	120
Daucus carota	wild carrot	f,r	50	100
Duchesnea indica	strawberry	f	75	150
Impatiens capensis	jewelweed	s	25	50
Ipomoea pandurata	wild potato-vine	r	50	100
Lactuca canadensis	wild lettuce	l,s	50	100
Lemna minor	duckweed	w	75	150
Lepidium virginicum	peppergrass	l,s	25	50
Lindera benzoin	spicebush	l,s,r	25	50
Morus alba	white mulberry	f,l,s	75	150
Oxalis corniculata	wood-sorrel	l,s	50	100
Perilla frutescens	wild mint	l,s	50	100
Phytolacca americana	poke	l	50	100
Plantago major	common plantain	l,s	50	100
Podophyllum peltatum	mayapple	f,r	25	50
Polygonatum biflorum	solomon's seal	r	25	50
Pteridium aquilinum	bracken fern	l,s	50	100
Ranunculus acris	buttercup	l,s	50	100
Rubus allegheniensis	blackberry	f	75	150
Rumex crispus	curly dock	l,s,r	50	100
Sagittaria latifolia	arrowhead root	r	50	100
Salix nigra	black willow	l,b,r	25	50
Sambucus canadensis	elderberry	f	75	150
Smilax glauca	greenbrier	l,s,r	25	50
Symphoricarpus orbiculatus	buckbrush	s	25	50
Taraxacum offincinale	dandelion	l,s	50	100
Verbascum thapsus	mullein	l,s	25	50
Viola canadensis	violet	l,s,r	50	100
Vitis vulpina	wild grape	f,l,s,r	75	150

[a] f = fruit, l = leaves, r = root, s = stem, w = whole plant.

[b] serving size is approximated on what a child Tribal member weighing 23 kg typically consumes.

[c] serving size is approximated on what an adult Tribal member weighing 70 kg typically consumes.

Statistical Analysis

All statistical tests were performed using Statistica 9 software (Statsoft®, Tulsa, OK). Normality was tested using two methods; firstly, by using histograms to visually inspect the data and secondly, by performing two statistical tests for normality (Kolmogorov-Smirnov and Shipiro-Wilks). All parameters tested were non-normal. Therefore, it was concluded that non-parametric statistical analyses would be used in all cases. Statistical differences between two groups of data were determined using the Mann-Whitney U test for independent samples. Statistical comparisons between groups of data were made using the Spearman Rank Order correlation test. All statistical analyses were performed at a 95% confidence interval.

RESULTS AND DISCUSSIONS

Heavy Metal Concentrations in Culturally Significant Plants

Background levels for each plant species sampled were determined by observing the lowest recorded value for Cd, Pb, and Zn in control samples. In almost all instances, background levels for Cd, Pb, and Zn were exceeded for plant samples (on a species by species basis) taken within impacted areas. Additionally, no single sample measured below the background concentration for all three trace metals. These data are presented in Appendix B.

Culturally significant plant tissues were collected from individuals within the floodplain that were located near the same transects sampled in a sediment/soil XRF study by Garvin et al. (2010). Soil data from Garvin et al. (2010) are shown in Appendix C. As seen in Table 4, plant tissue metal concentrations for Pb and Zn were compared to concentrations within the soil. Lead concentrations in plant tissues and soil were significantly, positively correlated ($r = 0.48$, $p = 0.00$). Zinc concentrations in plant tissues and soil were also significantly, positively correlated ($r = 0.70$, $p = 0.00$). These results indicate a contamination pathway in which culturally significant plants are exposed to heavy metal concentrations via floodplain soils.

Table 4: Results of a correlation analysis for Pb and Zn concentrations in plant tissues and clay fraction of floodplain soils (soil data from Garvin et al., 2010).

Correlation	r	p - value	n
Lead Plant vs. Soil	0.48	0.00	285
Zinc Plant vs. Soil	0.70	0.00	291

Using plant tissue heavy metal concentration data and serving size estimations for Tribal consumption, the PTWI was calculated for Cd, Pb, and Zn of each culturally important species at each sampling location. These data are shown in Appendix B, and indicate the percentage of the PTWI that is consumed (for each trace metal) should a child (weighing 23 kg) and adult

(weighing 70 kg) consume only one serving of a particular plant species. In Table 5, the number and percentage of plant tissue samples (n = 202) with concentrations of Cd, Pb, and Zn[4] that exceeded the PTWI are shown. For a child, 35% of plant tissue samples exceeded metal concentration the PTWI (with only one serving) for Cd, 42% for Pb, and 2% for Zn. For an adult, 21% exceeded the PTWI for Cd, 34% for Pb, and 1% for Zn. These results indicate that Tribal consumption of only one serving of culturally important species per week from impacted gathering areas pose serious health risks from exposure of Cd and Zn to Tribal members, especially to children.

Table 5: Number and percentage of plant tissue samples (n = 202) that exceeded the PTWI for Cd, Pb, and Zn with only one serving.

Number/Percentage	Child (23 kg)			Adult (70 kg)		
	Cd	Pb	Zn	Cd	Pb	Zn
# Samples in Exceedance of PTWI	70	85	3	45	69	2
% Samples in Exceedance of PTWI	35%	42%	2%	21%	34%	1%

DETERMINATION OF INJURY AND CONCLUSIONS

Culturally important plant species growing within the floodplain habitats of the Grand Lake watershed that are exposed to heavy metal releases from the TSMD contain highly elevated concentrations of Cd, Pb, and Zn compared to background concentrations. Since a significant, positive correlation was shown for metal concentrations in plant tissues and soil (Pb: $r = 0.48$, $p = 0.00$; Zn: $r = 0.70$, $p = 0.00$), these results identify a pathway to culturally significant plants from heavy metal in floodplain soils. Results have shown an abundance of culturally significant plants still available for Tribal use even though there are very high concentrations of heavy metals in the soils. The metal exposure to Tribal members who gather at these locations is of serious concern because of the established contamination pathway to plants via soil.

As defined by the DOI, an injury to a biological resource has resulted from a release of a hazardous substance if the concentration of the substance is sufficient to exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. § 342, in edible portions of organisms. 43 CFR § 11.62(f)(1)(ii). The regulations further specify that [i]njury to biological resources, as such injury is defined in § 11.62(f)(1)(ii), may be determined by using methods acceptable to or used by the Food and Drug Administration or the appropriate State health agency in determining the levels defined in that paragraph. 43 CFR § 11.64(f)(3). Methods that FDA accepts or uses for these purposes include those used by the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives to establish tolerable human intakes of Cd, Pb, and Zn contained

[4] Even though there are few exceedances of the PTWI with respect to Zn, it is important to include since Zn is colocated with Cd and Pb.

in foods (B. Harper, personal communication, March 11, 2014). These limits are referred to as the provisional tolerable weekly intake (PTWI) and represent the acceptable human weekly exposure to contaminants within foods (FAO/WHO, 2004).

Injury to plant species that are culturally important to the Six Treaty Tribes of Oklahoma can therefore be determined based on their exceedance of the PTWI levels for Cd, Pb, and Zn. The calculations of the PTWI within this study were based on a Tribal member, adult or child, eating only one serving per week of a culturally important plant species. Results showed that: 35%, 40%, and 2% of samples exceeded the PTWI for a child (23 kg) for Cd, Pb, and Zn, and 21%, 33%, and 1% of samples exceeded the PTWI for an adult (70 kg), respectively (Table 5). Injured species were found to be widespread across the study area and were collected adjacent to all the water bodies in question in this study; namely, Tar Creek, Elm Creek, Lost Creek, Spring River, and Grand River. Of the 36 species sampled, 33 were found to be injured (92%) for at least one sampling location for at least one metal. Injured species include: arrowhead root, black willow, bracken fern, buckbrush, buttercup, common milkweed, common mullein, common plantain, creeping wood-sorrel, curly dock, dandelion, duckweed, green dragon, greenbrier, Jack-in-the-pulpit, jewelweed, pawpaw, peppergrass, poke, river birch, solomon's seal, violet, white mulberry, wild blackberry, wild carrot, wild ginger, wild grape, wild lettuce, wild mint, wild potato-vine, and wild strawberry. The number and relative percentage of injured species found at each sampling site are shown in Table 6. The full list of injured species at each sampling site can be seen in Appendix D.

Table 6: Number and percentage of injured plant species based on PTWI exceedances of Cd, Pb, and Zn (by consuming only one serving per week) found at each sampling site.

	Site							
	EC-1	GR-3	GR-4	LC-1	LC-2	LC-3	SR-1	SR-11
# Plant Species Sampled	29	6	6	22	18	12	20	8
# Plant Species Injured	17	2	2	9	3	4	11	4
% Injured Species at Site	59%	33%	33%	41%	17%	33%	55%	50%
	Site							
	SR-2	SR-3	SR-6	SR-7	SR-9	TC-1	TC-2	TC-4
# Plant Species Sampled	18	15	6	11	1	6	7	3
# Plant Species Injured	11	11	3	7	1	5	5	3
% Injured Species at Site	61%	73%	50%	64%	100%	83%	71%	100%

The degree of exceedance of the PTWI for each metal was another important aspect to consider. For example, a duckweed sample from TC1 had 7,547%, 6,743%, and 1,118% exceedance of the PTWI values for Cd, Pb, and Zn, respectively. Table 7 shows the numbers of samples that exceeded the PTWI for Pb, Zn, and Cd to different degrees.

Table 7: Number and degree of exceedance of the PTWI (by consuming only one serving per week) for Cd, Pb, and Zn of plant tissue samples (n = 202) for a typical child or adult.

Degree of Exceedance	Number of Exceedances					
	Child (n = 202)			Adult (n = 202)		
	Pb	Zn	Cd	Pb	Zn	Cd
≥ 100%	85	3	70	69	2	70
≥ 150%	69	2	46	43	2	46
≥ 200%	54	2	37	31	2	37
≥ 400%	26	2	8	10	1	8
≥ 600%	10	1	4	2	1	4
≥ 800%	3	1	3	2	0	3
≥ 1000%	2	1	2	2	0	2

It is important to clarify that the majority of Tribal members are likely eating much more than one serving of one species per week (i.e. multiple servings of multiple species are eaten daily). If a Tribal member were to consume one serving of a particular plant that contained greater than 100% of the PTWI (per their body weight) for a metal then they could not safely consume any more of that metal within a seven day period. As such, service loss due to [i]njuries to plant species are most likely greater than what is estimated within this study, and Tribal health is more at risk.

In order to better understand the severity of exposure to heavy metals within the diets of Tribal members, a weekly consumption scenario has been included in this discussion. As seen in Table 8, the consumption scenario consists of a hypothetical weekly diet of a Tribal member living within the Grand Lake watershed. It is assumed that the Tribal member actively consumes traditional plants from gathering areas that were sampled within this study. All traditional food items chosen within the scenario have been shown to be commonly eaten by Tribal members (Garvin et al., 2011). Within the scenario, each food item is based on one serving size (see Table 3). The PTWI is calculated only for traditional plants that were hypothetically gathered from locations within this study (It is important to mention that fish are commonly harvested within the Grand Lake watershed, and therefore present an major exposure pathway via consumption as well (ODEQ 2003, 2007)). If an adult Tribal member were to follow the weekly consumption scenario as part of their diet, they would have consumed 17,054% of their allowable weekly limit intake for Cd, 22,461% for Pb, and 2,320% for Zn (see Table 9). Additionally, a child Tribal member would have consumed 25,952% of their allowable weekly limit for Cd, 34,180% for Pb, and 3,531% for Zn (see Table 10). These calculations highlight the severe magnitude of heavy metal exposure to Tribal members who gather and consume traditional plants within the Grand

Lake watershed. As a product of this research, Tribes and government entities will be better equipped to make decisions on managing natural resources that will be protective of Tribal health and traditional lifeways.

Table 8: Tribal consumption scenario: a hypothetical weekly diet of a Tribal member who consumes traditional plants growing in gathering locations sampled within this study.

Day	Breakfast	Lunch	Dinner
Monday	eggs wild onions (TC-1) toast blackberry jam (SR-3)	chicken sandwich chips	fish wild ginger (SR-2) common milkweed (SR-7) poke (SR-3) bread
Tuesday	cereal milk toast blackberry jam (SR-3) spicebush tea (SR-2)	fish poke (SR-3) dandelion (SR-3) peppergrass (SR-3) wild onions (TC-1)	venison hominy wild potato (TC-2) poke (SR-3) bread
Wednesday	eggs wild onions (TC-1) toast strawberry jam (LC-1)	fish poke (SR-3) dandelion (SR-3) peppergrass (SR-3) wild onions (TC-1)	venison corn duckweed soup (TC-1) wild onions (TC-1) bread
Thursday	eggs wild onions (TC-1) venison toast elderberry jam (SR-1)	ham sandwich chips	chicken mashed potatoes common milkweed (SR-7) poke (SR-3) bread
Friday	cereal milk toast blackberry jam (SR-3) wild mint tea (LC-1)	poke (SR-3) dandelion (SR-3) bracken fern (SR-1) wild lettuce (EC-1) wild onions (TC-1)	fish hominy poke (SR-3) dandelion (SR-3) peppergrass (SR-3) wild onions (TC-1) bread
Saturday	eggs wild onions (TC-1) venison toast blackberry jam (SR-3)	chicken sandwich chips	fish wild ginger (SR-2) common milkweed (SR-7) poke (SR-3) bread
Sunday	eggs wild onions (TC-1) venison toast blackberry jam (SR-3)	venison corn duckweed soup (TC-1) wild onions (TC-1) bread	fish hominy poke (SR-3) dandelion (SR-3) peppergrass (SR-3) wild onions (TC-1) bread

*Elm Creek (EC), Lost Creek (LC), Spring River (SR), and Tar Creek (TC). Reflects the location at which the plant species was gathered from.

*Assume each food item within each meal is based on one serving size (see Table 3).

*Assume fish and venison are collected by Tribal members within the Grand Lake watershed.

Table 9: Calculated PTWI for an adult Tribal member (weighing 70 kg) that has followed the weekly diet within the Tribal consumption scenario.

Day	Weight (mg/g serving size)			Plant Species
	Cd	Pb	Zn	
Monday	0.99	5.5	88	wild onion
	0.349	3.49	52.5	wild ginger
	0.331	2.11	39.8	common milkweed
	0.775	7.91	133	poke
	0.663	5.79	113.7	wild blackberry
Tuesday	0.663	5.79	113.7	wild blackberry
	0.391	1.53	38.5	wild potato-vine
	1.38	0.3685	25.4	spicebush
	0.775	7.91	133	poke
	0.775	7.91	133	poke
	0.99	5.5	88	wild onion
	1.05	7.57	111	dandelion
	0.461	0.4485	51.5	peppergrass
Wednesday	0.99	5.5	88	wild onion
	0.99	5.5	88	wild onion
	0.99	5.5	88	wild onion
	0.775	7.91	133	poke
	1.05	7.57	111	dandelion
	0.461	0.4485	51.5	peppergrass
	24.3	77.55	3600	duckweed
	0.3615	4.98	64.5	wild strawberry
Thursday	0.99	5.5	88	wild onion
	0.331	2.11	39.8	common milkweed
	0.775	7.91	133	poke
	0.0285	0.2955	14.7	elderberry
Friday	0.663	5.79	113.7	wild blackberry
	0.177	2.85	29.5	wild mint
	0.775	7.91	133	poke
	1.05	7.57	111	dandelion
	0.602	7.01	116	bracken fern
	1.07	1.84	74.2	wild lettuce
	0.99	5.5	88	wild onion
	0.775	7.91	133	poke
	1.05	7.57	111	dandelion
	0.461	0.4485	51.5	peppergrass
	0.99	5.5	88	wild onion
Saturday	0.99	5.5	88	wild onion
	0.663	5.79	113.7	wild blackberry
	0.349	3.49	52.5	wild ginger
	0.331	2.11	39.8	common milkweed
	0.775	7.91	133	poke
Sunday	0.99	5.5	88	wild onion
	0.663	5.79	113.7	wild blackberry
	24.3	77.55	3600	duckweed
	0.99	5.5	88	wild onion
	0.775	7.91	133	poke
	1.05	7.57	111	dandelion
	0.461	0.4485	51.5	peppergrass
	0.99	5.5	88	wild onion
Total mg:	83.56	393.06	11369.7	
PTWI:	17,054%	22,461%	2,320%	

Table 10: Calculated PTWI for a child Tribal member (weighing 23 kg) that has followed the weekly diet within the Tribal consumption scenario.

Day	Weight (mg/g serving size)			Plant Species
	Cd	Pb	Zn	
Monday	0.495	2.75	44	wild onion
	0.1745	1.745	26.25	wild ginger
	0.1655	1.055	19.9	common milkweed
	0.3875	3.955	66.5	poke
	0.3315	2.895	56.85	wild blackberry
Tuesday	0.3315	2.895	56.85	wild blackberry
	0.1955	0.765	19.25	wild potato-vine
	0.69	0.18425	12.7	spicebush
	0.3875	3.955	66.5	poke
	0.3875	3.955	66.5	poke
	0.495	2.75	44	wild onion
	0.525	3.785	55.5	dandelion
	0.2305	0.22425	25.75	peppergrass
Wednesday	0.495	2.75	44	wild onion
	0.495	2.75	44	wild onion
	0.495	2.75	44	wild onion
	0.3875	3.955	66.5	poke
	0.525	3.785	55.5	dandelion
	0.2305	0.22425	25.75	peppergrass
	12.15	38.775	1800	duckweed
	0.18075	2.49	32.25	wild strawberry
Thursday	0.495	2.75	44	wild onion
	0.1655	1.055	19.9	common milkweed
	0.3875	3.955	66.5	poke
	0.01425	0.14775	7.35	elderberry
Friday	0.3315	2.895	56.85	wild blackberry
	0.0885	1.425	14.75	wild mint
	0.3875	3.955	66.5	poke
	0.525	3.785	55.5	dandelion
	0.301	3.505	58	bracken fern
	0.535	0.92	37.1	wild lettuce
	0.495	2.75	44	wild onion
	0.3875	3.955	66.5	poke
	0.525	3.785	55.5	dandelion
	0.2305	0.22425	25.75	peppergrass
	0.495	2.75	44	wild onion
Saturday	0.495	2.75	44	wild onion
	0.3315	2.895	56.85	wild blackberry
	0.1745	1.745	26.25	wild ginger
	0.1655	1.055	19.9	common milkweed
	0.3875	3.955	66.5	poke
Sunday	0.495	2.75	44	wild onion
	0.3315	2.895	56.85	wild blackberry
	12.15	38.775	1800	duckweed
	0.495	2.75	44	wild onion
	0.3875	3.955	66.5	poke
	0.525	3.785	55.5	dandelion
	0.2305	0.22425	25.75	peppergrass
	0.495	2.75	44	wild onion
Total mg:	41.78	196.53	5684.85	
PTWI:	25,952%	34,180%	3,531%	

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APPENDIX A: XRF Study (Garvin et al., 2010)

Table A1: Number of transects that exceeded background concentrations established by Pope, 2004.

Stream	Number of Transects Sampled	Number of Transects Exceeding Background Concentrations established by Pope, 2004	
		Pb	Zn
Elm Creek	4	4	4
Lost Creek	5	5	5
Tar Creek	4	4	4
Spring River	11	11	11
Neosho River	12	10	10
Grand River	12	12	12

APPENDIX B: Heavy Metal Concentrations and PTWI Values for Individual Plant Species

Allium stellatum—Wild Onion

Table B1: Heavy metal concentrations in wild onion samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.20	1.40	38
EC-1-21-E	1.90	8.80	161
LC-1-16-W	0.44	3.30	64
LC-1-21-W	0.77	5.12	114
LC-2-02-E	1.08	3.97	103
SR-11-01-E	3.74	38.70	497
SR-2-08-W	16.90	48.70	1160
TC-1-06-E	19.80	110.00	1760

Table B2: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of wild onion consumed by a 70 kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.01	2%	0.07	4%	1.9	0%
EC-1-21-E	0.095	19%	0.44	25%	8.05	2%
LC-1-16-W	0.022	4%	0.165	9%	3.2	1%
LC-1-21-W	0.0385	8%	0.256	15%	5.7	1%
LC-2-02-E	0.054	11%	0.1985	11%	5.15	1%
SR-11-01-E	0.187	38%	1.935	111%	24.85	5%
SR-2-08-W	0.845	172%	2.435	139%	58	12%
TC-1-06-E	0.99	202%	5.5	314%	88	18%

Table B3: Provisional Tolerable Weekly Intake (PTWI) values for a 25g serving of wild onion consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.01	3%	0.04	6%	0.95	1%
EC-1-21-E	0.05	30%	0.22	38%	4.03	3%
LC-1-16-W	0.01	7%	0.08	14%	1.60	1%
LC-1-21-W	0.02	12%	0.13	22%	2.85	2%
LC-2-02-E	0.03	17%	0.10	17%	2.58	2%
SR-11-01-E	0.09	58%	0.97	168%	12.43	8%
SR-2-08-W	0.42	262%	1.22	212%	29.00	18%
TC-1-06-E	0.50	307%	2.75	478%	44.00	27%

***Arisaema dracontium*—Green Dragon**

Table B4: Heavy metal concentrations in green dragon samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.08	0.13	19
EC-1-03-E	5.07	33.10	362
SR-1-13-W	12.80	17.50	671
SR-3-05-E	9.34	19.40	534
TC-4-02-E	20.60	14.40	1320

Table B5: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of green dragon consumed by a 70 kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.004	1%	0.0065	0%	0.95	0%
EC-1-03-E	0.2535	52%	1.655	95%	18.1	4%
SR-1-13-W	0.64	131%	0.875	50%	33.55	7%
SR-3-05-E	0.467	95%	0.97	55%	26.7	5%
TC-4-02-E	1.03	210%	0.72	41%	66	13%

Table B6: Provisional Tolerable Weekly Intake (PTWI) values for a 25g serving of green dragon consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.002	1%	0.00325	1%	0.475	0%
EC-1-03-E	0.12675	79%	0.8275	144%	9.05	6%
SR-1-13-W	0.32	199%	0.4375	76%	16.775	10%
SR-3-05-E	0.2335	145%	0.485	84%	13.35	8%
TC-4-02-E	0.515	320%	0.36	63%	33	20%

***Arisaema triphyllum*—Jack-in-the-Pulpit**

Table B7: Heavy metal concentrations in jack-in-the-pulpit samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.09	0.67	37
SR-1-14-W	11.00	10.60	762
SR-2-18-W	26.70	67.20	1970

Table B8: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of jack-in-the-pulpit consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.009	2%	0.067	4%	3.7	1%
SR-1-14-W	1.1	224%	1.06	61%	76.2	16%
SR-2-18-W	2.67	545%	6.72	384%	197	40%

Table B9: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of jack-in-the-pulpit consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0045	3%	0.0335	6%	1.85	1%
SR-1-14-W	0.55	342%	0.53	92%	38.1	24%
SR-2-18-W	1.335	829%	3.36	584%	98.5	61%

***Asarum canadense*—Wild Ginger**

Table B10: Heavy metal concentrations in wild ginger samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.47	2.14	112
SR-1-12-W	9.10	9.30	422
SR-2-15-W	6.98	69.80	1050

Table B11: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of wild ginger consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0235	5%	0.107	6%	5.6	1%
SR-1-12-W	0.455	93%	0.465	27%	21.1	4%
SR-2-15-W	0.349	71%	3.49	199%	52.5	11%

Table B12: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of wild ginger consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.01175	7%	0.0535	9%	2.8	2%
SR-1-12-W	0.2275	141%	0.2325	40%	10.55	7%
SR-2-15-W	0.1745	108%	1.745	303%	26.25	16%

***Asclepias syriaca*—Common Milkweed**

Table B13: Heavy metal concentrations in common milkweed samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.10	0.20	28
EC-1-16-E	0.15	0.14	74
EC-1-36-E	0.70	0.5	182
LC-2-01-E	0.50	1.12	117
LC-2-19-E	0.25	0.15	73
LC-3-10-E	0.29	2.88	60
SR-11-02-E	0.20	0.36	60
SR-7-04-W	3.31	21.10	398
TC-1-05-W	1.40	7.80	309

Table B14: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of common milkweed consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.01	2%	0.02	1%	2.8	1%
EC-1-16-E	0.015	3%	0.014	1%	7.4	2%
EC-1-36-E	0.07	14%	0.05	3%	18.2	4%
LC-2-01-E	0.05	10%	0.112	6%	11.7	2%
LC-2-19-E	0.025	5%	0.015	1%	7.3	1%
LC-3-10-E	0.029	6%	0.288	16%	6	1%
SR-11-02-E	0.02	4%	0.036	2%	6	1%
SR-7-04-W	0.331	68%	2.11	121%	39.8	8%
TC-1-05-W	0.14	29%	0.78	45%	30.9	6%

Table B15: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of common milkweed consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.005	3%	0.01	2%	1.4	1%
EC-1-16-E	0.0075	5%	0.007	1%	3.7	2%
EC-1-36-E	0.035	22%	0.025	4%	9.1	6%
LC-2-01-E	0.025	16%	0.056	10%	5.85	4%
LC-2-19-E	0.0125	8%	0.0075	1%	3.65	2%
LC-3-10-E	0.0145	9%	0.144	25%	3	2%
SR-11-02-E	0.01	6%	0.018	3%	3	2%
SR-7-04-W	0.1655	103%	1.055	183%	19.9	12%
TC-1-05-W	0.07	43%	0.39	68%	15.45	10%

***Asimina triloba*—Pawpaw**

Table B16: Heavy metal concentrations in pawpaw samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.13	0.46	25
EC-1-08-E	0.61	16.60	93
SR-1-10-W	1.45	0.30	83
SR-2-06-W	2.09	0.64	169
SR-3-02-E	7.77	59.00	758
SR-6-02-W	3.76	0.52	126
SR-7-11-W	2.07	0.25	80

Table B17: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of pawpaw consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	0.0195	4%	0.069	4%	3.75	1%
EC-1-08-E	0.0915	19%	2.49	142%	13.95	3%
SR-1-10-W	0.2175	44%	0.045	3%	12.45	3%
SR-2-06-W	0.3135	64%	0.096	5%	25.35	5%
SR-3-02-E	1.1655	238%	8.85	506%	113.7	23%
SR-6-02-W	0.564	115%	0.078	4%	18.9	4%
SR-7-11-W	0.3105	63%	0.0375	2%	12	2%

Table B18: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of pawpaw consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	0.00975	6%	0.0345	6%	1.875	1%
EC-1-08-E	0.04575	28%	1.245	217%	6.975	4%
SR-1-10-W	0.10875	68%	0.0225	4%	6.225	4%
SR-2-06-W	0.15675	97%	0.048	8%	12.675	8%
SR-3-02-E	0.58275	362%	4.425	770%	56.85	35%
SR-6-02-W	0.282	175%	0.039	7%	9.45	6%
SR-7-11-W	0.15525	96%	0.01875	3%	6	4%

***Betula nigra*—River Birch**

Table B19: Heavy metal concentrations in river birch samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	1.38	0.43	333
EC-1-37-E	11.00	0.52	570
TC-1-03-W	3.80	9.80	1430

Table B20: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of river birch consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	0.207	42%	0.0645	4%	49.95	10%
EC-1-37-E	1.65	337%	0.078	4%	85.5	17%
TC-1-03-W	0.57	116%	1.47	84%	214.5	44%

Table B21: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of river birch consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	0.1035	64%	0.03225	6%	24.975	16%
EC-1-37-E	0.825	512%	0.039	7%	42.75	27%
TC-1-03-W	0.285	177%	0.735	128%	107.25	67%

***Carya illinoinensis*—Pecan**

Table B22: Heavy metal concentrations in pecan samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.20	0.20	28
EC-1-24-E	0.46	0.19	64
EC-1-35-E	0.20	ND	120
LC-2-20-E	0.58	0.22	73

Table B23: Provisional Tolerable Weekly Intake (PTWI) values for a 120 g serving of pecan consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/120g)	Percent of PTWI	Weight (mg/120g)	Percent of PTWI	Weight (mg/120g)	Percent of PTWI
Background	0.024	5%	0.024	1%	3.36	1%
EC-1-24-E	0.0552	11%	0.0228	1%	7.68	2%
EC-1-35-E	0.024	5%	0	0%	14.4	3%
LC-2-20-E	0.0696	14%	0.0264	2%	8.76	2%

Table B24: Provisional Tolerable Weekly Intake (PTWI) values for a 60 g serving of pecan consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/60g)	Percent of PTWI	Weight (mg/60g)	Percent of PTWI	Weight (mg/60g)	Percent of PTWI
Background	0.012	7%	0.012	2%	1.68	1%
EC-1-24-E	0.0276	17%	0.0114	2%	3.84	2%
EC-1-35-E	0.012	7%	0	0%	7.2	4%
LC-2-20-E	0.0348	22%	0.0132	2%	4.38	3%

***Daucus carota*—Wild Carrot**

Table B25: Heavy metal concentrations in wild carrot samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.20	0.66	60
EC-1-10-E	3.12	10.90	354
LC-1-19-W	0.82	1.62	78

Table B26: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of wild carrot consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.02	4%	0.066	4%	6	1%
EC-1-10-E	0.312	64%	1.09	62%	35.4	7%
LC-1-19-W	0.082	17%	0.162	9%	7.8	2%

Table B27: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of wild carrot consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.01	6%	0.033	6%	3	2%
EC-1-10-E	0.156	97%	0.545	95%	17.7	11%
LC-1-19-W	0.041	25%	0.081	14%	3.9	2%

***Duchesnea indica*—Wild Strawberry**

Table B28: Heavy metal concentrations in wild strawberry samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.48	13.2	55
EC-1-22-E	3.80	32.20	398
LC-1-11-W	2.41	33.20	430
LC-1-25-W	1.85	14.7	216

Table B29: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of wild strawberry consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	0.072	15%	1.98	113%	8.25	2%
EC-1-22-E	0.57	116%	4.83	276%	59.7	12%
LC-1-11-W	0.3615	74%	4.98	285%	64.5	13%
LC-1-25-W	0.2775	57%	2.205	126%	32.4	7%

Table B30: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of wild strawberry consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	0.036	22%	0.99	172%	4.125	3%
EC-1-22-E	0.285	177%	2.415	420%	29.85	19%
LC-1-11-W	0.18075	112%	2.49	433%	32.25	20%
LC-1-25-W	0.13875	86%	1.1025	192%	16.2	10%

***Impatiens capensis*—Jewelweed**

Table B31: Heavy metal concentrations in jewelweed samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.55	0.29	69
LC-1-17-W	2.58	26.20	263
LC-3-05-E	2.57	3.60	151
SR-1-06-E	13.50	21.10	955
SR-2-16-W	6.90	50.10	676

Table B32: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of jewelweed consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0275	6%	0.0145	1%	3.45	1%
LC-1-17-W	0.129	26%	1.31	75%	13.15	3%
LC-3-05-E	0.1285	26%	0.18	10%	7.55	2%
SR-1-06-E	0.675	138%	1.055	60%	47.75	10%
SR-2-16-W	0.345	70%	2.505	143%	33.8	7%

Table B33: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of jewelweed consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.01375	9%	0.00725	1%	1.725	1%
LC-1-17-W	0.0645	40%	0.655	114%	6.575	4%
LC-3-05-E	0.06425	40%	0.09	16%	3.775	2%
SR-1-06-E	0.3375	210%	0.5275	92%	23.875	15%
SR-2-16-W	0.1725	107%	1.2525	218%	16.9	10%

***Ipomoea pandurata*—Wild Potato-Vine**

Table B34: Heavy metal concentrations in wild potato-vine samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.08	0.07	19
EC-1-12-W	2.41	14.10	353
EC-1-28-E	0.81	5.24	251
GR-3-05-E	1.00	3.50	98
GR-4-01-E	0.57	0.23	88
LC-1-06-W	1.84	11.60	208
LC-2-16-E	0.22	1.92	44
LC-3-09-E	2.11	23.50	164
SR-11-03-E	1.71	18.4	365
SR-1-11-E	7.32	61.20	985
SR-2-04-W	8.35	32.50	894
SR-3-13-E	4.59	25.80	653
SR-7-02-W	1.44	4.24	307
TC-2-01-W	3.91	15.30	385

Table B35: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of wild potato-vine consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.008	2%	0.007	0%	1.9	0%
EC-1-12-W	0.241	49%	1.41	81%	35.3	7%
EC-1-28-E	0.081	17%	0.524	30%	25.1	5%
GR-3-05-E	0.1	20%	0.35	20%	9.8	2%
GR-4-01-E	0.057	12%	0.023	1%	8.8	2%
LC-1-06-W	0.184	38%	1.16	66%	20.8	4%
LC-2-16-E	0.022	4%	0.192	11%	4.4	1%
LC-3-09-E	0.211	43%	2.35	134%	16.4	3%
SR-11-03-E	0.171	35%	1.84	105%	36.5	7%
SR-1-11-E	0.732	149%	6.12	350%	98.5	20%
SR-2-04-W	0.835	170%	3.25	186%	89.4	18%
SR-3-13-E	0.459	94%	2.58	147%	65.3	13%
SR-7-02-W	0.144	29%	0.424	24%	30.7	6%
TC-2-01-W	0.391	80%	1.53	87%	38.5	8%

Table B36: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of wild potato-vine consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.004	2%	0.0035	1%	0.95	1%
EC-1-12-W	0.1205	75%	0.705	123%	17.65	11%
EC-1-28-E	0.0405	25%	0.262	46%	12.55	8%
GR-3-05-E	0.05	31%	0.175	30%	4.9	3%
GR-4-01-E	0.0285	18%	0.0115	2%	4.4	3%
LC-1-06-W	0.092	57%	0.58	101%	10.4	6%
LC-2-16-E	0.011	7%	0.096	17%	2.2	1%
LC-3-09-E	0.1055	66%	1.175	204%	8.2	5%
SR-11-03-E	0.0855	53%	0.92	160%	18.25	11%
SR-1-11-E	0.366	227%	3.06	532%	49.25	31%
SR-2-04-W	0.4175	259%	1.625	283%	44.7	28%
SR-3-13-E	0.2295	143%	1.29	224%	32.65	20%
SR-7-02-W	0.072	45%	0.212	37%	15.35	10%
TC-2-01-W	0.1955	121%	0.765	133%	19.25	12%

***Lactuca canadensis*—Wild Lettuce**

Table B37: Heavy metal concentrations in wild lettuce samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	1.02	0.09	156
EC-1-06-E	10.70	18.40	742
LC-1-12-W	2.43	7.85	284

Table B38: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of wild lettuce consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.102	21%	0.009	1%	15.6	3%
EC-1-06-E	1.07	218%	1.84	105%	74.2	15%
LC-1-12-W	0.243	50%	0.785	45%	28.4	6%

Table B39: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of wild lettuce consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.051	32%	0.0045	1%	7.8	5%
EC-1-06-E	0.535	332%	0.92	160%	37.1	23%
LC-1-12-W	0.1215	75%	0.3925	68%	14.2	9%

Lemna minor—Duckweed

Table B40: Heavy metal concentrations in duckweed samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	4.80	2.80	269
EC-1-20-W	9.64	55.20	2280
GR-3-03-E	6.00	37.20	859
LC-2-11-E	2.11	18.90	235
TC-1-01-E	162.00	517.00	24000

Table B41: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of duckweed consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	0.72	147%	0.42	24%	40.35	8%
EC-1-20-W	1.446	295%	8.28	473%	342	70%
GR-3-03-E	0.9	184%	5.58	319%	128.85	26%
LC-2-11-E	0.3165	65%	2.835	162%	35.25	7%
TC-1-01-E	24.3	4959%	77.55	4431%	3600	735%

Table B42: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of duckweed consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	0.36	224%	0.21	37%	20.175	13%
EC-1-20-W	0.723	449%	4.14	720%	171	106%
GR-3-03-E	0.45	280%	2.79	485%	64.425	40%
LC-2-11-E	0.15825	98%	1.4175	247%	17.625	11%
TC-1-01-E	12.15	7547%	38.775	6743%	1800	1118%

***Lepidium virginicum*—Peppergrass**

Table B43: Heavy metal concentrations in peppergrass samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.36	0.43	88
EC-1-13-E	1.20	4.80	192
EC-1-33-E	3.90	6.50	300
GR-2-01-E	3.39	6.77	327
GR-4-06-E	1.84	4.35	151
LC-1-18-W	0.94	5.88	160
LC-2-09-E	1.55	16.90	179
LC-2-10-E	0.38	1.23	49
SR-1-05-E	4.24	13.10	409
SR-2-09-W	9.56	8.68	844
SR-3-14-E	9.22	8.97	1030
TC-2-07-W	1.45	7.82	265

Table B44: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of peppergrass consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.018	4%	0.0215	1%	4.4	1%
EC-1-13-E	0.06	12%	0.24	14%	9.6	2%
EC-1-33-E	0.195	40%	0.325	19%	15	3%
GR-2-01-E	0.1695	35%	0.3385	19%	16.35	3%
GR-4-06-E	0.092	19%	0.2175	12%	7.55	2%
LC-1-18-W	0.047	10%	0.294	17%	8	2%
LC-2-09-E	0.0775	16%	0.845	48%	8.95	2%
LC-2-10-E	0.019	4%	0.0615	4%	2.45	1%
SR-1-05-E	0.212	43%	0.655	37%	20.45	4%
SR-2-09-W	0.478	98%	0.434	25%	42.2	9%
SR-3-14-E	0.461	94%	0.4485	26%	51.5	11%
TC-2-07-W	0.0725	15%	0.391	22%	13.25	3%

Table B45: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of peppergrass consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.018	4%	0.0215	1%	4.4	1%
EC-1-13-E	0.06	12%	0.24	14%	9.6	2%
EC-1-33-E	0.195	40%	0.325	19%	15	3%
GR-2-01-E	0.1695	35%	0.3385	19%	16.35	3%
GR-4-06-E	0.092	19%	0.2175	12%	7.55	2%
LC-1-18-W	0.047	10%	0.294	17%	8	2%
LC-2-09-E	0.0775	16%	0.845	48%	8.95	2%
LC-2-10-E	0.019	4%	0.0615	4%	2.45	1%
SR-1-05-E	0.212	43%	0.655	37%	20.45	4%
SR-2-09-W	0.478	98%	0.434	25%	42.2	9%
SR-3-14-E	0.461	94%	0.4485	26%	51.5	11%
TC-2-07-W	0.0725	15%	0.391	22%	13.25	3%

***Lindera benzoin*—Spicebush**

Table B46: Heavy metal concentrations in spicebush samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	1.84	0.80	79
LC-1-01-W	14.50	2.07	246
LC-1-24-W	20.1	0.45	305
SR-1-07-W	2.97	0.15	190
SR-2-14-W	27.60	7.37	508
SR-7-10-W	8.6	0.15	609

Table B47: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of spicebush consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.092	19%	0.04	2%	3.95	1%
LC-1-01-W	0.725	148%	0.1035	6%	12.3	3%
LC-1-24-W	1.005	205%	0.0225	1%	15.25	3%
SR-1-07-W	0.1485	30%	0.0075	0%	9.5	2%
SR-2-14-W	1.38	282%	0.3685	21%	25.4	5%
SR-7-10-W	0.43	88%	0.0075	0%	30.45	6%

Table B48: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of spicebush consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.046	29%	0.02	3%	1.975	1%
LC-1-01-W	0.3625	225%	0.05175	9%	6.15	4%
LC-1-24-W	0.5025	312%	0.01125	2%	7.625	5%
SR-1-07-W	0.07425	46%	0.00375	1%	4.75	3%
SR-2-14-W	0.69	429%	0.18425	32%	12.7	8%
SR-7-10-W	0.215	134%	0.00375	1%	15.225	9%

***Morus alba*—White Mulberry**

Table B49: Heavy metal concentrations in white mulberry samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	ND	0.25	34
GR-3-01-E	0.50	4.10	114
SR-11-04-E	0.24	1.28	125
SR-2-02-W	ND	0.30	211
SR-3-12-E	0.06	0.47	110
SR-7-07-W	2.21	19.90	493

Table B50: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of white mulberry consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	-	-	0.0375	2%	5.1	1%
GR-3-01-E	0.075	15%	0.615	35%	17.1	3%
SR-11-04-E	0.036	7%	0.192	11%	18.75	4%
SR-2-02-W	-	-	0.045	3%	31.65	6%
SR-3-12-E	0.009	2%	0.0705	4%	16.5	3%
SR-7-07-W	0.3315	68%	2.985	171%	73.95	15%

Table B51: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of white mulberry consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	-	-	0.01875	3%	2.55	2%
GR-3-01-E	0.0375	23%	0.3075	53%	8.55	5%
SR-11-04-E	0.018	11%	0.096	17%	9.375	6%
SR-2-02-W	-	-	0.0225	4%	15.825	10%
SR-3-12-E	0.0045	3%	0.03525	6%	8.25	5%
SR-7-07-W	0.16575	103%	1.4925	260%	36.975	23%

***Oxalis corniculata*—Wood-Sorrel**

Table B52: Heavy metal concentrations in creeping wood-sorrel samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.30	0.38	28
EC-1-15-E	3.66	39.70	592
EC-1-30-E	3.09	37.2	415
LC-1-20-W	0.83	7.57	170
LC-2-05-E	0.72	3.61	130
LC-3-11-E	1.18	5.88	128
SR-11-07-E	7.68	99.8	1140
SR-1-18-E	6.29	64.80	1010
SR-2-07-W	3.08	26.70	440
SR-3-07-E	1.91	8.81	310
SR-6-01-W	4.64	33.50	712
TC-2-04-W	4.46	33.10	1040

Table B53: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of creeping wood-sorrel consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.03	6%	0.038	2%	2.8	1%
EC-1-15-E	0.366	75%	3.97	227%	59.2	12%
EC-1-30-E	0.309	63%	3.72	213%	41.5	8%
LC-1-20-W	0.083	17%	0.757	43%	17	3%
LC-2-05-E	0.072	15%	0.361	21%	13	3%
LC-3-11-E	0.118	24%	0.588	34%	12.8	3%
SR-11-07-E	0.768	157%	9.98	570%	114	23%
SR-1-18-E	0.629	128%	6.48	370%	101	21%
SR-2-07-W	0.308	63%	2.67	153%	44	9%
SR-3-07-E	0.191	39%	0.881	50%	31	6%
SR-6-01-W	0.464	95%	3.35	191%	71.2	15%
TC-2-04-W	0.446	91%	3.31	189%	104	21%

Table B54: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of creeping wood-sorrel consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.015	9%	0.019	3%	1.4	1%
EC-1-15-E	0.183	114%	1.985	345%	29.6	18%
EC-1-30-E	0.1545	96%	1.86	323%	20.75	13%
LC-1-20-W	0.0415	26%	0.3785	66%	8.5	5%
LC-2-05-E	0.036	22%	0.1805	31%	6.5	4%
LC-3-11-E	0.059	37%	0.294	51%	6.4	4%
SR-11-07-E	0.384	239%	4.99	868%	57	35%
SR-1-18-E	0.3145	195%	3.24	563%	50.5	31%
SR-2-07-W	0.154	96%	1.335	232%	22	14%
SR-3-07-E	0.0955	59%	0.4405	77%	15.5	10%
SR-6-01-W	0.232	144%	1.675	291%	35.6	22%
TC-2-04-W	0.223	139%	1.655	288%	52	32%

***Perilla frutescens*—Wild Mint**

Table B55: Heavy metal concentrations in wild mint samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.06	0.63	49
LC-1-08-W	1.77	28.50	295
LC-1-22-W	0.42	2.01	96
LC-2-03-E	0.15	0.75	62

Table B56: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of wild mint consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.006	1%	0.063	4%	4.9	1%
LC-1-08-W	0.177	36%	2.85	163%	29.5	6%
LC-1-22-W	0.042	9%	0.201	11%	9.6	2%
LC-2-03-E	0.015	3%	0.075	4%	6.2	1%

Table B57: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of wild mint consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.003	2%	0.0315	5%	2.45	2%
LC-1-08-W	0.0885	55%	1.425	248%	14.75	9%
LC-1-22-W	0.021	13%	0.1005	17%	4.8	3%
LC-2-03-E	0.0075	5%	0.0375	7%	3.1	2%

***Phytolacca Americana*—Poke**

Table B58: Heavy metal concentrations in poke samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.11	0.18	27
EC-1-11-E	9.19	0.33	1140
EC-1-25-E	0.69	0.33	49
GR-4-03-E	1.45	0.16	273
LC-1-09-W	0.56	4.88	137
LC-2-04-E	0.71	3.37	166
LC-3-03-E	0.18	2.00	91
SR-1-15-E	7.66	1.73	693
SR-2-10-W	1.38	0.16	180
SR-3-06-E	7.75	79.10	1330
SR-7-09-W	7.86	0.34	1030

Table B59: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of poke consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.011	2%	0.018	1%	2.7	1%
EC-1-11-E	0.919	188%	0.033	2%	114	23%
EC-1-25-E	0.069	14%	0.033	2%	4.9	1%
GR-4-03-E	0.145	30%	0.016	1%	27.3	6%
LC-1-09-W	0.056	11%	0.488	28%	13.7	3%
LC-2-04-E	0.071	14%	0.337	19%	16.6	3%
LC-3-03-E	0.018	4%	0.2	11%	9.1	2%
SR-1-15-E	0.766	156%	0.173	10%	69.3	14%
SR-2-10-W	0.138	28%	0.016	1%	18	4%
SR-3-06-E	0.775	158%	7.91	452%	133	27%
SR-7-09-W	0.786	160%	0.034	2%	103	21%

Table B60: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of poke consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0055	3%	0.009	2%	1.35	1%
EC-1-11-E	0.4595	285%	0.0165	3%	57	35%
EC-1-25-E	0.0345	21%	0.0165	3%	2.45	2%
GR-4-03-E	0.0725	45%	0.008	1%	13.65	8%
LC-1-09-W	0.028	17%	0.244	42%	6.85	4%
LC-2-04-E	0.0355	22%	0.1685	29%	8.3	5%
LC-3-03-E	0.009	6%	0.1	17%	4.55	3%
SR-1-15-E	0.383	238%	0.0865	15%	34.65	22%
SR-2-10-W	0.069	43%	0.008	1%	9	6%
SR-3-06-E	0.3875	241%	3.955	688%	66.5	41%
SR-7-09-W	0.393	244%	0.017	3%	51.5	32%

***Plantago major*—Common Plantain**

Table B61: Heavy metal concentrations in common plantain samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.44	7.74	78
EC-1-18-E	2.27	10.90	401
EC-1-34-E	2.94	8.40	344
LC-1-13-W	1.60	17.30	298
LC-2-08-E	1.83	24.10	241
LC-3-02-E	1.19	11.10	134
SR-1-08-E	6.83	87.10	1080
SR-2-13-W	6.84	57.90	1210
SR-3-10-E	5.34	46.60	909
TC-4-01-E	81.00	265.00	16500

Table B62: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of common plantain consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.044	9%	0.774	44%	7.8	2%
EC-1-18-E	0.227	46%	1.09	62%	40.1	8%
EC-1-34-E	0.294	60%	0.84	48%	34.4	7%
LC-1-13-W	0.16	33%	1.73	99%	29.8	6%
LC-2-08-E	0.183	37%	2.41	138%	24.1	5%
LC-3-02-E	0.119	24%	1.11	63%	13.4	3%
SR-1-08-E	0.683	139%	8.71	498%	108	22%
SR-2-13-W	0.684	140%	5.79	331%	121	25%
SR-3-10-E	0.534	109%	4.66	266%	90.9	19%
TC-4-01-E	8.1	1653%	26.5	1514%	1650	337%

Table B63: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of common plantain consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.022	14%	0.387	67%	3.9	2%
EC-1-18-E	0.1135	70%	0.545	95%	20.05	12%
EC-1-34-E	0.147	91%	0.42	73%	17.2	11%
LC-1-13-W	0.08	50%	0.865	150%	14.9	9%
LC-2-08-E	0.0915	57%	1.205	210%	12.05	7%
LC-3-02-E	0.0595	37%	0.555	97%	6.7	4%
SR-1-08-E	0.3415	212%	4.355	757%	54	34%
SR-2-13-W	0.342	212%	2.895	503%	60.5	38%
SR-3-10-E	0.267	166%	2.33	405%	45.45	28%
TC-4-01-E	4.05	2516%	13.25	2304%	825	512%

***Podophyllum peltatum*—Mayapple**

Table B64: Heavy metal concentrations in mayapple samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.55	0.50	44
SR-1-04-W	3.99	4.69	425
SR-2-17-W	6.67	18.70	859

Table B65: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of mayapple consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0275	6%	0.025	1%	2.2	0%
SR-1-04-W	0.1995	41%	0.2345	13%	21.25	4%
SR-2-17-W	0.3335	68%	0.935	53%	42.95	9%

Table B66: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of mayapple consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.01375	9%	0.0125	2%	1.1	1%
SR-1-04-W	0.09975	62%	0.11725	20%	10.625	7%
SR-2-17-W	0.16675	104%	0.4675	81%	21.475	13%

***Polygonatum biflorum*—Solomon's Seal**

Table B67: Heavy metal concentrations in solomon's seal samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.30	0.60	27
EC-1-05-E	2.05	27.50	292
LC-1-02-W	1.16	2.56	91
SR-1-02-W	2.36	14.70	243
SR-2-03-W	1.52	9.12	232
SR-3-09-E	1.91	23.40	318

Table B68: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of solomon's seal consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.015	3%	0.03	2%	1.35	0%
EC-1-05-E	0.1025	21%	1.375	79%	14.6	3%
LC-1-02-W	0.058	12%	0.128	7%	4.55	1%
SR-1-02-W	0.118	24%	0.735	42%	12.15	2%
SR-2-03-W	0.076	16%	0.456	26%	11.6	2%
SR-3-09-E	0.0955	19%	1.17	67%	15.9	3%

Table B69: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of solomon's seal consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.0075	5%	0.015	3%	0.675	0%
EC-1-05-E	0.05125	32%	0.6875	120%	7.3	5%
LC-1-02-W	0.029	18%	0.064	11%	2.275	1%
SR-1-02-W	0.059	37%	0.3675	64%	6.075	4%
SR-2-03-W	0.038	24%	0.228	40%	5.8	4%
SR-3-09-E	0.04775	30%	0.585	102%	7.95	5%

***Pteridium aquilinum*—Bracken Fern**

Table B70: Heavy metal concentrations in bracken fern samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.20	0.35	45
SR-1-03-W	6.02	70.10	1160

Table B71: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of bracken fern consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.02	4%	0.035	2%	4.5	1%
SR-1-03-W	0.602	123%	7.01	401%	116	24%

Table B72: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of bracken fern consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.01	6%	0.0175	3%	2.25	1%
SR-1-03-W	0.301	187%	3.505	610%	58	36%

***Ranunculus acris*—Buttercup**

Table B73: Heavy metal concentrations in buttercup samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.51	3.52	61
EC-1-07-E	4.78	47.40	627
SR-1-09-E	8.71	39.50	842

Table B74: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of buttercup consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.051	10%	0.352	20%	6.1	1%
EC-1-07-E	0.478	98%	4.74	271%	62.7	13%
SR-1-09-E	0.871	178%	3.95	226%	84.2	17%

Table B75: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of buttercup consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0255	16%	0.176	31%	3.05	2%
EC-1-07-E	0.239	148%	2.37	412%	31.35	19%
SR-1-09-E	0.4355	270%	1.975	343%	42.1	26%

***Rubus allegheniensis*—Wild Blackberry**

Table B76: Heavy metal concentrations in wild blackberry samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.07	0.14	24
EC-1-01-E	2.04	30.20	239.00
EC-1-26-E	0.92	0.45	64.00
LC-2-17-E	0.49	1.17	57.00
LC-2-18-E	0.11	ND	46.00
LC-3-12-E	0.42	2.80	80.00
SR-11-06-E	0.42	0.53	101.00
SR-2-11-W	1.04	7.19	200.00
SR-3-04-E	4.42	38.60	758.00
SR-7-06-W	4.83	57.60	997.00
TC-2-06-W	5.17	13.80	691.00

Table B77: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of wild blackberry consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	0.0105	2%	0.021	1%	3.6	1%
EC-1-01-E	0.306	62%	4.53	259%	35.85	7%
EC-1-26-E	0.138	28%	0.0675	4%	9.6	2%
LC-2-17-E	0.0735	15%	0.1755	10%	8.55	2%
LC-2-18-E	0.0165	3%	-	-	6.9	1%
LC-3-12-E	0.063	13%	0.42	24%	12	2%
SR-11-06-E	0.063	13%	0.0795	5%	15.15	3%
SR-2-11-W	0.156	32%	1.0785	62%	30	6%
SR-3-04-E	0.663	135%	5.79	331%	113.7	23%
SR-7-06-W	0.7245	148%	8.64	494%	149.55	31%
TC-2-06-W	0.7755	158%	2.07	118%	103.65	21%

Table B78: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of wild blackberry consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	0.00525	3%	0.0105	2%	1.8	1%
EC-1-01-E	0.153	95%	2.265	394%	17.925	11%
EC-1-26-E	0.069	43%	0.03375	6%	4.8	3%
LC-2-17-E	0.03675	23%	0.08775	15%	4.275	3%
LC-2-18-E	0.00825	5%	-	-	3.45	2%
LC-3-12-E	0.0315	20%	0.21	37%	6	4%
SR-11-06-E	0.0315	20%	0.03975	7%	7.575	5%
SR-2-11-W	0.078	48%	0.53925	94%	15	9%
SR-3-04-E	0.3315	206%	2.895	503%	56.85	35%
SR-7-06-W	0.36225	225%	4.32	751%	74.775	46%
TC-2-06-W	0.38775	241%	1.035	180%	51.825	32%

***Rumex crispus*—Curly Dock**

Table B79: Heavy metal concentrations in curly dock samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.18	0.45	23
EC-1-02-E	5.02	3.41	387
EC-1-32-E	1.99	4.72	163
GR-3-02-E	3.80	24.30	506
GR-4-05-E	0.74	2.16	85
LC-1-14-W	1.05	8.66	166
LC-2-07-E	1.25	9.78	122
LC-3-04-E	0.77	6.61	83
SR-11-08-E	2.06	13.2	285
SR-6-03-W	5.50	31.50	498
TC-2-05-W	8.27	33.20	1010

Table B80: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of curly dock consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.018	4%	0.045	3%	2.3	0%
EC-1-02-E	0.502	102%	0.341	19%	38.7	8%
EC-1-32-E	0.199	41%	0.472	27%	16.3	3%
GR-3-02-E	0.38	78%	2.43	139%	50.6	10%
GR-4-05-E	0.074	15%	0.216	12%	8.5	2%
LC-1-14-W	0.105	21%	0.866	49%	16.6	3%
LC-2-07-E	0.125	26%	0.978	56%	12.2	2%
LC-3-04-E	0.077	16%	0.661	38%	8.3	2%
SR-11-08-E	0.206	42%	1.32	75%	28.5	6%
SR-6-03-W	0.55	112%	3.15	180%	49.8	10%
TC-2-05-W	0.827	169%	3.32	190%	101	21%

Table B81: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of curly dock consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.009	6%	0.0225	4%	1.15	1%
EC-1-02-E	0.251	156%	0.1705	30%	19.35	12%
EC-1-32-E	0.0995	62%	0.236	41%	8.15	5%
GR-3-02-E	0.19	118%	1.215	211%	25.3	16%
GR-4-05-E	0.037	23%	0.108	19%	4.25	3%
LC-1-14-W	0.0525	33%	0.433	75%	8.3	5%
LC-2-07-E	0.0625	39%	0.489	85%	6.1	4%
LC-3-04-E	0.0385	24%	0.3305	57%	4.15	3%
SR-11-08-E	0.103	64%	0.66	115%	14.25	9%
SR-6-03-W	0.275	171%	1.575	274%	24.9	15%
TC-2-05-W	0.4135	257%	1.66	289%	50.5	31%

Sagittaria latifolia—Arrowhead Root

Table B82: Heavy metal concentrations in arrowhead root samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.46	9.27	54
LC-2-15-E	0.79	12.9	129
LC-3-01-E	1.50	22.00	201

Table B83: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of arrowhead root consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.046	9%	0.927	53%	5.4	1%
LC-2-15-E	0.079	16%	1.29	74%	12.9	3%
LC-3-01-E	0.15	31%	2.2	126%	20.1	4%

Table B84: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of arrowhead root consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.023	14%	0.4635	81%	2.7	2%
LC-2-15-E	0.0395	25%	0.645	112%	6.45	4%
LC-3-01-E	0.075	47%	1.1	191%	10.05	6%

***Salix nigra*—Black Willow**

Table B85: Heavy metal concentrations in black willow samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	1.19	0.17	103
GR-3-04-E	3.30	ND	365
GR-4-02-E	6.84	ND	965
TC-1-04-W	7.70	4.70	651

Table B86: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of black willow consumed by a 70 kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.0595	12%	0.0085	0%	5.15	3%
GR-3-04-E	0.165	34%	-	-	18.25	11%
GR-4-02-E	0.342	70%	-	-	48.25	30%
TC-1-04-W	0.385	79%	0.235	13%	32.55	20%

Table B87: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of black willow consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.02975	18%	0.00425	1%	2.575	2%
GR-3-04-E	0.0825	51%	-	-	9.125	6%
GR-4-02-E	0.171	106%	-	-	24.125	15%
TC-1-04-W	0.1925	120%	0.1175	20%	16.275	10%

***Sambucus canadensis*—Elderberry**

Table B88: Heavy metal concentrations in elderberry samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	ND	0.14	27
EC-1-19-E	0.11	0.14	106
SR-1-16-E	0.19	1.97	98
SR-3-01-E	0.13	0.24	102

Table B89: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of elderberry consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	-	-	0.021	1%	4.05	1%
EC-1-19-E	0.0165	3%	0.021	1%	15.9	3%
SR-1-16-E	0.0285	6%	0.2955	17%	14.7	3%
SR-3-01-E	0.0195	4%	0.036	2%	15.3	3%

Table B90: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of elderberry consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	-	-	0.0105	2%	2.025	1%
EC-1-19-E	0.00825	5%	0.0105	2%	7.95	5%
SR-1-16-E	0.01425	9%	0.14775	26%	7.35	5%
SR-3-01-E	0.00975	6%	0.018	3%	7.65	5%

***Smilax glauca*—Greenbrier**

Table B91: Heavy metal concentrations in greenbrier samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.08	0.12	20
EC-1-04-E	1.67	5.67	220
LC-1-15-W	0.08	0.27	37
LC-3-06-E	0.31	2.79	48
SR-1-19-E	0.79	5.01	486
SR-2-01-W	3.57	17.30	404
SR-3-03-E	5.77	49.10	683
SR-7-03-W	1.68	6.21	507
TC-2-03-W	2.02	9.97	258

Table B92: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of greenbrier consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.004	1%	0.006	0%	1	0%
EC-1-04-E	0.0835	17%	0.2835	16%	11	2%
LC-1-15-W	0.004	1%	0.0135	1%	1.85	0%
LC-3-06-E	0.0155	3%	0.1395	8%	2.4	0%
SR-1-19-E	0.0395	8%	0.2505	14%	24.3	5%
SR-2-01-W	0.1785	36%	0.865	49%	20.2	4%
SR-3-03-E	0.2885	59%	2.455	140%	34.15	7%
SR-7-03-W	0.084	17%	0.3105	18%	25.35	5%
TC-2-03-W	0.101	21%	0.4985	28%	12.9	3%

Table B93: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of greenbrier consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.002	1%	0.003	1%	0.5	0%
EC-1-04-E	0.04175	26%	0.14175	25%	5.5	3%
LC-1-15-W	0.002	1%	0.00675	1%	0.925	1%
LC-3-06-E	0.00775	5%	0.06975	12%	1.2	1%
SR-1-19-E	0.01975	12%	0.12525	22%	12.15	8%
SR-2-01-W	0.08925	55%	0.4325	75%	10.1	6%
SR-3-03-E	0.14425	90%	1.2275	213%	17.075	11%
SR-7-03-W	0.042	26%	0.15525	27%	12.675	8%
TC-2-03-W	0.0505	31%	0.24925	43%	6.45	4%

***Symphoricarpus orbiculatus*—Buckbrush**

Table B94: Heavy metal concentrations in buckbrush samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.08	0.57	40
EC-1-09-E	2.59	47.70	360
EC-1-23-E	0.88	10.30	158
LC-1-05-W	0.90	3.55	111
LC-1-26-W	0.70	1.66	105
LC-2-12-E	1.13	1.10	95
SR-1-17-E	4.43	48.90	790
SR-2-12-W	7.79	86.50	1100
SR-7-05-W	0.40	1.04	120
TC-1-02-E	3.20	36.50	770

Table B95: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of buckbrush consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.004	1%	0.0285	2%	2	0%
EC-1-09-E	0.1295	26%	2.385	136%	18	4%
EC-1-23-E	0.044	9%	0.515	29%	7.9	2%
LC-1-05-W	0.045	9%	0.1775	10%	5.55	1%
LC-1-26-W	0.035	7%	0.083	5%	5.25	1%
LC-2-12-E	0.0565	12%	0.055	3%	4.75	1%
SR-1-17-E	0.2215	45%	2.445	140%	39.5	8%
SR-2-12-W	0.3895	79%	4.325	247%	55	11%
SR-7-05-W	0.02	4%	0.052	3%	6	1%
TC-1-02-E	0.16	33%	1.825	104%	38.5	8%

Table B96: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of buckbrush consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.002	1%	0.01425	2%	1	1%
EC-1-09-E	0.06475	40%	1.1925	207%	9	6%
EC-1-23-E	0.022	14%	0.2575	45%	3.95	2%
LC-1-05-W	0.0225	14%	0.08875	15%	2.775	2%
LC-1-26-W	0.0175	11%	0.0415	7%	2.625	2%
LC-2-12-E	0.02825	18%	0.0275	5%	2.375	1%
SR-1-17-E	0.11075	69%	1.2225	213%	19.75	12%
SR-2-12-W	0.19475	121%	2.1625	376%	27.5	17%
SR-7-05-W	0.01	6%	0.026	5%	3	2%
TC-1-02-E	0.08	50%	0.9125	159%	19.25	12%

***Taraxacum officinale*—Dandelion**

Table B97: Heavy metal concentrations in dandelion samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.34	5.83	52
EC-1-27-E	2.49	18.80	211
EC-1-29-E	2.29	7.96	164
GR-3-06-E	1.40	3.80	174
GR-4-04-E	8.49	10.00	253
SR-3-15-E	10.50	75.7	1110
SR-3-16-E	11.10	56.3	828

Table B98: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of dandelion consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.034	7%	0.583	33%	5.2	1%
EC-1-27-E	0.249	51%	1.88	107%	21.1	4%
EC-1-29-E	0.229	47%	0.796	45%	16.4	3%
GR-3-06-E	0.14	29%	0.38	22%	17.4	4%
GR-4-04-E	0.849	173%	1	57%	25.3	5%
SR-3-15-E	1.05	214%	7.57	433%	111	23%
SR-3-16-E	1.11	227%	5.63	322%	82.8	17%

Table B99: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of dandelion consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.017	11%	0.2915	51%	2.6	2%
EC-1-27-E	0.1245	77%	0.94	163%	10.55	7%
EC-1-29-E	0.1145	71%	0.398	69%	8.2	5%
GR-3-06-E	0.07	43%	0.19	33%	8.7	5%
GR-4-04-E	0.4245	264%	0.5	87%	12.65	8%
SR-3-15-E	0.525	326%	3.785	658%	55.5	34%
SR-3-16-E	0.555	345%	2.815	490%	41.4	26%

***Verbascum Thapsus*—Common Mullein**

Table B100: Heavy metal concentrations in common mullein samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.12	1.26	35
LC-1-07-W	3.10	33.50	338
LC-1-23-W	1.11	10.3	169
LC-2-14-E	0.15	ND	38

Table B101: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of common mullein consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.006	1%	0.063	4%	1.75	0%
LC-1-07-W	0.155	32%	1.675	96%	16.9	3%
LC-1-23-W	0.0555	11%	0.515	29%	8.45	2%
LC-2-14-E	0.0075	2%	-	-	1.9	0%

Table B102: Provisional Tolerable Weekly Intake (PTWI) values for a 25 g serving of common mullein consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI	Weight (mg/25g)	Percent of PTWI
Background	0.003	2%	0.0315	5%	0.875	1%
LC-1-07-W	0.0775	48%	0.8375	146%	8.45	5%
LC-1-23-W	0.02775	17%	0.2575	45%	4.225	3%
LC-2-14-E	0.00375	2%	-	-	0.95	1%

***Viola Canadensis*—Violet**

Table B103: Heavy metal concentrations in violet samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.58	11.30	70
EC-1-17-E	4.43	21.40	463
EC-1-31-E	4.47	46.4	481
LC-1-03-W	2.63	34.50	343
LC-2-06-E	2.12	9.85	140
LC-3-07-E	1.36	18.20	161
SR-3-08-E	7.17	53.00	1010
SR-7-01-W	14.30	50.60	1390
SR-9-01-I	3.78	15.4	355
TC-2-02-E	20.80	50.00	2510

Table B104: Provisional Tolerable Weekly Intake (PTWI) values for a 100 g serving of violet consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI	Weight (mg/100g)	Percent of PTWI
Background	0.058	12%	1.13	65%	7	1%
EC-1-17-E	0.443	90%	2.14	122%	46.3	9%
EC-1-31-E	0.447	91%	4.64	265%	48.1	10%
LC-1-03-W	0.263	54%	3.45	197%	34.3	7%
LC-2-06-E	0.212	43%	0.985	56%	14	3%
LC-3-07-E	0.136	28%	1.82	104%	16.1	3%
SR-3-08-E	0.717	146%	5.3	303%	101	21%
SR-7-01-W	1.43	292%	5.06	289%	139	28%
SR-9-01-I	0.378	77%	1.54	88%	35.5	7%
TC-2-02-E	2.08	424%	5	286%	251	51%

Table B105: Provisional Tolerable Weekly Intake (PTWI) values for a 50 g serving of violet consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI	Weight (mg/50g)	Percent of PTWI
Background	0.029	18%	0.565	98%	3.5	2%
EC-1-17-E	0.2215	138%	1.07	186%	23.15	14%
EC-1-31-E	0.2235	139%	2.32	403%	24.05	15%
LC-1-03-W	0.1315	82%	1.725	300%	17.15	11%
LC-2-06-E	0.106	66%	0.4925	86%	7	4%
LC-3-07-E	0.068	42%	0.91	158%	8.05	5%
SR-3-08-E	0.3585	223%	2.65	461%	50.5	31%
SR-7-01-W	0.715	444%	2.53	440%	69.5	43%
SR-9-01-I	0.189	117%	0.77	134%	17.75	11%
TC-2-02-E	1.04	646%	2.5	435%	125.5	78%

***Vitis vulpine*—Wild Grape**

Table B106: Heavy metal concentrations in wild grape samples and background levels.

Site	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Background	0.08	0.11	19
EC-1-14-E	ND	0.09	27
LC-1-04-W	0.63	2.57	110
LC-2-13-E	0.26	1.08	34
LC-3-08-E	1.19	14.40	152
SR-1-01-E	0.39	2.54	45
SR-11-05-E	ND	0.47	25
SR-2-05-W	1.58	16.30	329
SR-3-11-E	0.89	4.28	73
SR-7-08-W	1.08	13.40	170
TC-4-03-E	2.90	17.70	864

Table B107: Provisional Tolerable Weekly Intake (PTWI) values for a 150 g serving of wild grape consumed by a 70kg adult.

Sample	Cd		Pb		Zn	
	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI	Weight (mg/150g)	Percent of PTWI
Background	0.012	2%	0.0165	1%	2.85	1%
EC-1-14-E	-	-	0.0135	1%	4.05	1%
LC-1-04-W	0.0945	19%	0.3855	22%	16.5	3%
LC-2-13-E	0.039	8%	0.162	9%	5.1	1%
LC-3-08-E	0.1785	36%	2.16	123%	22.8	5%
SR-1-01-E	0.0585	12%	0.381	22%	6.75	1%
SR-11-05-E	-	-	0.0705	4%	3.75	1%
SR-2-05-W	0.237	48%	2.445	140%	49.35	10%
SR-3-11-E	0.1335	27%	0.642	37%	10.95	2%
SR-7-08-W	0.162	33%	2.01	115%	25.5	5%
TC-4-03-E	0.435	89%	2.655	152%	129.6	26%

Table B108: Provisional Tolerable Weekly Intake (PTWI) values for a 75 g serving of wild grape consumed by a 23 kg child.

Sample	Cd		Pb		Zn	
	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI	Weight (mg/75g)	Percent of PTWI
Background	0.006	4%	0.00825	1%	1.425	1%
EC-1-14-E	-	-	0.00675	1%	2.025	1%
LC-1-04-W	0.04725	29%	0.19275	34%	8.25	5%
LC-2-13-E	0.0195	12%	0.081	14%	2.55	2%
LC-3-08-E	0.08925	55%	1.08	188%	11.4	7%
SR-1-01-E	0.02925	18%	0.1905	33%	3.375	2%
SR-11-05-E	-	-	0.03525	6%	1.875	1%
SR-2-05-W	0.1185	74%	1.2225	213%	24.675	15%
SR-3-11-E	0.06675	41%	0.321	56%	5.475	3%
SR-7-08-W	0.081	50%	1.005	175%	12.75	8%
TC-4-03-E	0.2175	135%	1.3275	231%	64.8	40%

APPENDIX C: Heavy Metal Concentrations in the Clay Fraction of Floodplain Soils from Garvin et al. (2010) that Correspond to Plant Tissue Samples

Table C1: Concentrations of Pb and Zn in floodplain soils (clay fraction) from Garvin et al. (2010) that correspond to plant tissue samples.

Site	Floodplain Soil (clay fraction)	
	Zn (mg/kg)	Pb (mg/kg)
EC-1-E	210.4	77.6
EC-1-W	210.4	77.6
GR-2-E	695.9	49.2
GR-3-E	510.2	42.4
GR-4-E	466.3	40.6
LC-1-W	308.5	32.7
LC-2-E	252.3	32.4
LC-3-E	155.6	25.1
NRC-5-W	71.6	20.9
SR-1-E	1454	70
SR-1-W	1149	61
SR-11-E	1242	61
SR-2-W	1581	74
SR-3-E	1261	65
SR-6-W	513.5	42.9
SR-7-W	898.5	55.7
SR-9-E	2198	85
SRC-5-W	99.8	21.4
TC-1-E	6372	177
TC-1-W	7175	192
TC-2-W	3037	103
TC-2-E	5421	158
TC-4-E	376.3	38.3

APPENDIX D: Injured Plant Species at Each Sampling Site Based on Exceedances of the PTWI

Site	Total number of Species Sampled	Injured Plant Species Based on Exceedance of PTWI
EC-1	29	wild blackberry
		curly dock
		green dragon
		solomon's seal
		wild lettuce
		buttercup
		pawpaw
		buckbrush
		poke
		wild potato-vine
		creeping wood-sorrel
		violet
		duckweed
		wild strawberry
		dandelion
		violet
		riverbirch
GR-3	6	curly dock
		duckweed
GR-4	6	black willow
		dandelion
LC-1	22	spicebuch
		violet
		wild potato-vine
		common mullein
		wild mint
		wild strawberry
		common plantain
		jewelweed
		spicebush
LC-2	18	common plantain
		duckweed
		arrowhead root

Site	Total number of Species Sampled	Injured Plant Species Based on Exceedance of PTWI
LC-3	12	arrowhead root
		violet
		wild grape
		wild potato-vine
SR-1	20	bracken fern
		jewelweed
		common plantain
		buttercup
		wild potato-vine
		wild ginger
		green dragon
		jack-in-the-pulpit
		poke
		buckbrush
		creeping wood-sorrel
SR-2	18	wild potato-vine
		wild grape
		creeping wood-sorrel
		wild onion
		peppergrass
		buckbrush
		common plantain
		spicebush
		wild ginger
		jewelweed
		jack-in-the-pulpit
SR-3	15	pawpaw
		greenbrier
		wild blackberry
		green dragon
		poke
		violet
		solomon’s seal
		common plantain
		wild potato-vine
		peppergrass
		dandelion

Site	Total number of Species Sampled	Injured Plant Species Based on Exceedance of PTWI
SR-6	6	creeping wood-sorrel
		pawpaw
		curly dock
SR-7	11	violet
		common milkweed
		wild blackberry
		white mulberry
		wild grape
		poke
		spicebush
SR-9	1	violet
SR-11	8	wild onion
		wild potato-vine
		creeping wood-sorrel
		curly dock
TC-1	6	duckweed
		buckbrush
		riverbirch
		black willow
		wild onion
TC-2	7	wild potato-vine
		violet
		creeping wood-sorrel
		curly dock
		wild blackberry
TC-4	3	common plantain
		green dragon
		wild grape