

Heavy Metals & Urban Community Gardens: Assessing Perceptions and Concentrations of Heavy Metals in St. Louis, MO

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Background

- Urban gardening is on the rise in the United States, with more than one million households participating in community gardens.¹
- St. Louis is a leader in urban gardening with over 200 community gardens.²
- There are many benefits of urban gardening including the local production of fresh produce, beautification of neighborhoods, and mitigation of heat island effects from abandoned land.³
- Urban gardens are often in settings with industrial and commercial legacies that have resulted in contamination of soils with heavy metals and other toxic compounds.³
- Toxic metals and metalloids, such as lead and arsenic, are common contaminants in urban soils.³
- Due to Missouri's history of lead mining and smelting, the St. Louis region has surface soil lead concentrations in the 90th percentile or higher within the country.⁴
- Heavy metal contamination can potentially undermine the environmental benefits of urban gardening.

Research Aims

- Examine the geospatial trends in heavy metal concentrations in urban gardens across St. Louis and identify the driving forces for these trends.
- Determine the levels of specific heavy metals in garden soils to enable estimation of the bioavailable fraction of metals.
- Explore gardener perceptions of risk to soil contamination in urban gardens.

Methods

- Community gardens were sampled in four regions (North County, North City, Central City, and South City) within St. Louis, MO (Figure 2).
- Structured interviews were conducted with gardeners to assess possible exposure to heavy metals in the soil, knowledge of soil contaminants, and perceptions of community gardens.
- Interviews were conducted with garden leaders to learn about the history of the garden.
- Plots in community gardens were sampled to a depth of 10 cm.
- Soil samples were analyzed for the total concentrations of a set of metals using hot acid digestion followed by inductively coupled plasma mass spectrometry (ICP-MS) analysis.

Results

- The majority of the gardeners were female (60.2%) and white (64.5%) (See Table 1). Most gardeners (71%) had attained at least a college degree, which is greater than the St. Louis average of 11.5%⁵ (Table 1).
- Average income in St. Louis in 2013 was \$50,431⁵ (Table 1).
- Community gardeners spent an average of four hours per week in their plots.
- Although, average lead mean concentration was 63 µg/g (Table 2), about half of the beds had lead concentrations near background levels for Missouri (29.2 µg/g)⁶, which is just above the national average (25.8 µg/g).⁷
- Less than half (48.4%) of gardeners were aware of heavy metals, particularly lead, as soil contaminants within the St. Louis region (Table 3).

Figure 1. Mean lead concentrations in community gardens

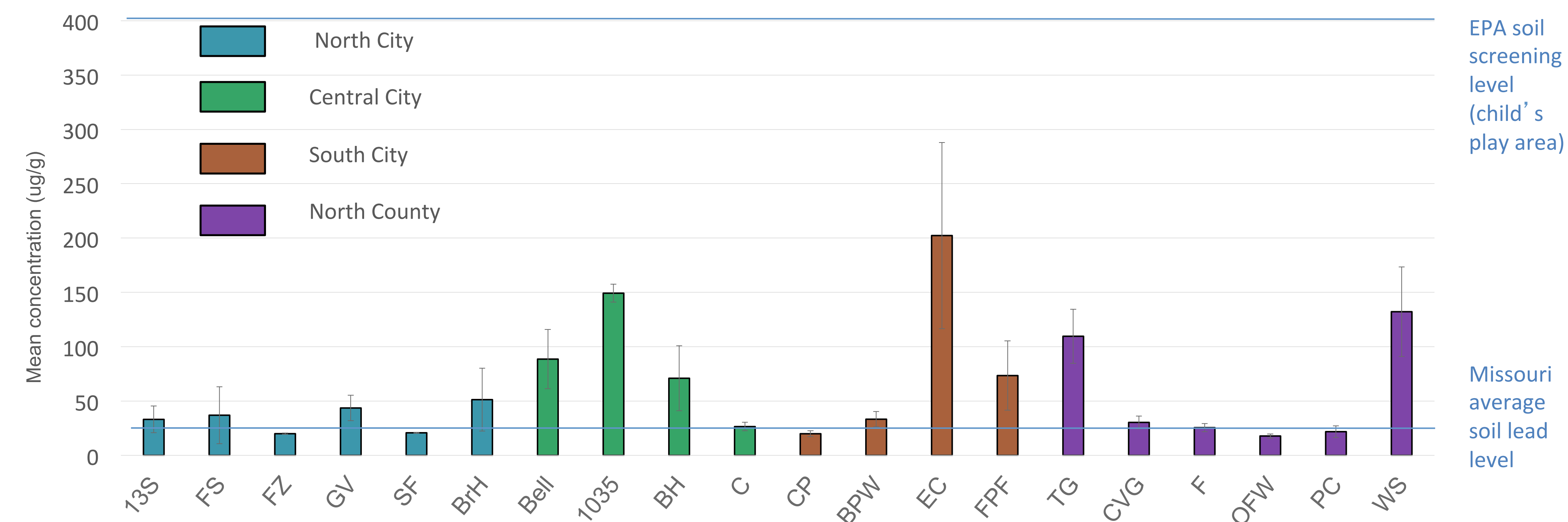


Table 1. Gardener demographics*

Gardener's Characteristics	N	%	Gardener's Characteristics	N	%	
Sex	Female	56	60.2	Household Income		
	Male	37	39.8	<\$10,000	5 (5.4)	
Age (mean, S.D.)	50.1	13.8	\$10,000-30,000	20	21.5	
Race	White	60	64.5	\$30,001-50,000	15	16.1
	Black	30	32.3	\$50,001-70,000	13	14
	Other	3	3.2	\$70,001-90,000	5	5.4
				\$90,000+	28	30.1
Highest Level of Education			Not applicable	1	1.1	
High school/GED	9	9.7	Occupation			
Some college	3	3.2	Retired	19	20.4	
Technical degree	14	15.0	Education, health, and social services	16	17.2	
Associate degree	6	6.5	Scientific, management, and administration	15	16.1	
Bachelor's degree	22	23.7	Information	8	8.6	
Graduate degree	38	40.9	Arts, entertainment, recreation	6	6.5	
No response	1	1.1	Unemployed	5	5.4	
			Other	24	25.8	

*Percent out of all gardeners (n=93).

Table 2. Garden Average Metal Concentrations

	Mean (µg/g)	SD (µg/g)	Median (µg/g)	Max (µg/g)	Min (µg/g)
Lead	63.4	22.5	58.5	96.9	39.8
Arsenic	7.2	1.5	6.8	9.4	5.6
Cadmium	0.9	0.2	0.7	0.9	0.5
Copper	104.2	124.4	35.5	317.5	28.3
Cobalt	6.2	0.7	6.1	7.1	5.3
Nickel	15.5	1.6	15.4	17.8	13.6
Molybdenum	1.4	0.4	1.3	2.0	1.1
Calcium	28740	10228	25846	44467	18801
Magnesium	4463	935	4334	5786	3397
Iron	12269	1422	12135	14205	10598
Zinc	146.2	49.9	125.5	227.8	105.9
Chromium	18.5	3.0	18.0	22.8	15.2

Figure 2. Gardens Sampled in St. Louis

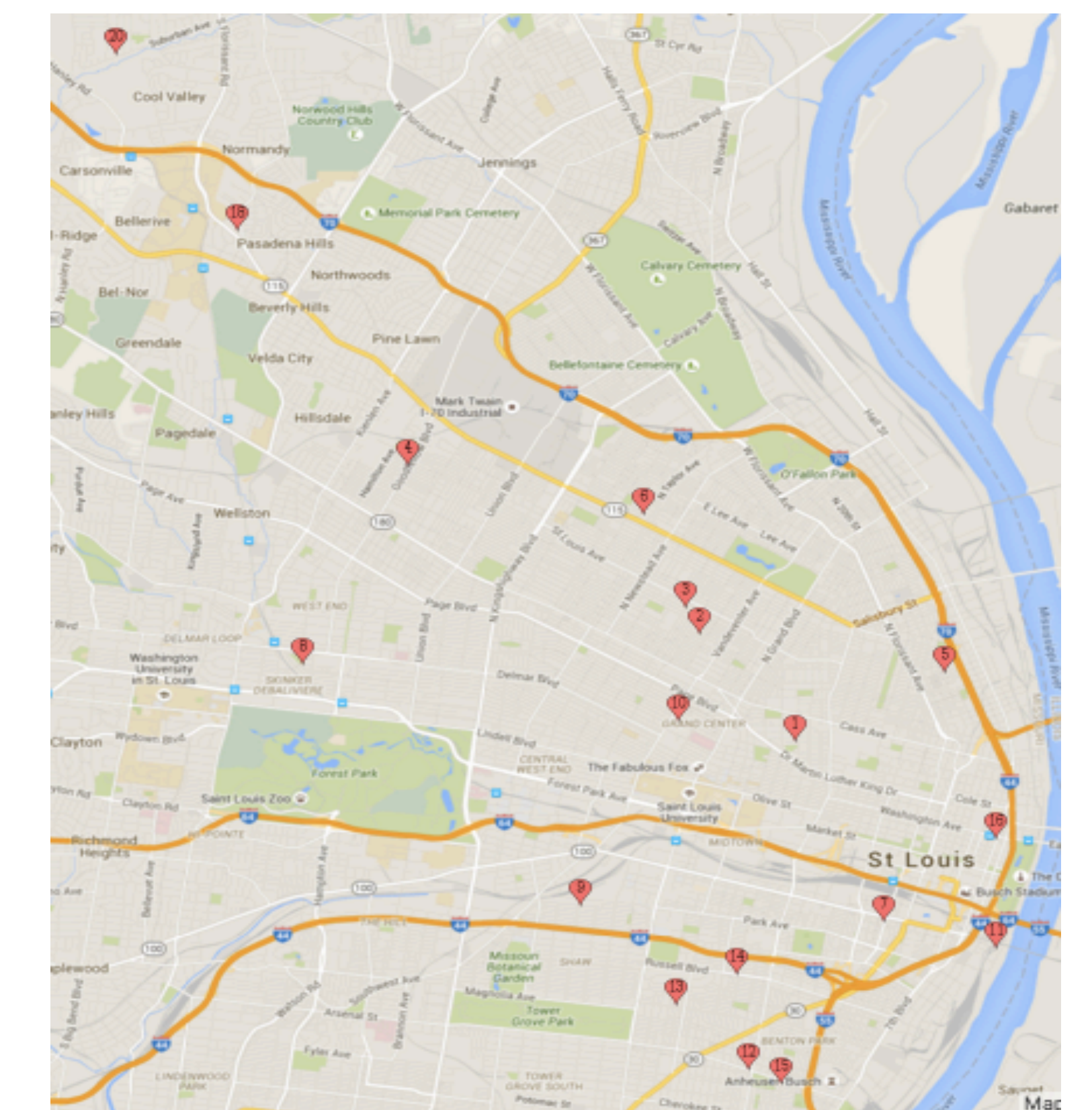


Table 3. Soil contaminants gardeners were aware of within the region

Contaminant Category	Contaminant	N (%)
Heavy Metals	Lead	45 (48.4%)
	Arsenic	5 (5.4%)
	Mercury	3 (3.2%)
	Zinc	1 (1.1%)
	Other (e.g. Erosion, landfill, and refinery)	8 (8.6%)
Organic Chemicals	Pesticides	6 (6.5%)
	Fertilizers	2 (2.2%)
	PCBs and Dioxins	2 (2.2%)
Asbestos		5 (5.4%)
Biological (e.g. Contaminated water and fecal matter)		3 (3.2%)
Medicine		1 (1.1%)
Radioactive Waste		4 (4.3%)

*Percent out of all gardeners (n=93).

Conclusions

- Lead concentrations in soils tested were below EPA guidelines of 400 µg/g for soil in children's play areas (Figure 1).
- Other metals with notable garden-to-garden variability included arsenic and copper (Figure 1).
- Approximately 58% of gardeners did not know of any practices to reduce exposure to soil contaminants.
- Gardeners were aware of lead as a possible contaminant (Table 3), but many gardens were around state average lead levels, and those that were above this average fell below the EPA's hazard threshold for residential soil.

Acknowledgements

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