



Biomonitoring with moss in Portland

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USFS PNW Research Station

**THE
MOSSBUSTERS**

Who ya gonna call?

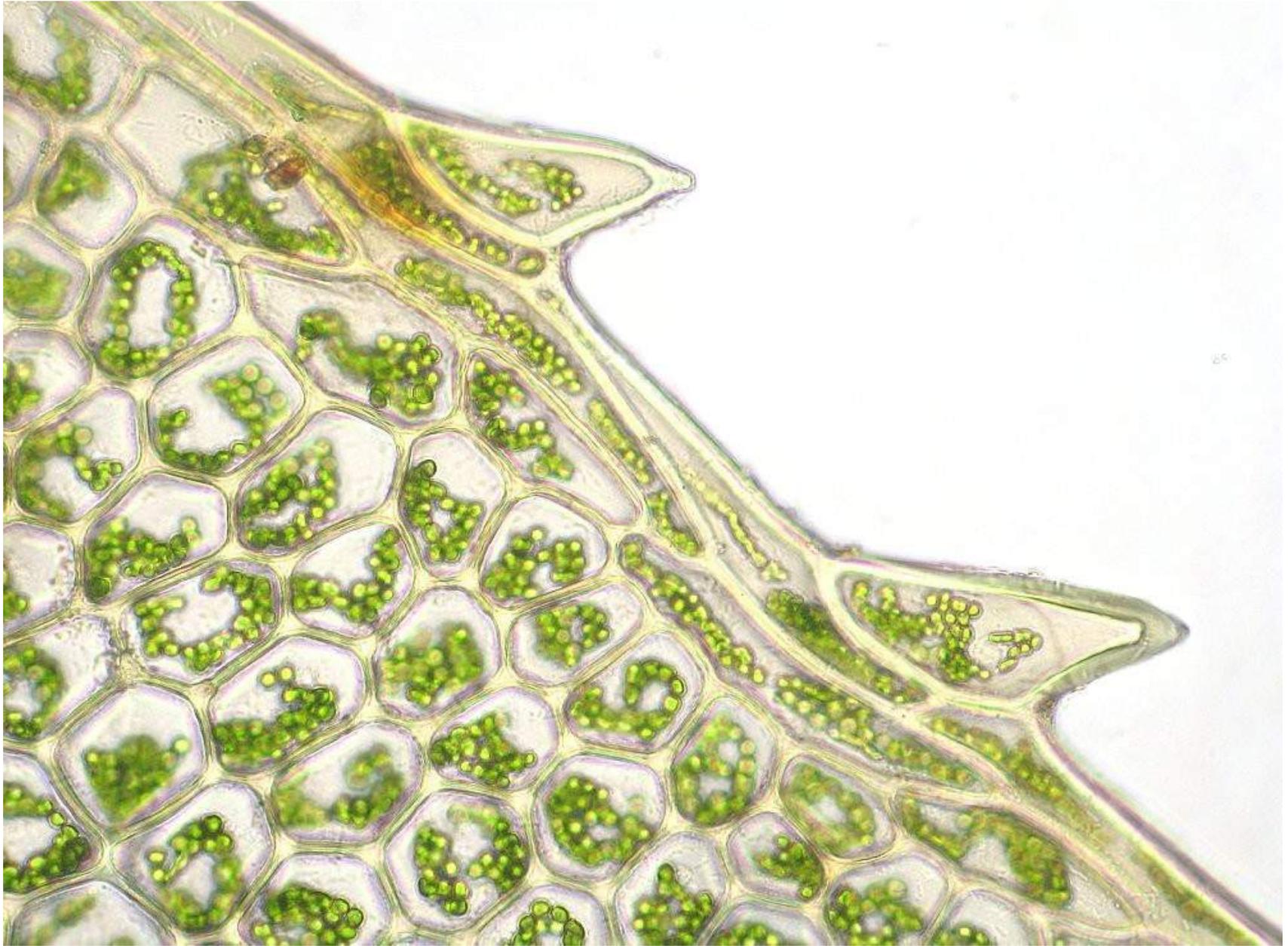
(425) 772-7055

- Roof Cleaning
- Gutter Cleaning
- Pressure Washing
- Moss Removal & Treatment









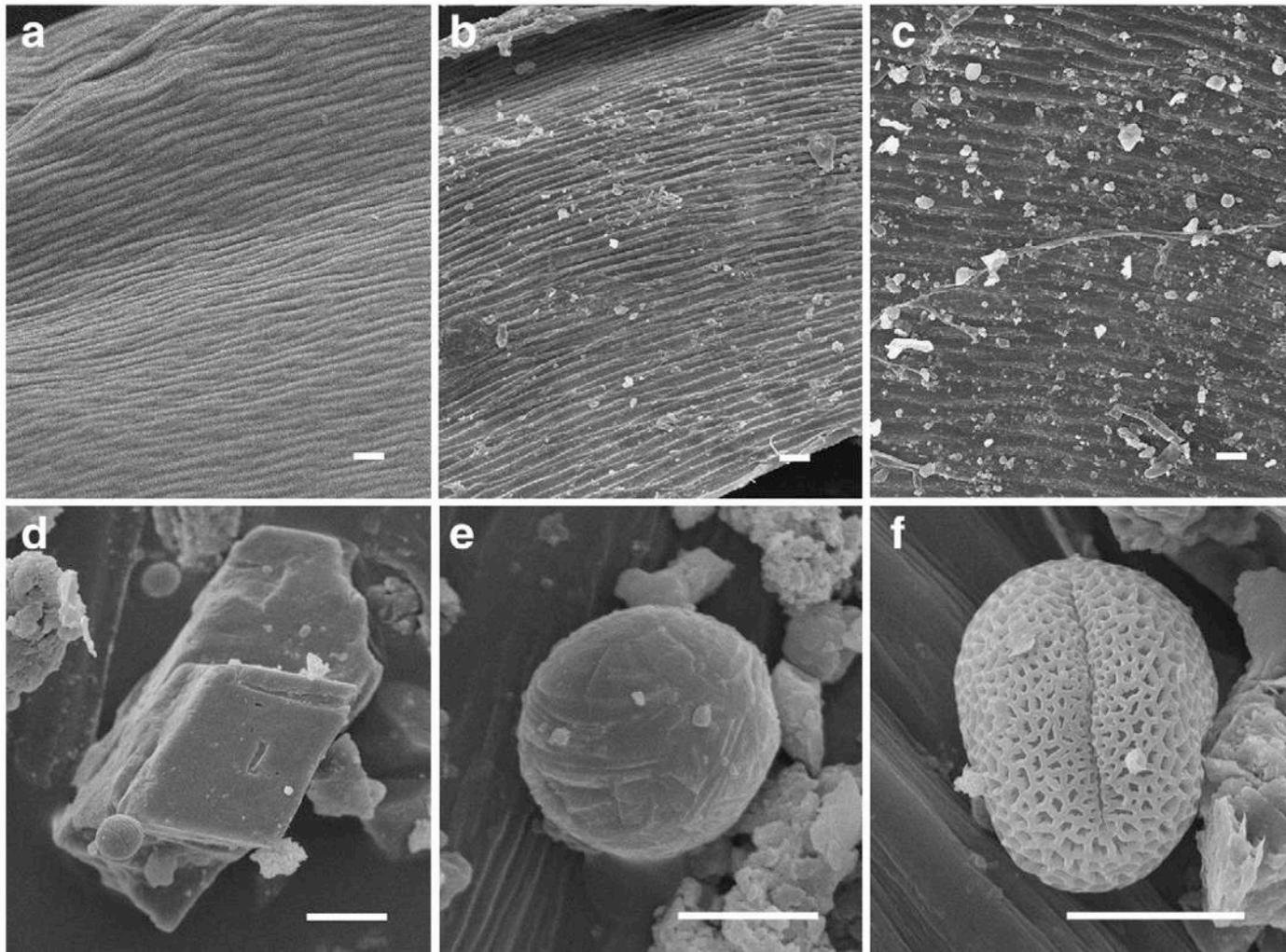
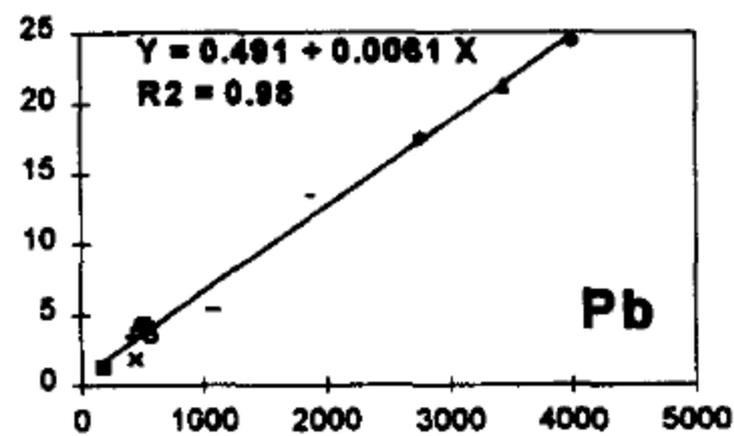
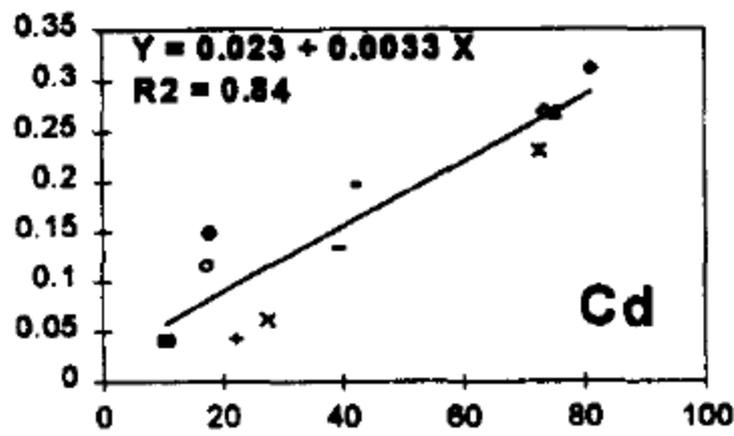
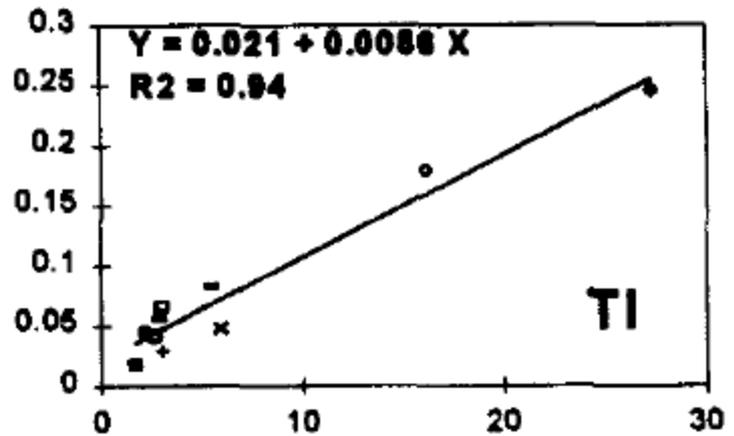
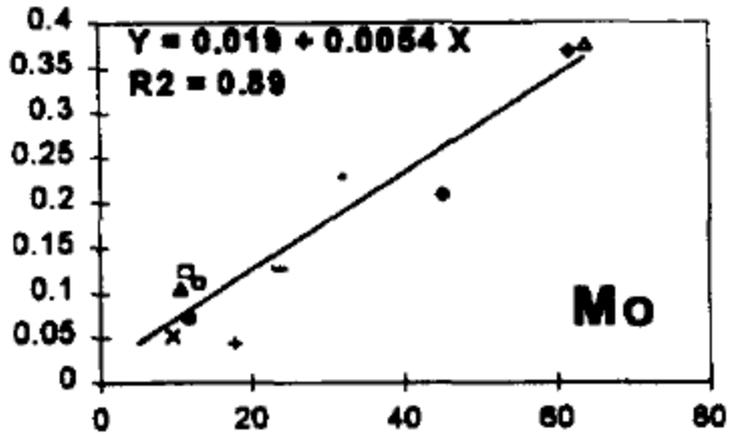


Fig. 5. SEM micrographs of moss leaflets before (a) and after exposure (b,c) in the green (b) and roadside (c) site pair nr. 9 of Fig. 1, and enlargement of particulate matter (d,e) and pollen grain (f). Bar = 10 μm (a–d, f); 3 μm (e).

Concentrations ($\mu\text{g g}^{-1}$) in *H. splendens*



Wet deposition ($\mu\text{g m}^{-2}$)

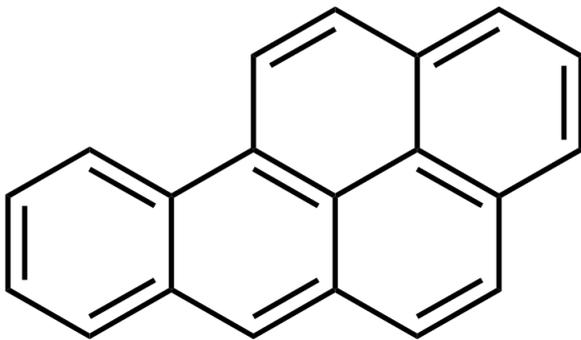
The benefits of bioindicators

2. Low cost/feasibility for fine scale mapping

PAH analysis of moss ~ \$300/sample

Metals, N, S ~ \$50/sample

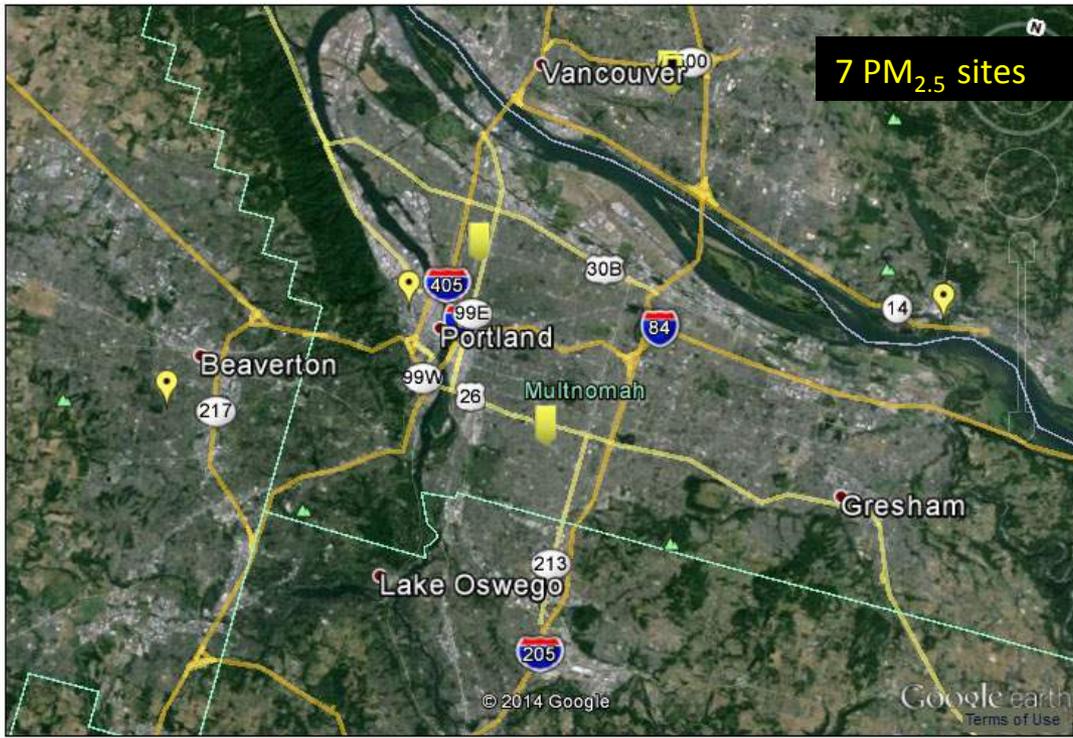
3. Long-term integration of pollutants:



Benzo(a)pyrene

Benzo(a)pyrene measured at Portland Roselawn site in 2013

	Monitor air conc. (ng/m ³)	Moss (µg/kg –dry wt)
Jan	0.242	
Feb	0.21	
Mar	ND	15.8
Apr	ND	1.96
May	ND	0.437
Jun	ND	0.467
July	ND	
Aug	ND	17.6

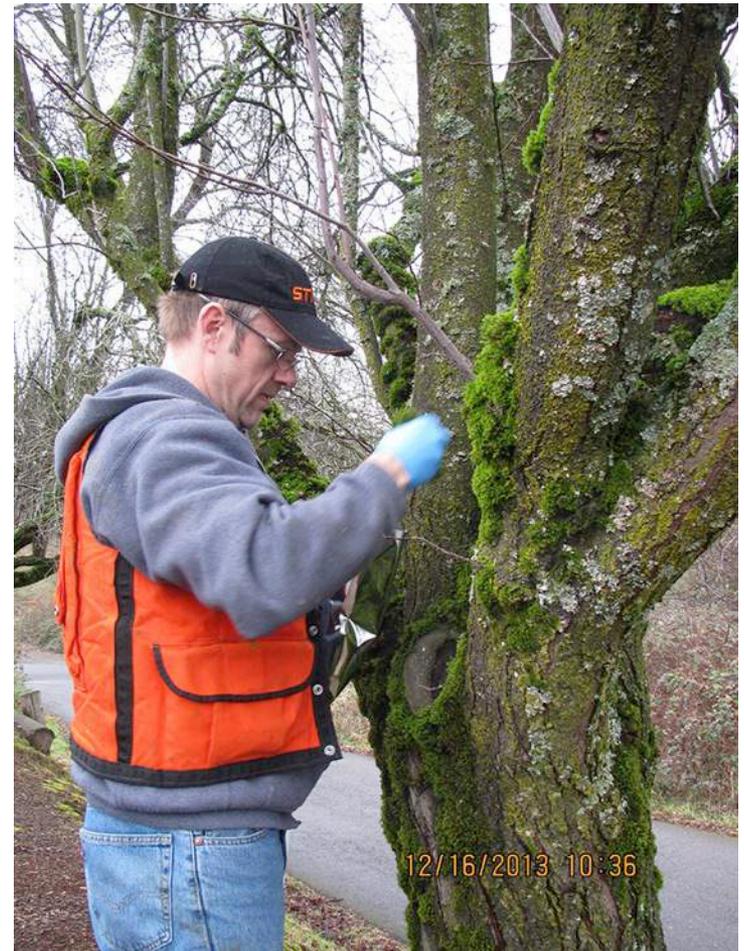


EPA toxics monitor, Hillsboro
Measures: Metals, VOCs, PAHs, black carbon





Orthotrichum lyellii
U.S. distribution: AK, CA, ID, OR, WA



Objectives

- Create high resolution maps
 - Public health research
 - how does human exposure vary? links to disease incidence?
 - Environmental justice
 - who is most affected?
 - Air quality monitoring/regulation
 - compliance (e.g. steering placement of instruments), tracking change, etc.
- Point source detection, inc. tracking down unknown/unregulated emissions sources

Portland moss studies

- PDX-wide study Dec. 2013
 - 347 samples (60 reps)
- Schools study Nov/Dec 2014
 - 165 samples (51 reps)

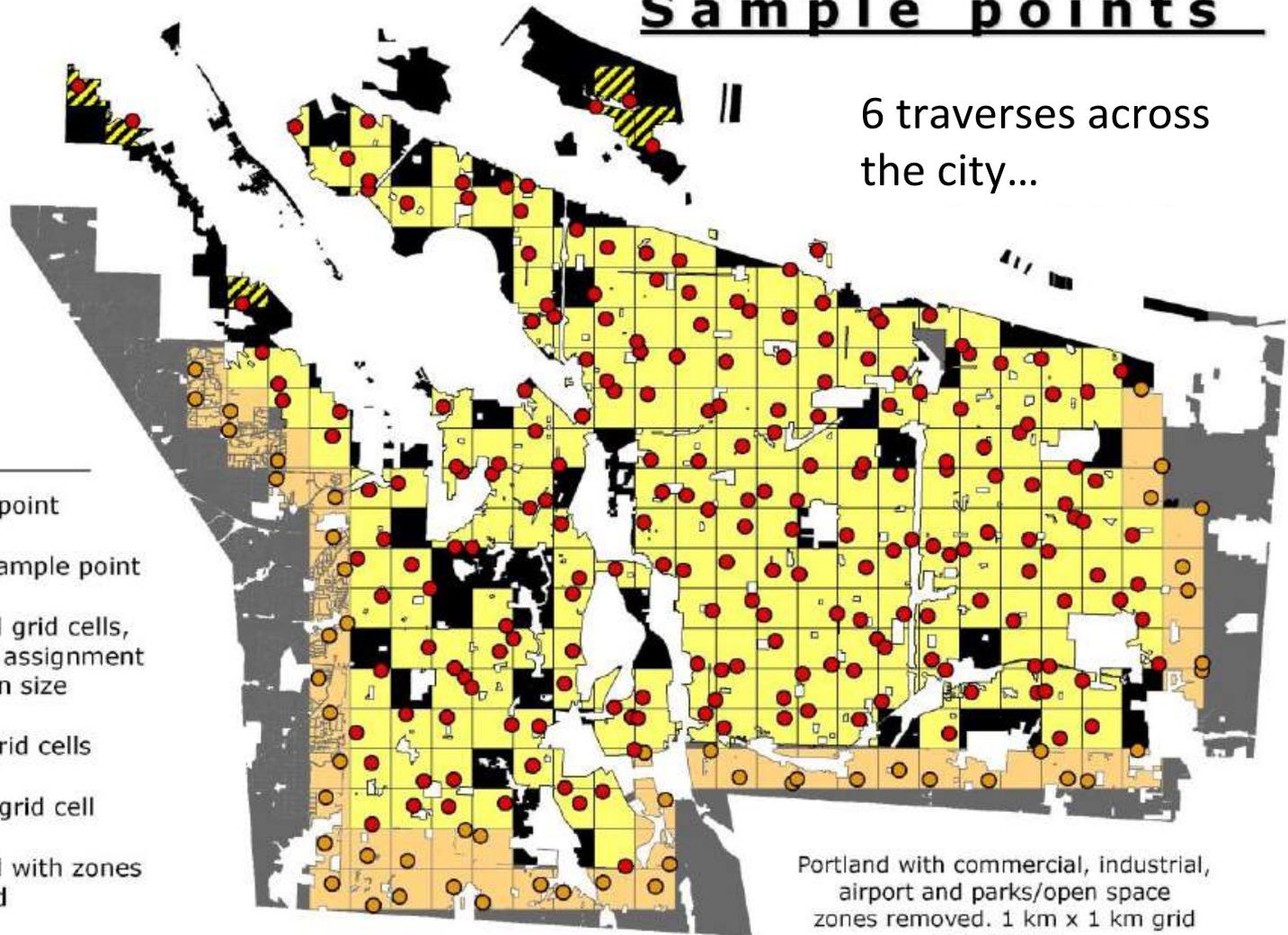


Sample points

6 traverses across
the city...



-  sample point
-  buffer sample point
-  portland grid cells,
random assignment
based on size
-  buffer grid cells
-  deleted grid cell
-  portland with zones
removed
-  buffer area with
zones removed



Portland with commercial, industrial,
airport and parks/open space
zones removed. 1 km x 1 km grid
cell overlay.

0 2 4 8 Kilometers

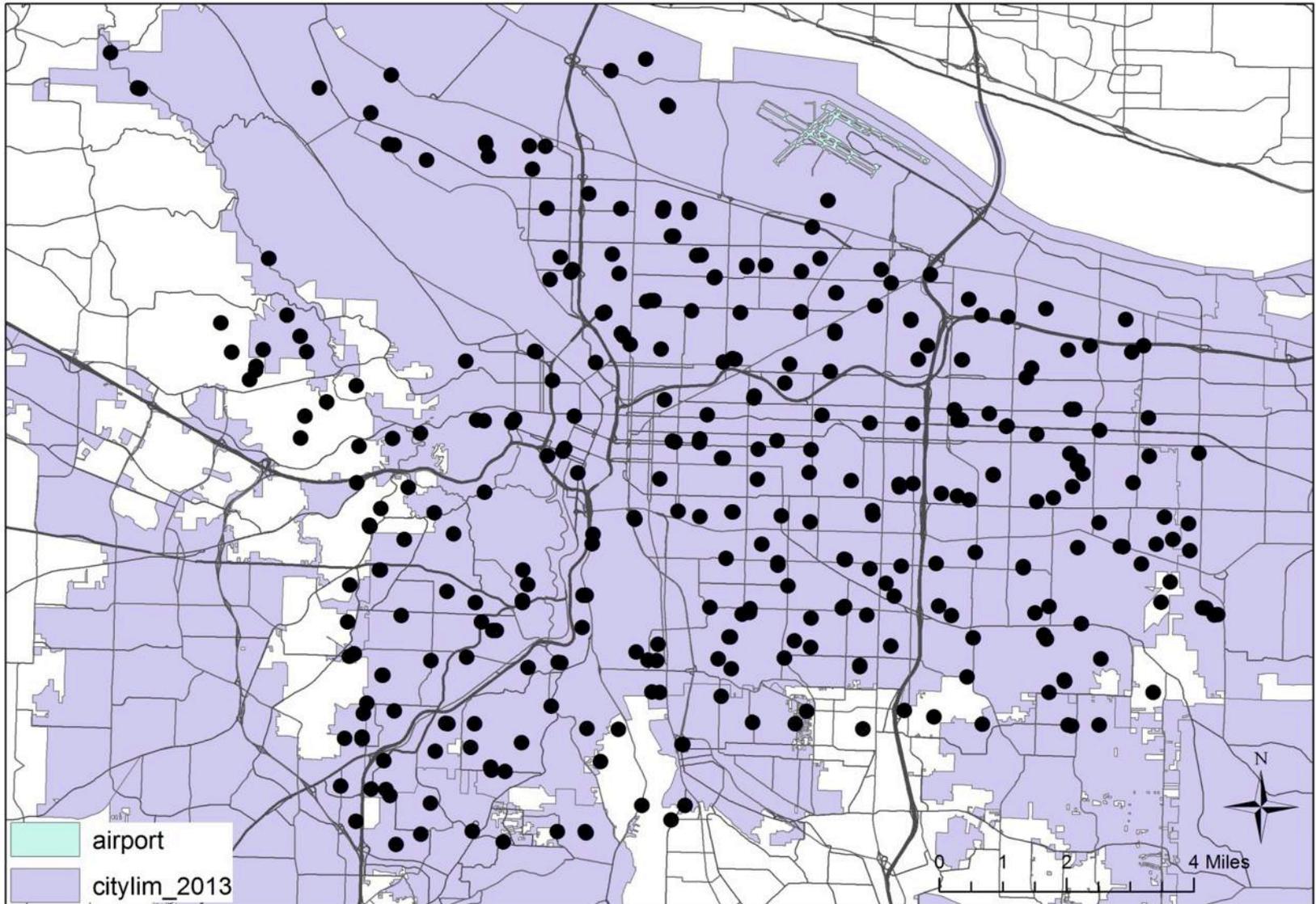
Re-sampling scheme for estimating sampling error and small-scale variability

Collected a second sample within short distance increments:

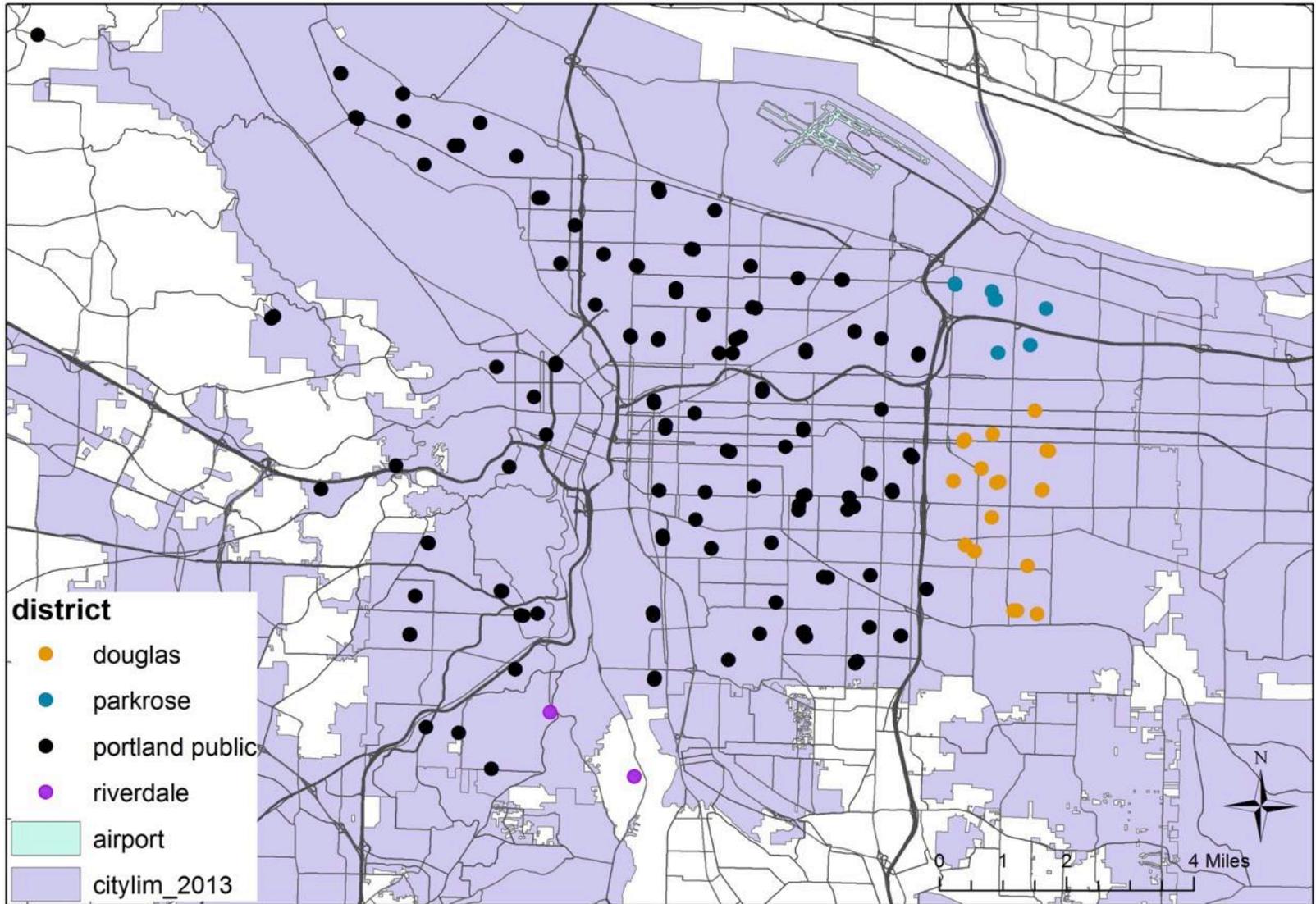
0m, 10m, 20m, 30m, 40m, 50m,
60m, 70m, 80m, 90m, 100m



PDX-wide



Portland Public Schools



School demographic variables

Race (%): Asian, African American, Hispanic, Multiracial, Native, Pacific Islander, White

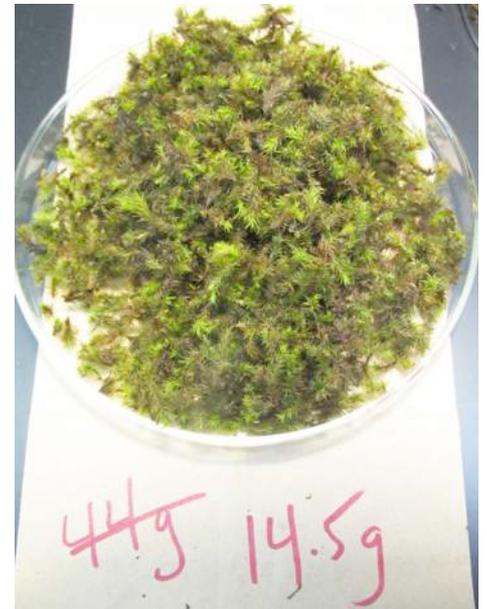
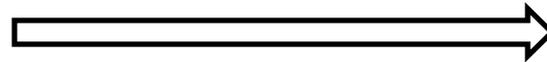
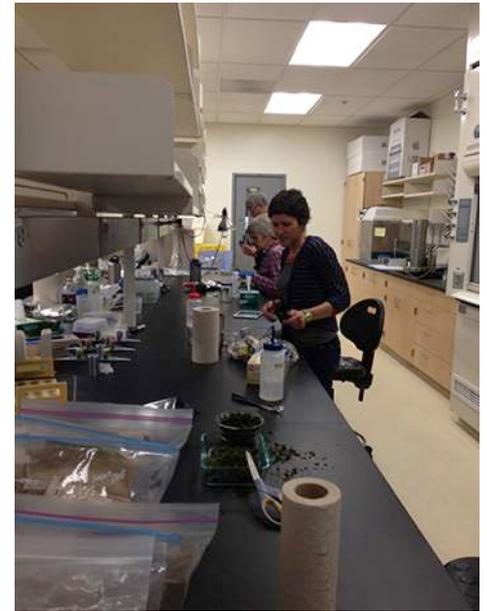
% free or reduced cost lunches

% English as second language

Total # students

Lab prep

- ~1hr per sample
- Sterile conditions
- Trim dead tissue, remove rhizoids and foreign debris



Pollutant extraction

- EPA's 16 priority PAHs using GC/MS
- Analysis for 16 metals + metalloids using ICP-OES: Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sr, Zn

Also-

- Nitrogen & Sulfur – Leco TruSpec combustion analyzer
- Waiting on Hg results- Leco TruSpec direct combustion analyzer

PAH Summary

in $\mu\text{g}/\text{kg}$

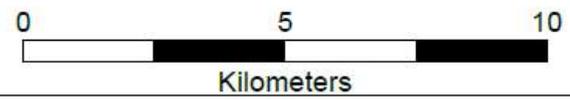
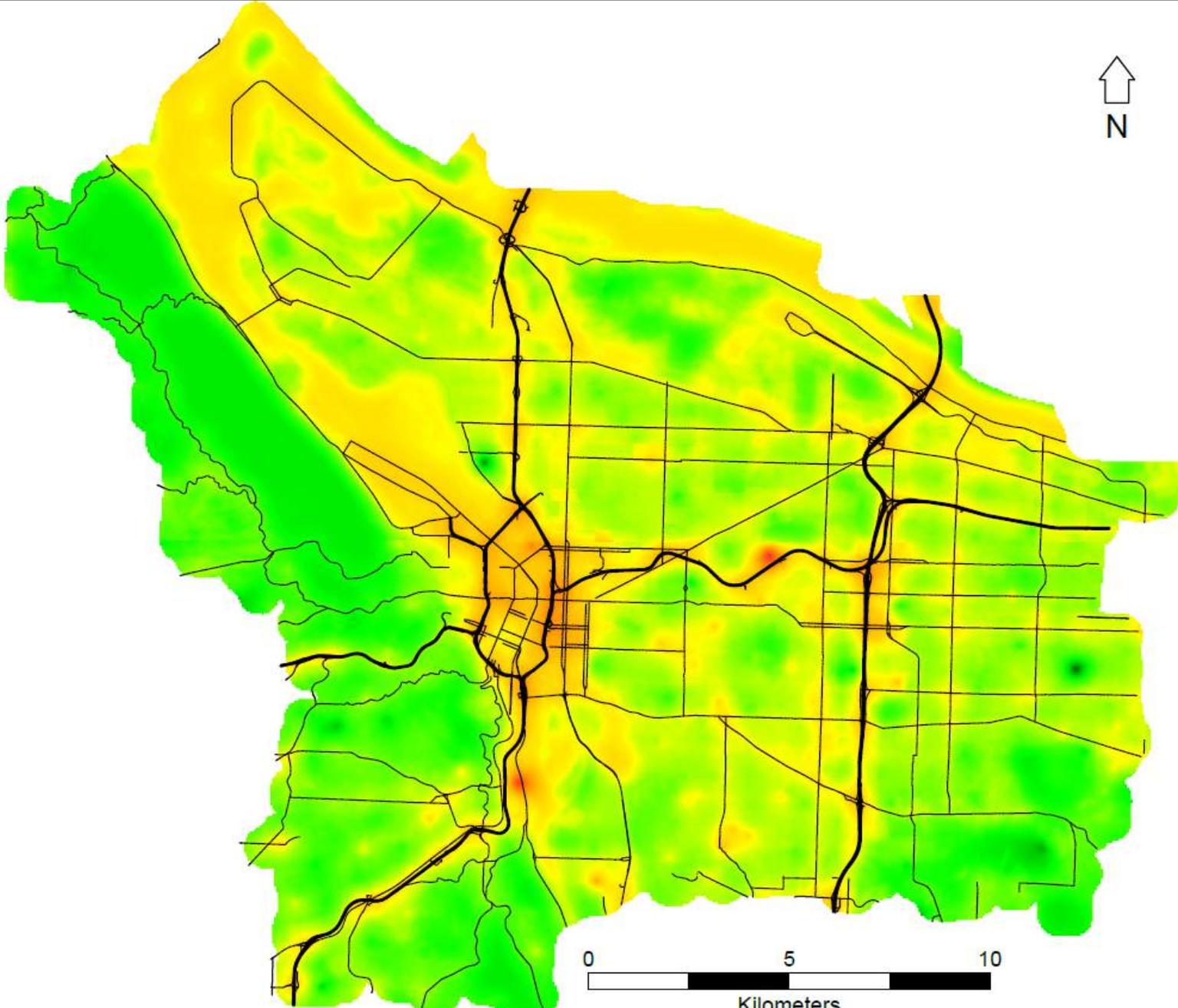
	MIN	MEAN	MAX
Acenaphthene	ND	7.06	52.8
Acenaphthylene	ND	8.02	175
Anthracene	ND	13.58	283
Benzo(a)anthracene	ND	42.06	1030
Benzo(a)pyrene	ND	33.15	838
Benzo(b)fluoranthene	1.54	50.75	624
Benzo(ghi)perylene	ND	59.07	1290
Benzo(k)fluoranthene	ND	37.18	838
Chrysene	ND	84.79	1270
Dibenzo(a,h)anthracene	ND	9.15	142
Dibenzofuran	ND	12.90	220
Fluoranthene	1.35	128.30	2900
Fluorene	ND	7.26	62
Ideno(1,2,3-cd)pyrene	ND	22.53	342
Naphthalene	ND	23.23	125
Perylene	ND	33.76	580
Phenanthrene	6.12	65.53	876
Pyrene	1.64	118.49	2340

Metals Summary

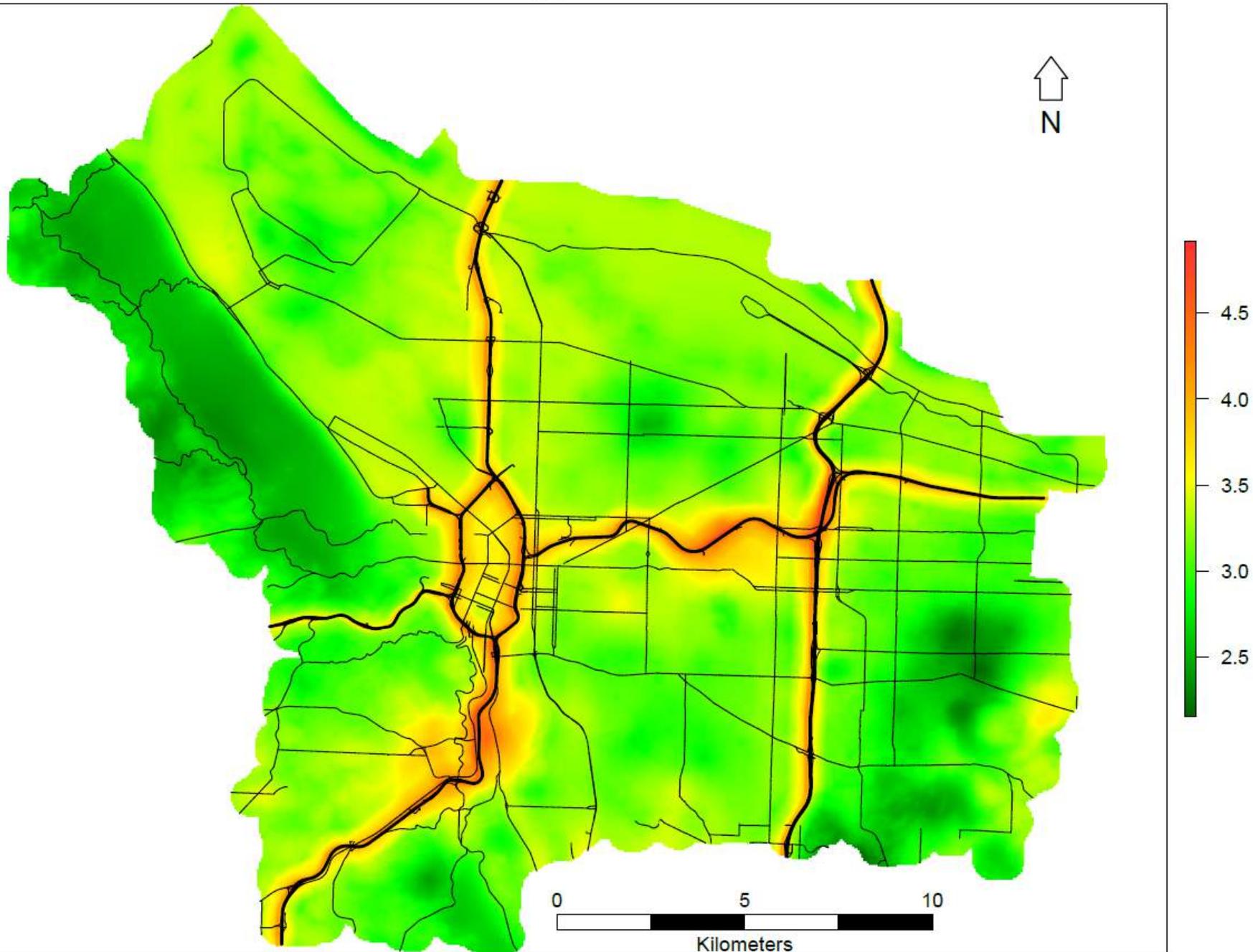
in mg/kg

	MIN	MEAN	MAX
Al	212.07	530.01	1734.82
Cd	0.06	0.32	4.38
Co	0.26	0.65	2.52
Cr	1.02	2.71	10.98
Cu	4.68	19.21	357.25
Fe	447.16	1150.19	4802.83
Mn	18.17	86.81	449.81
Ni	0.68	2.99	43.45
Pb	1.03	6.99	128.95
Si	23.90	434.66	1324.89
Zn	24.08	71.01	250.06

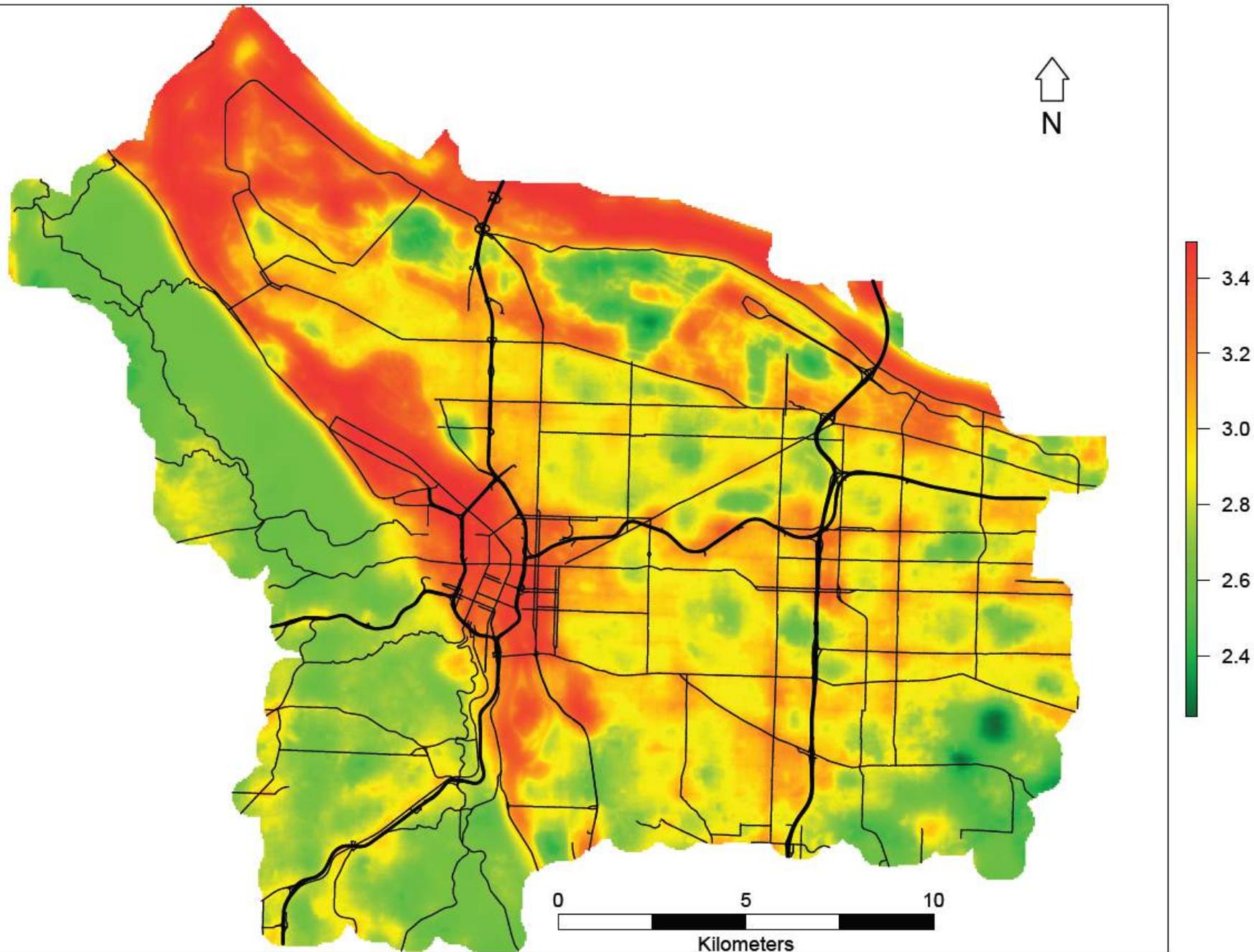
PYRENE



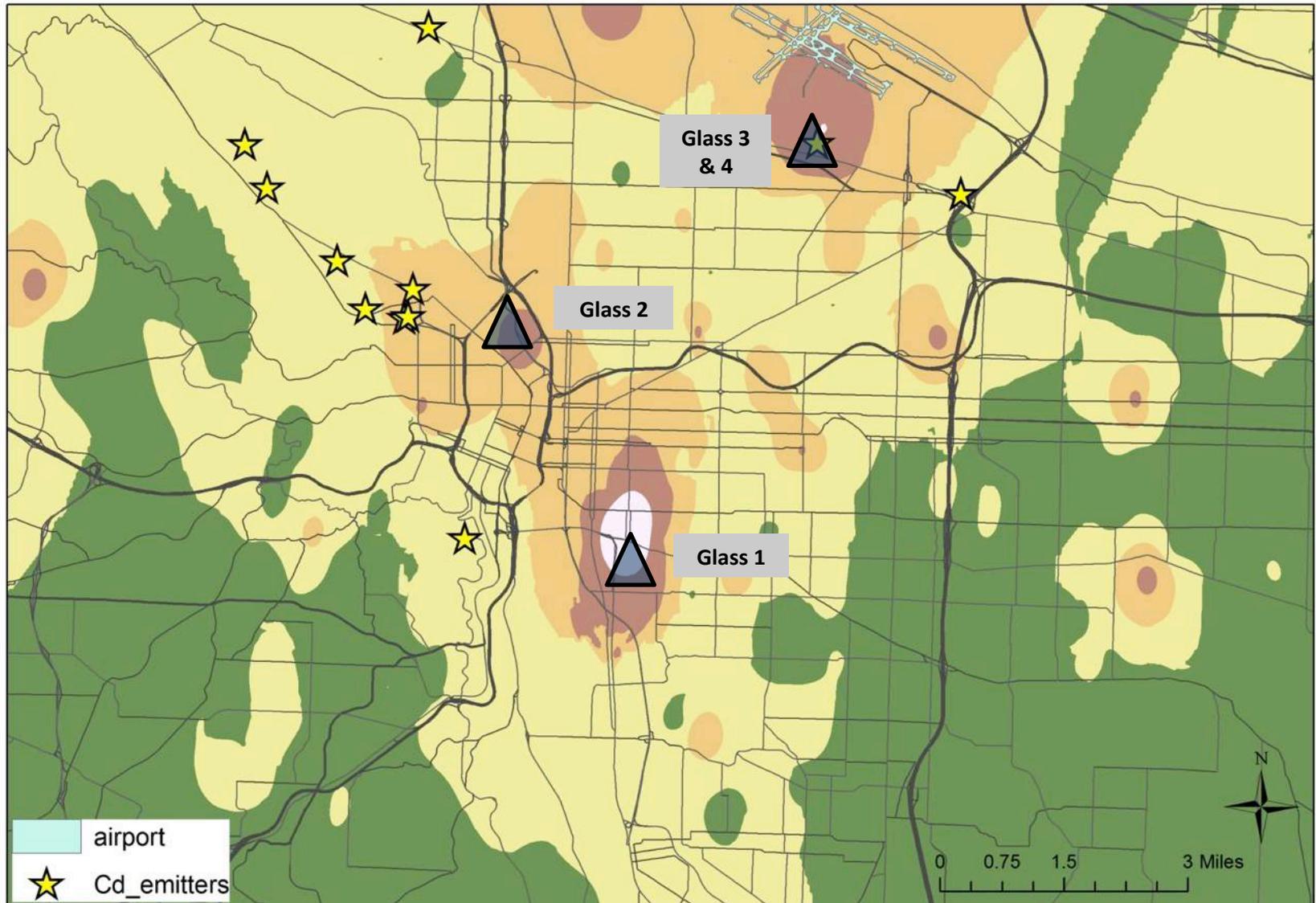
BENZO(A)PYRENE



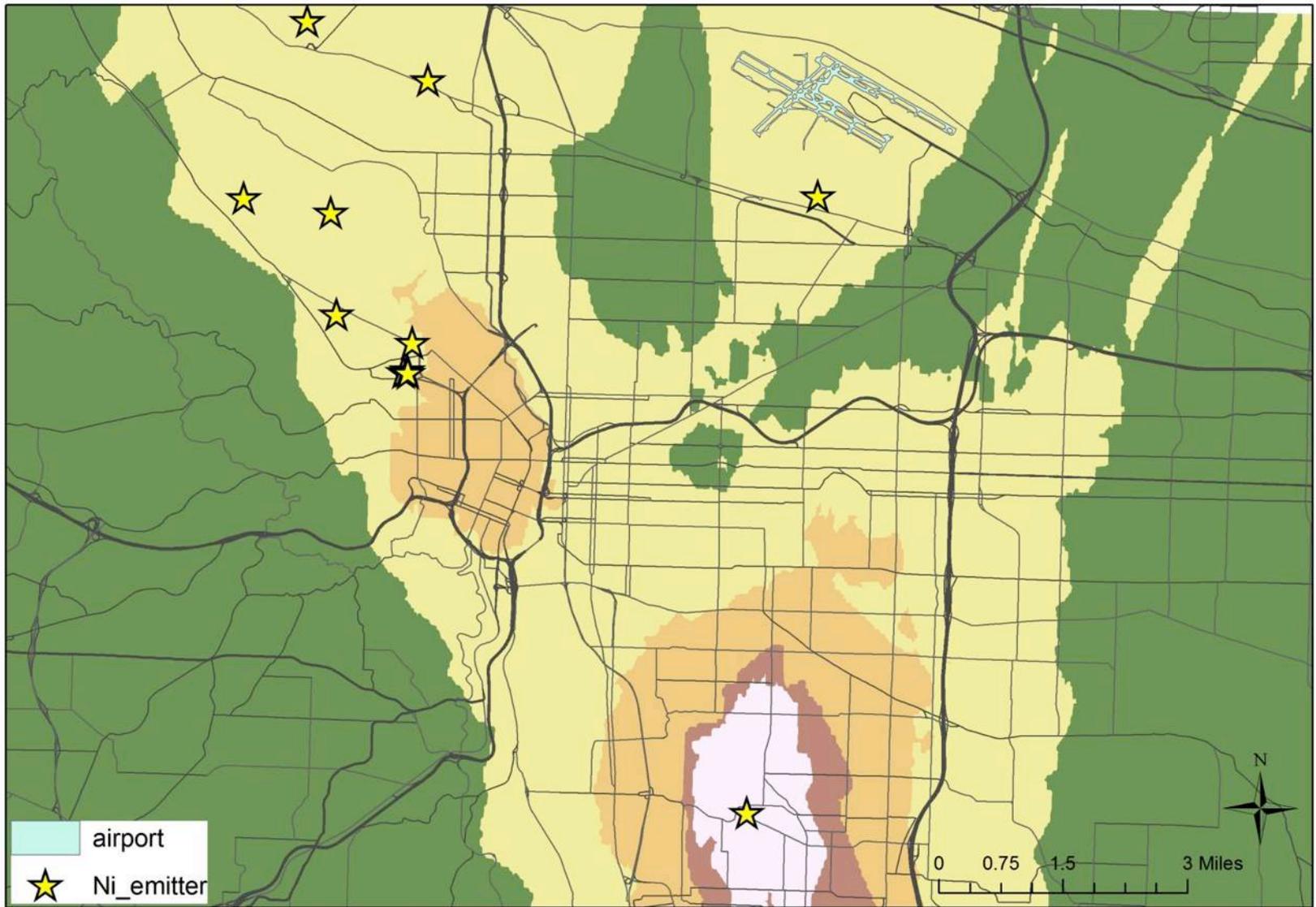
NAPHTHALENE



Cadmium in moss

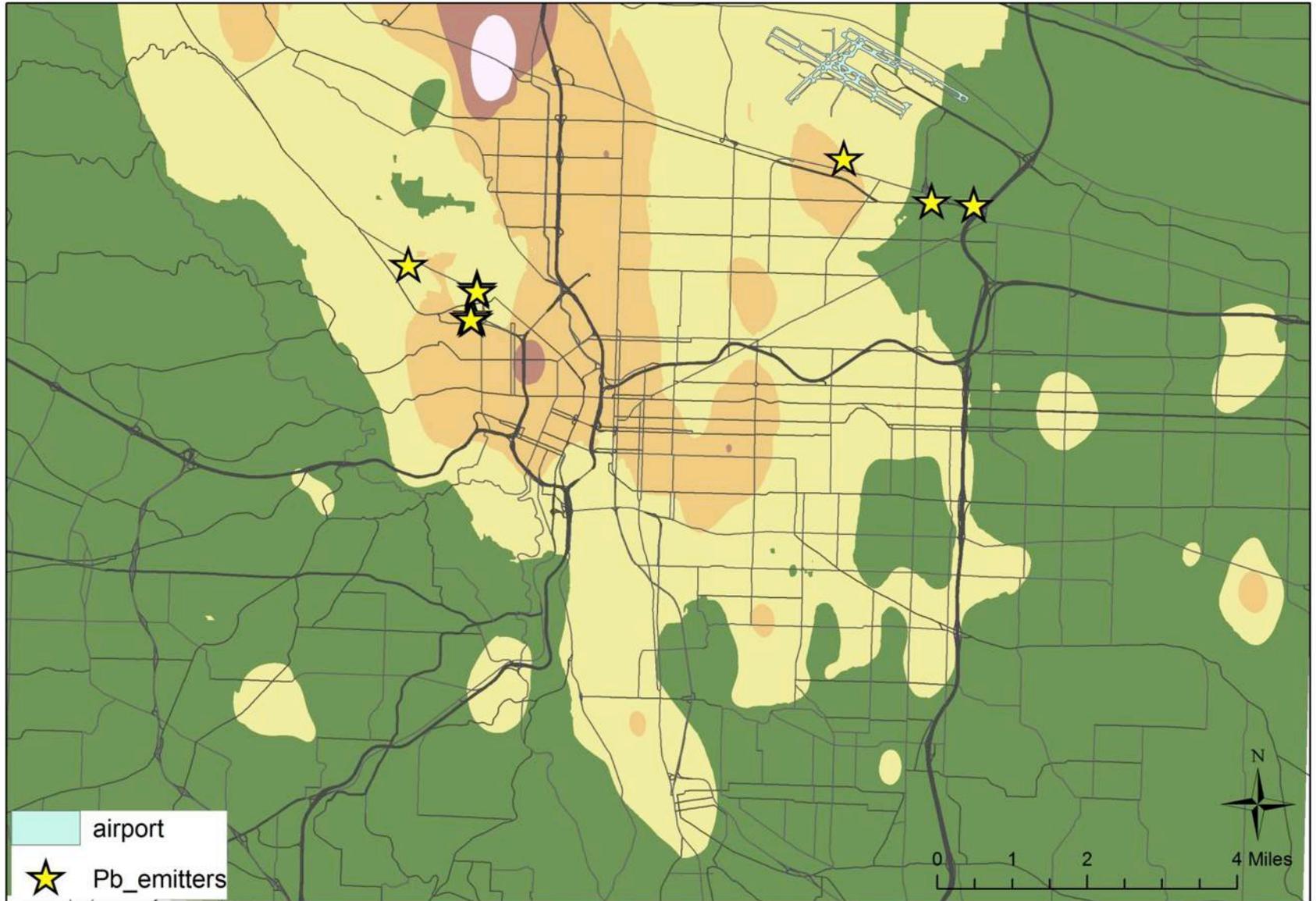


Nickel in moss

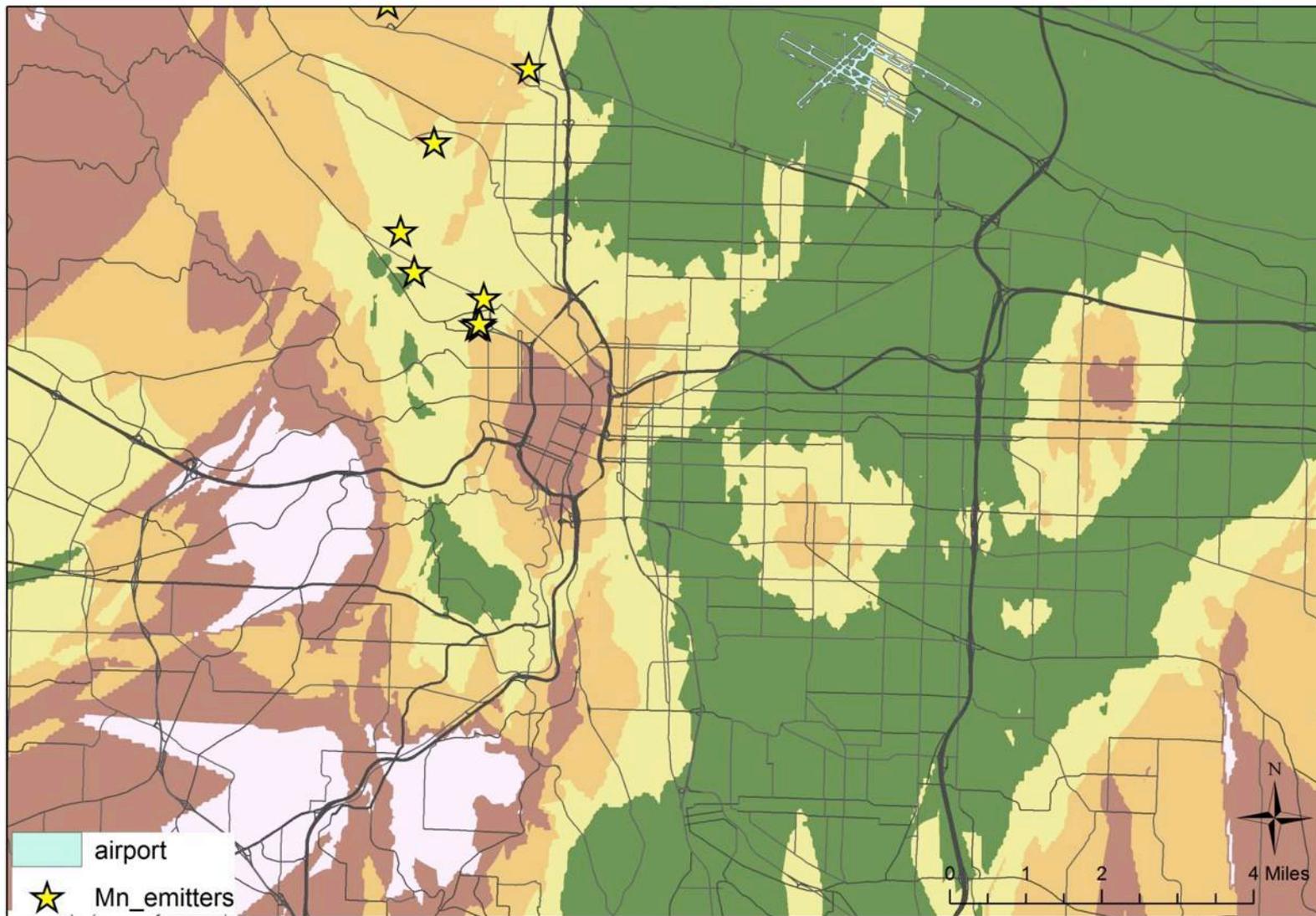


Additional metals maps

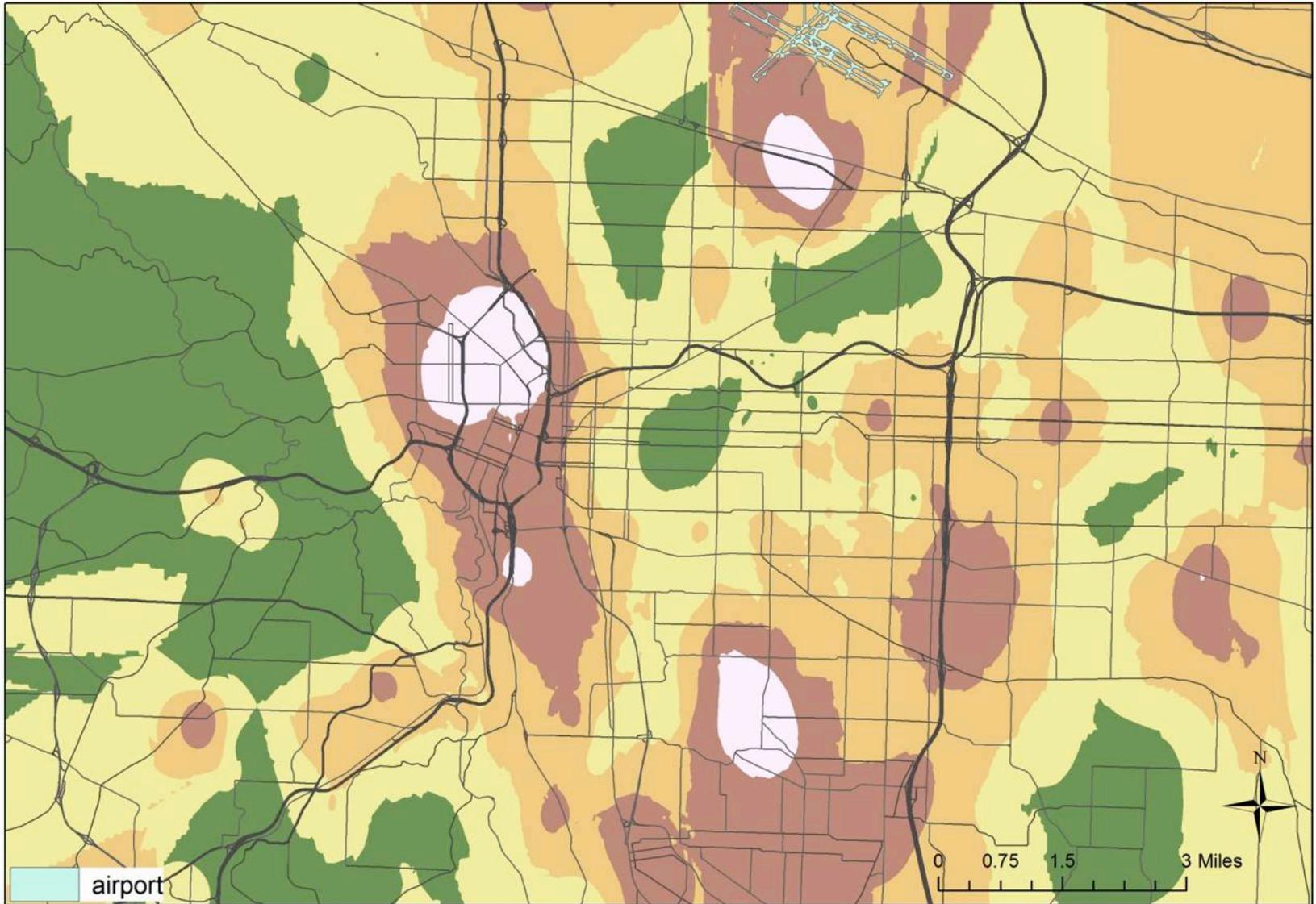
Lead in moss



Manganese in moss



Cobalt in moss



Chromium in moss

