Hydrologic Modeling of Urban Tree Cover Effects

David J. Nowak
US Forest Service
Syracuse, NY

Overview

- i-Tree Hydro
- 5 watershed analyses
- Precipitation partitioning
- Flow and water quality effects
- Leaf biomass

i-Tree Hydro

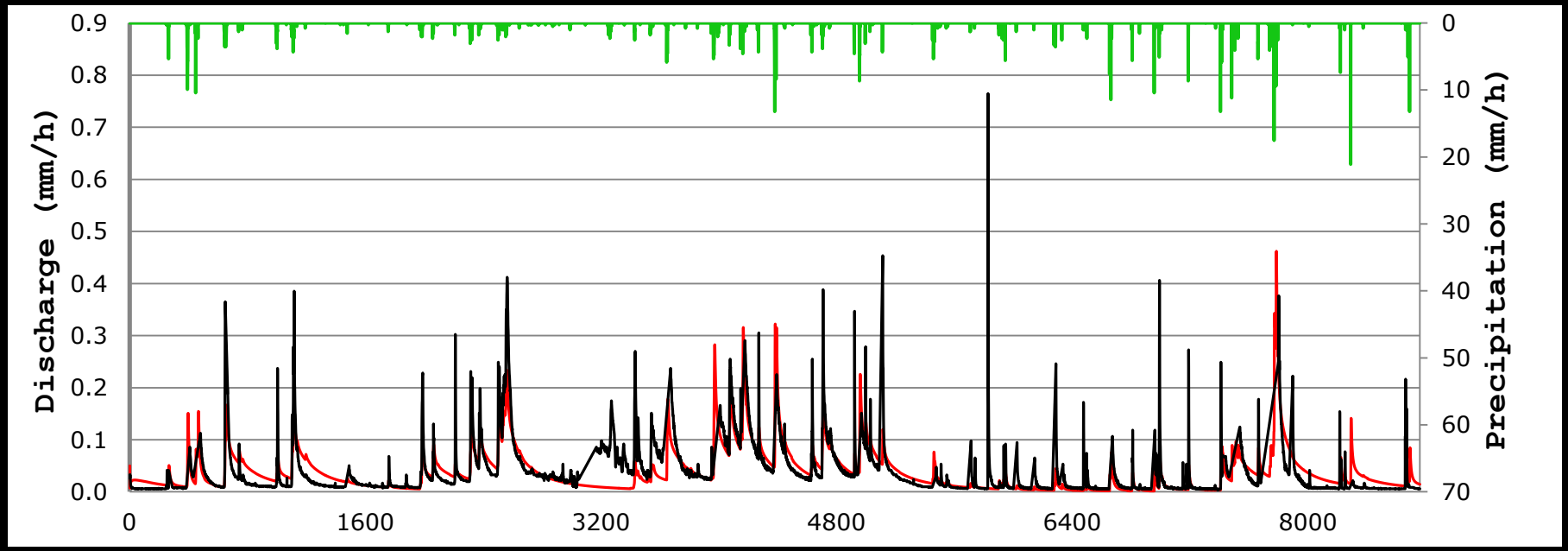
www.itreetools.org

Quantifies effects of:

- Tree cover
- Impervious cover

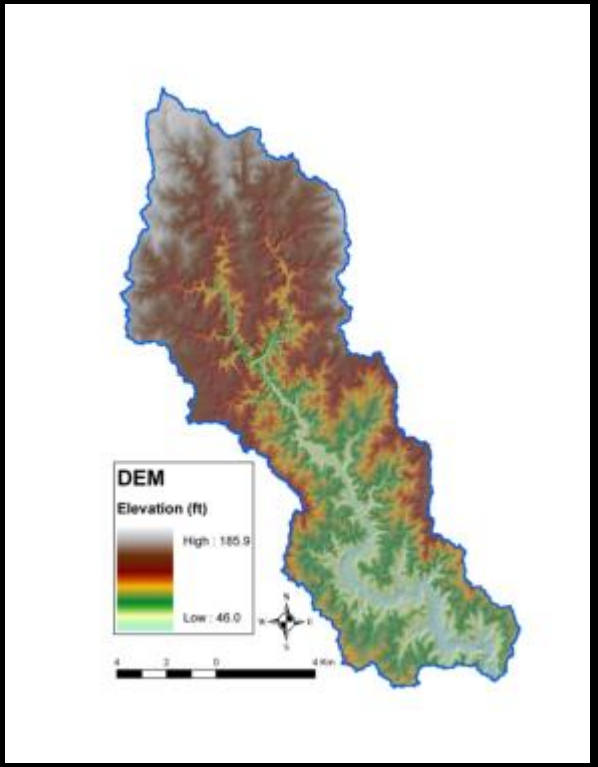
on:

- Hourly stream flow
- Water quality



5 Watersheds

- Cobbs Creek, Philadelphia, PA
  - 51.3 km^2, TC = 32%, IC = 51%
- Girtys Run, Pittsburgh, PA
  - 30.4 km^2, TC = 48%, IC = 33%
- Gwynns Falls, Baltimore, MD
  - 84.7 km^2, TC = 27%, IC = 19%
- Rock Creek, Washington, DC
  - 161.7 km^2, TC = 27%, IC = 18%
- Sandy Creek, Durham, NC
  - 12.0 km^2, TC = 57%, IC = 33%



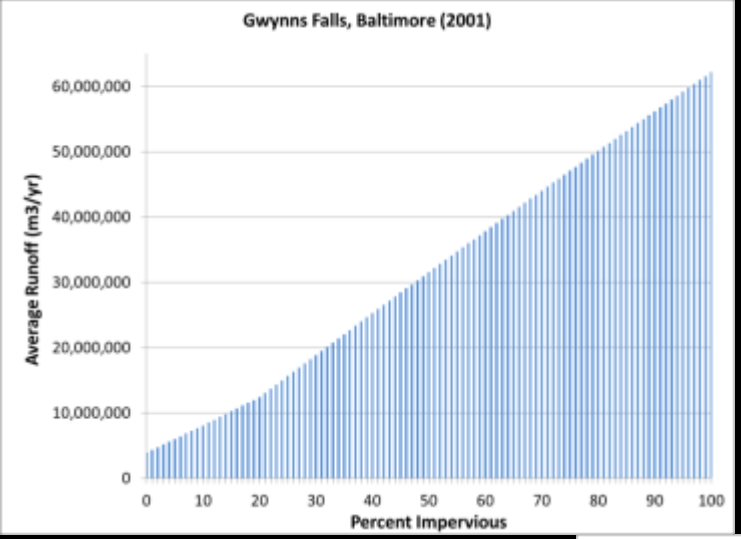
Rock Creek

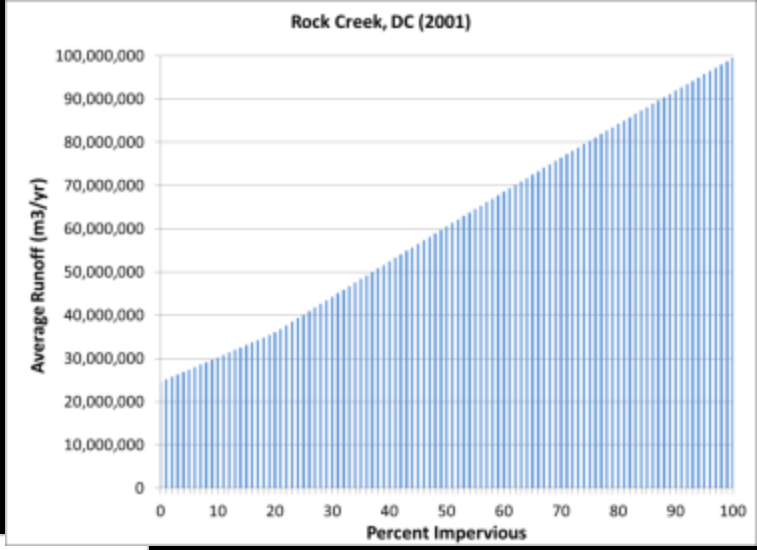
Precipitation Partitioning

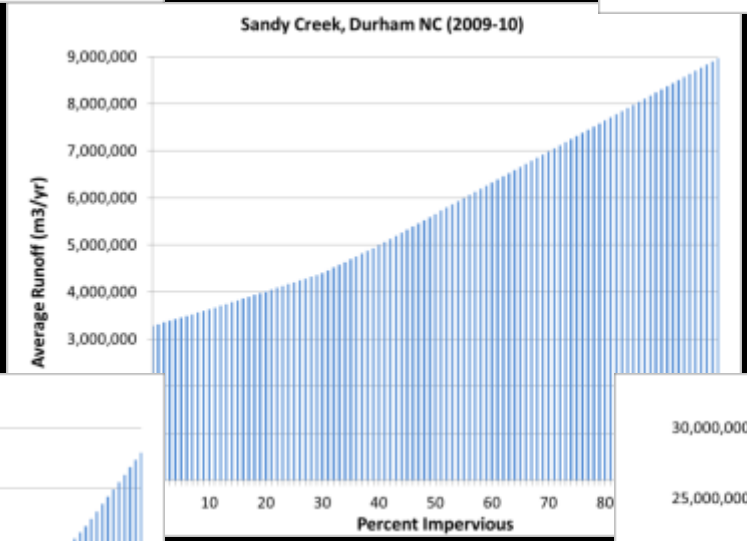
- Cobbs Creek, Philadelphia, PA
  - TI = 2.2%, GCI = 0.7%, Flow = 51.1%, ET/GWR = 46.0%
- Girtys Run, Pittsburgh, PA
  - TI = 4.1%, GCI = 0.9%, Flow = 37.9%, ET/GWR = 57.1%
- Gwynns Falls, Baltimore, MD
  - TI = 4.2%, GCI = 2.7%, Flow = 31.3%, ET/GWR = 61.8%
- Rock Creek, Washington, DC
  - TI = 5.3%, GCI = 3.4%, Flow = 36.0%, ET/GWR = 55.3%
- Sandy Creek, Durham, NC
  - TI = 3.8%, GCI = 0.7%, Flow = 38.4%, ET/GWR = 57.0%

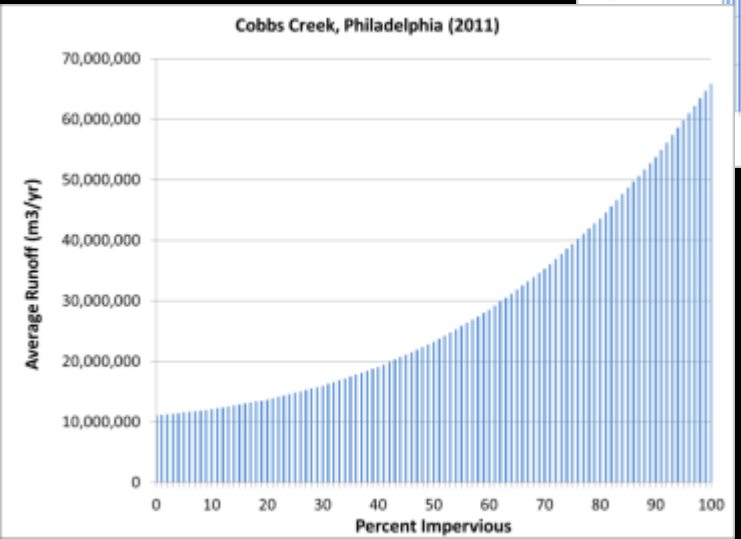
TI = tree interception; CGI = ground cover interception;
ET/GWR = other evapotranspiration / ground water recharge

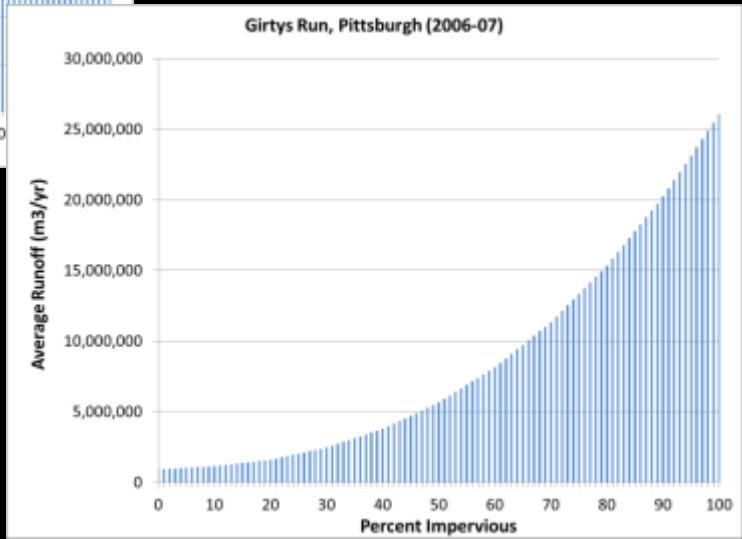
Total Runoff



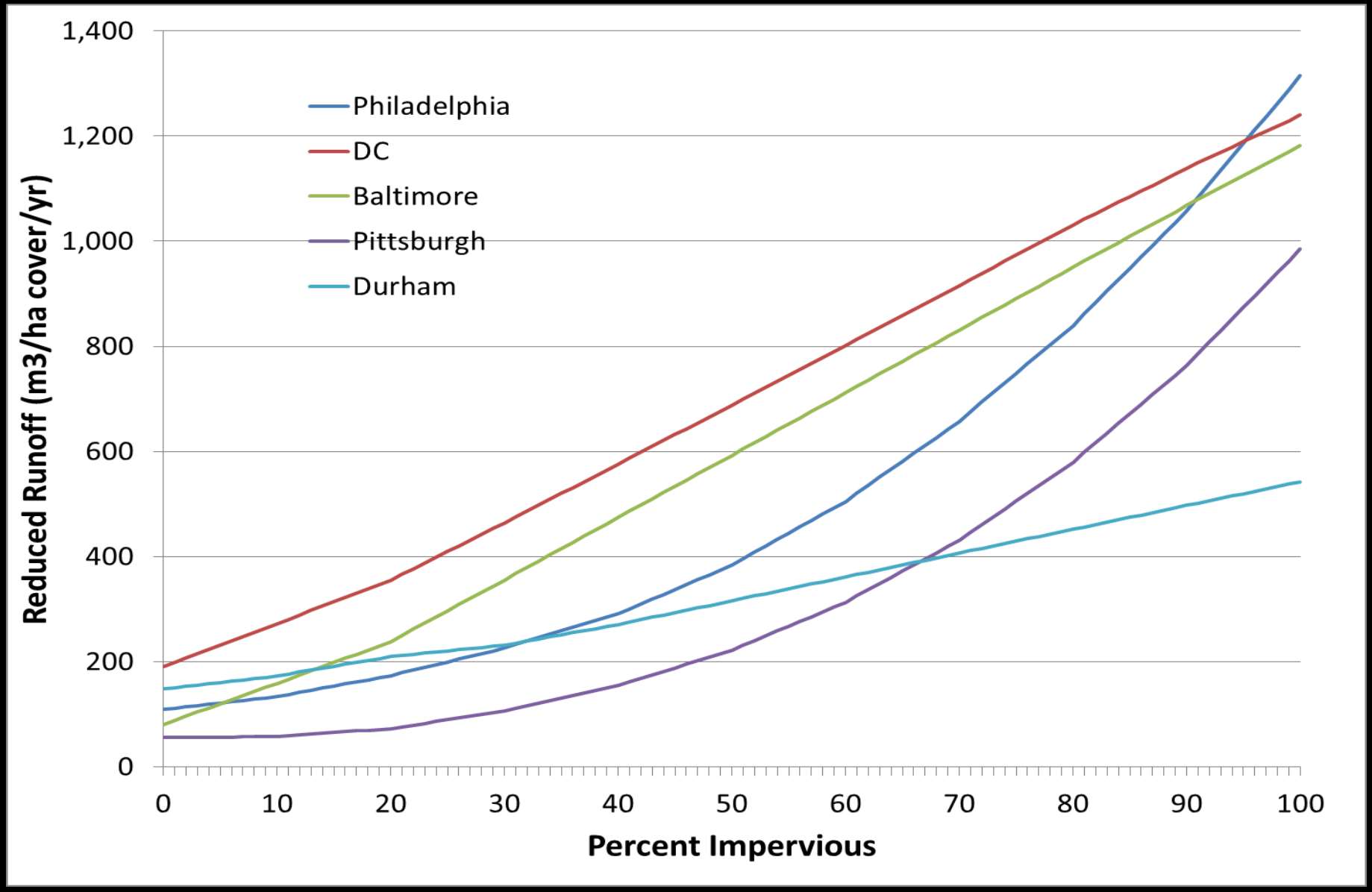




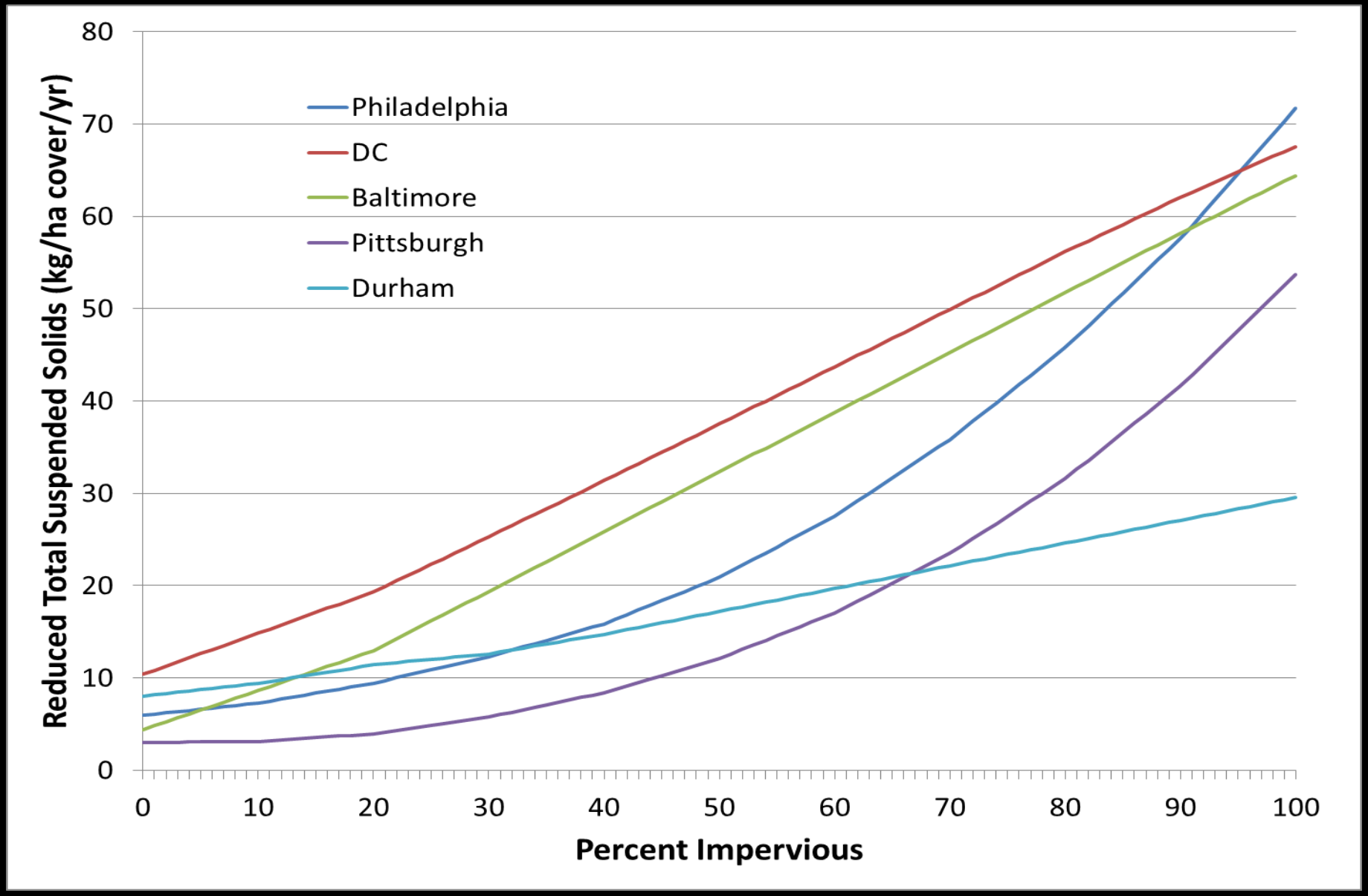




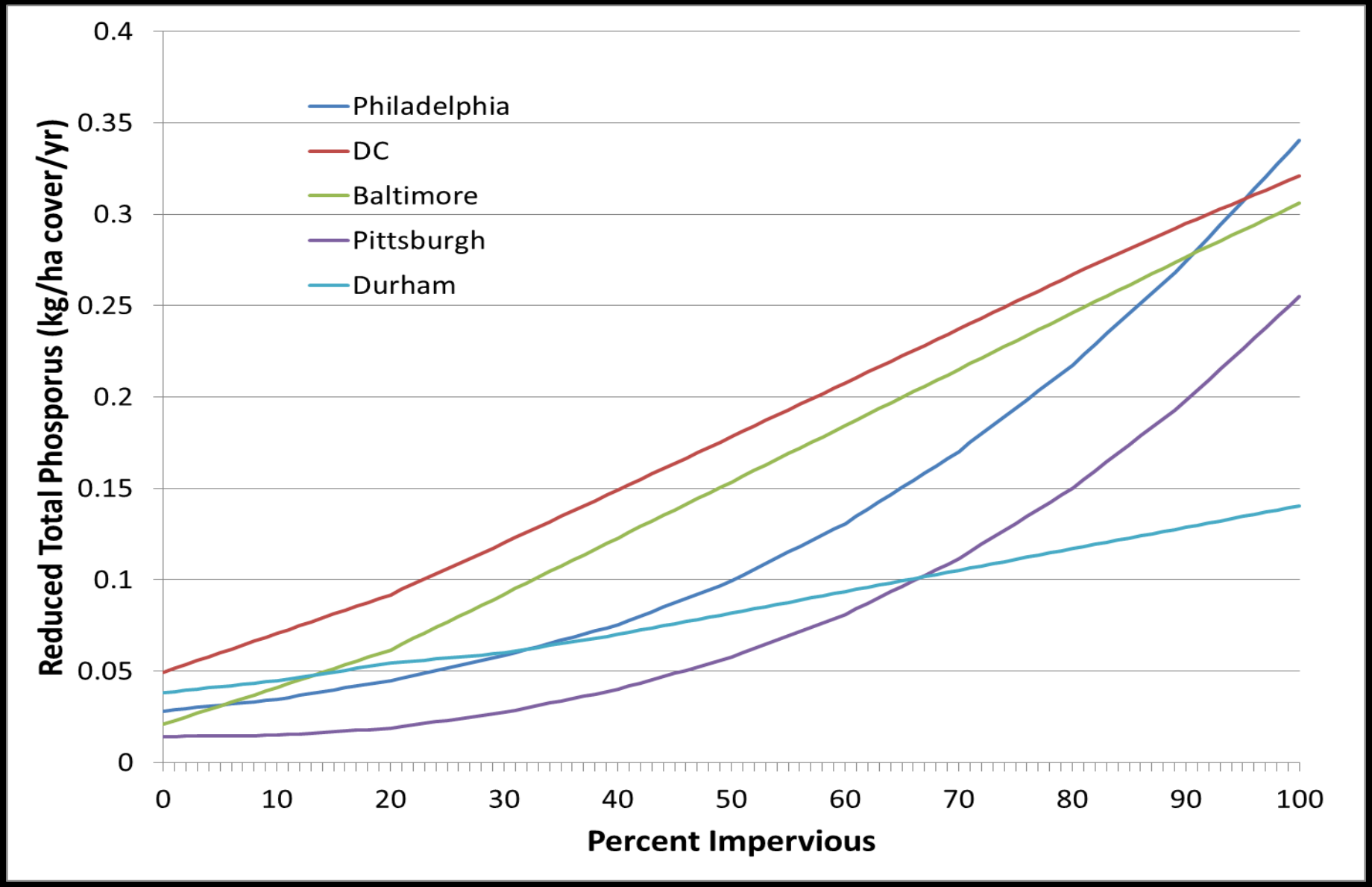
Reduced Runoff per ha of tree cover



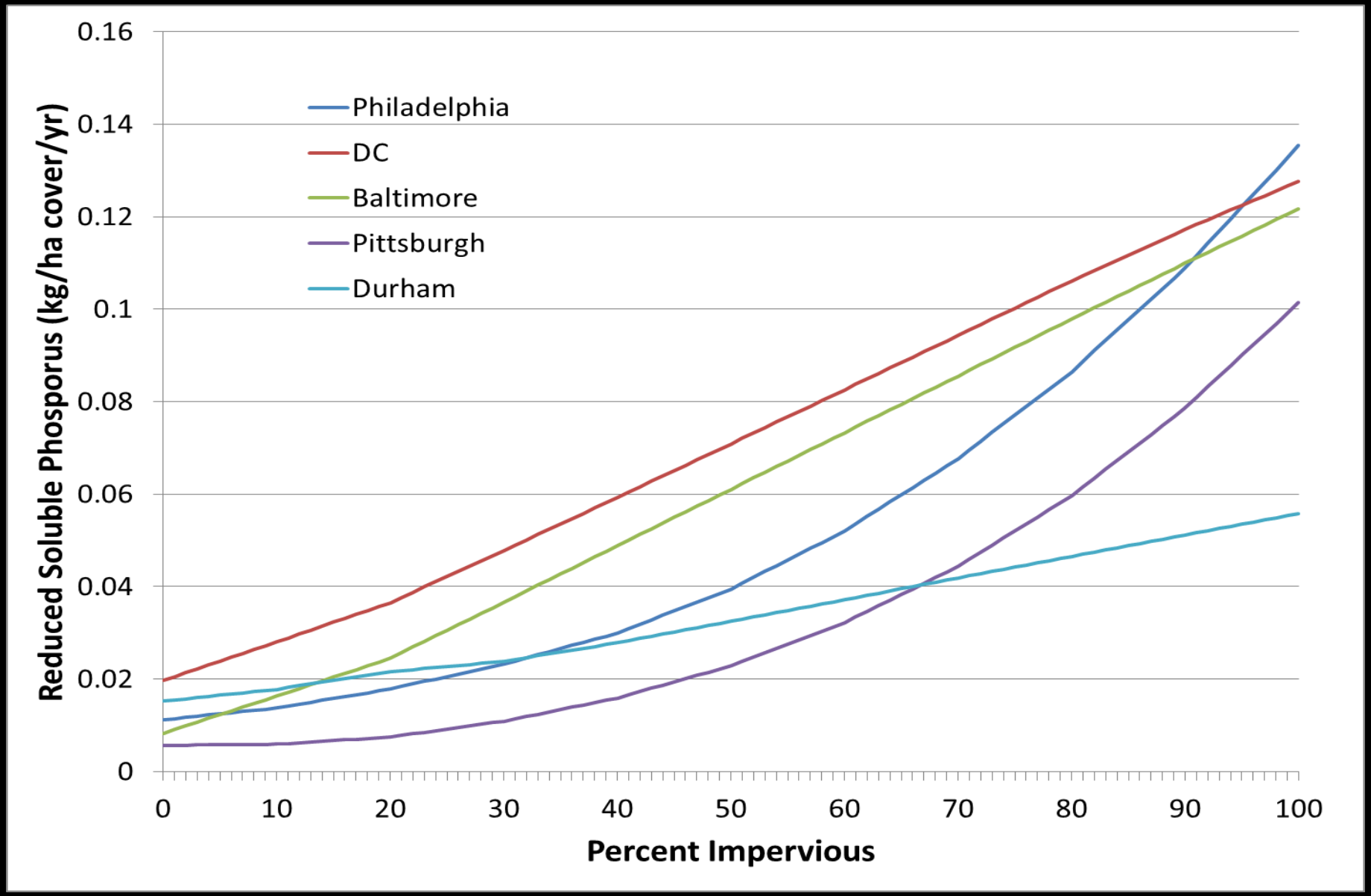
Reduced TSS per ha of tree cover



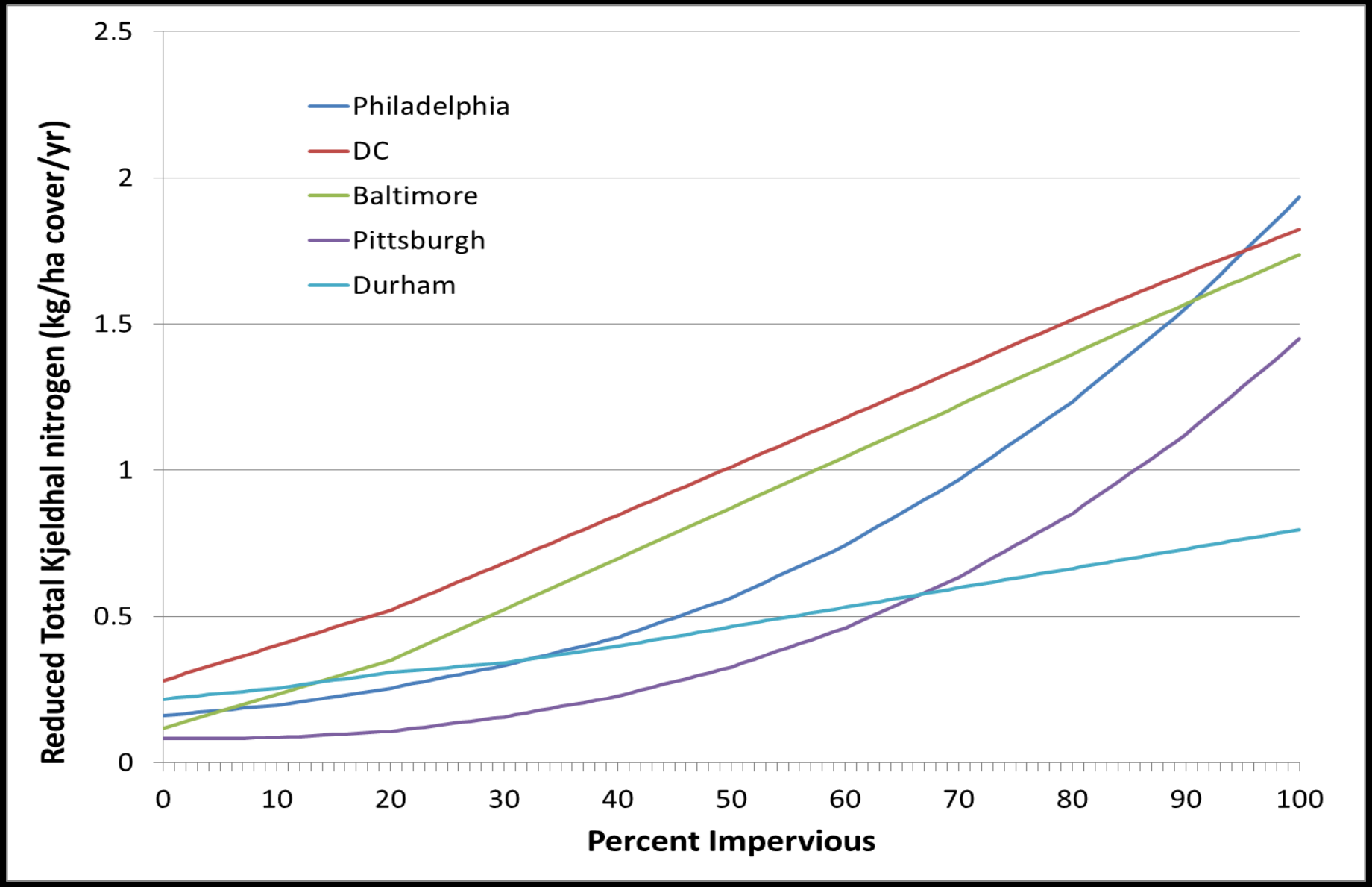
Reduced TP per ha of tree cover



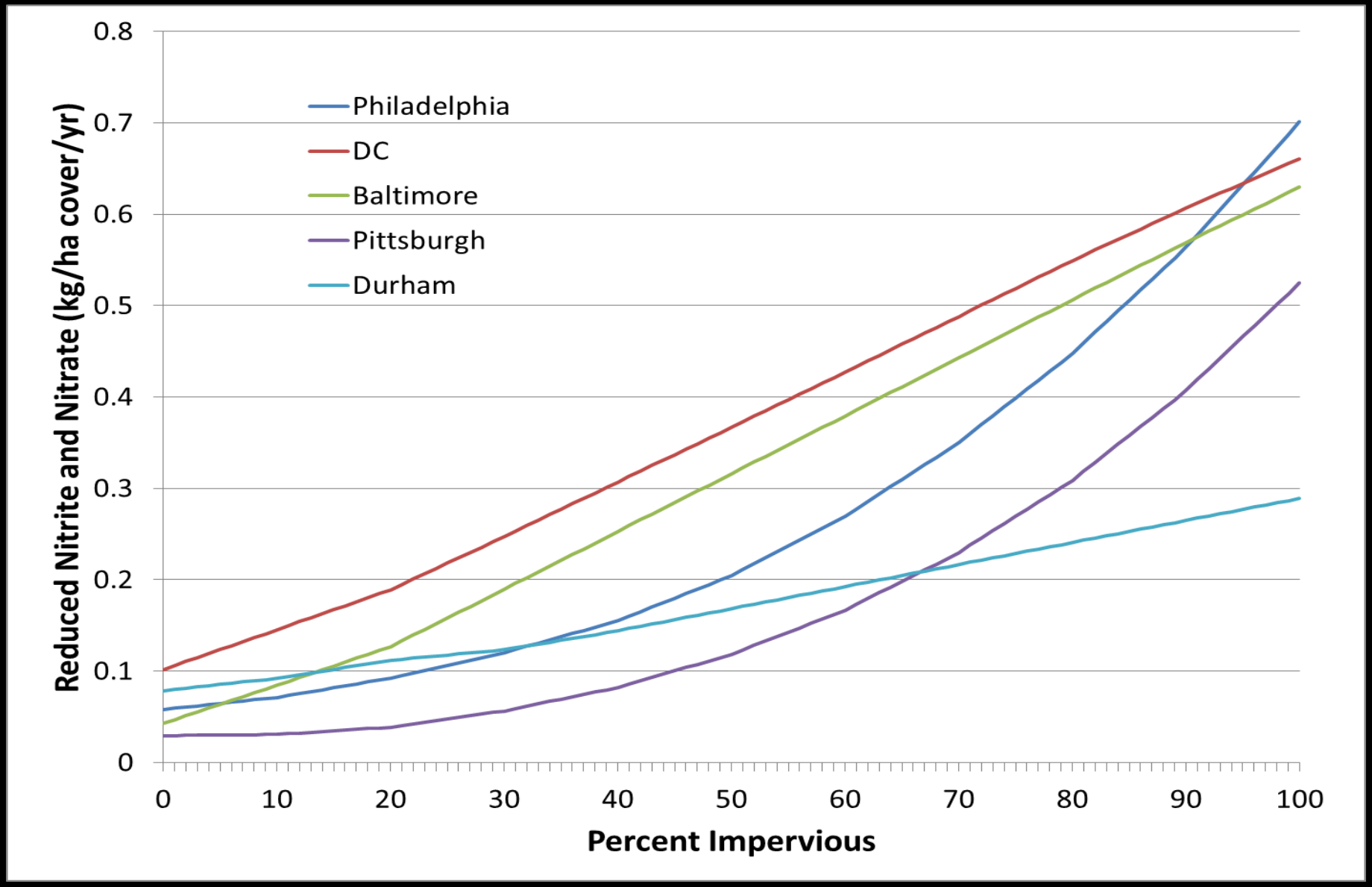
Reduced Sol P per ha of tree cover



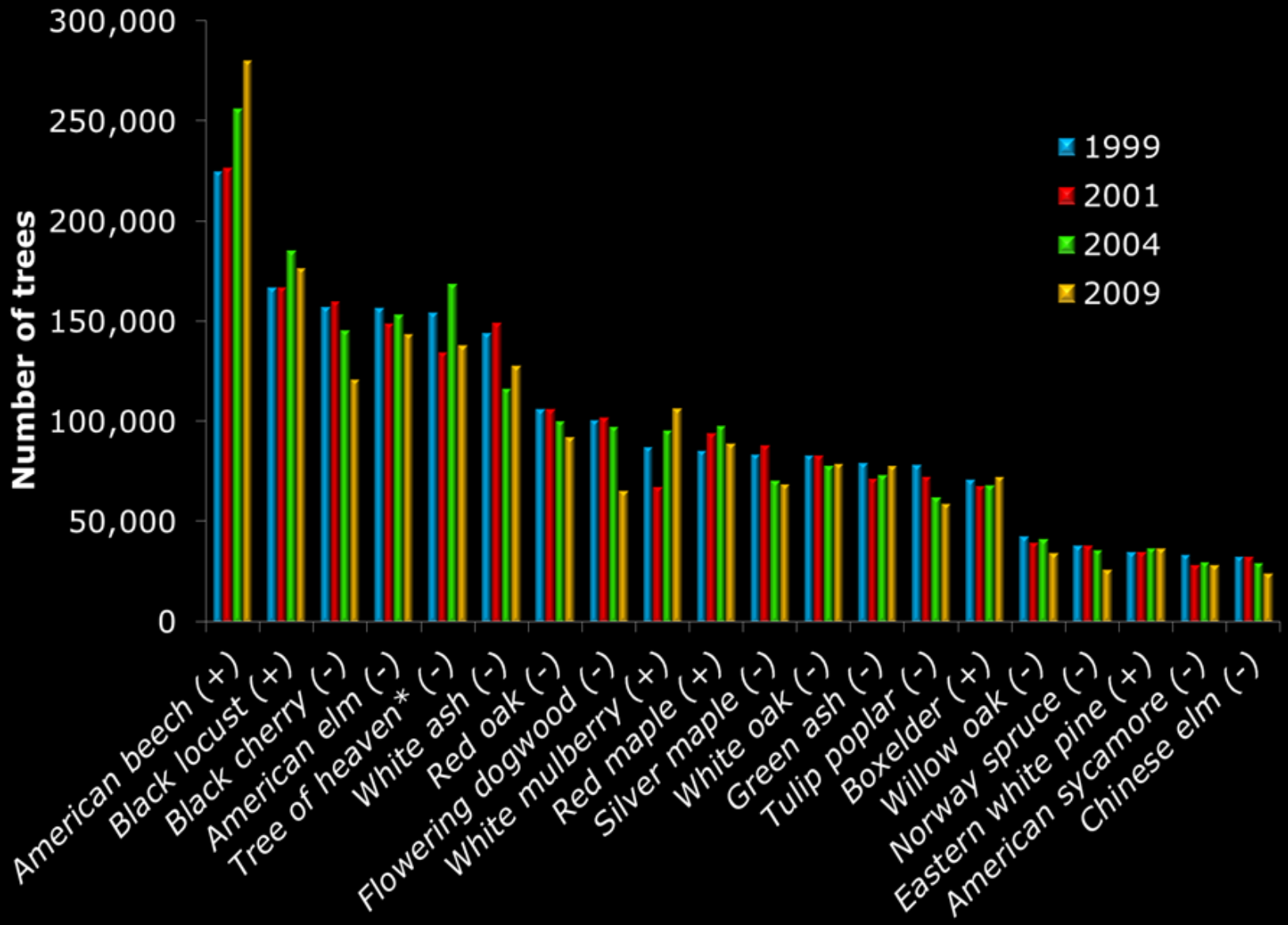
Reduced TKN per ha of tree cover



Reduced NO2/NO3 per ha of tree cover



Baltimore Field Plot Species Data



* Invasive species

194 plots

Urban Deciduous Leaf Biomass - Baltimore

Land Use	ha	DW leaves (tonnes)	t/ha
Barren/Trans.	798	223.5	0.28
Comm./Indust.	4,996	1409.7	0.28
Forest/Urb. Open	3,201	6189.4	1.93
Institutional	1,859	881.6	0.47
Hi Dens. Res.	5,870	2636.1	0.45
Md/Lw Den. Res.	4,192	2,2	0.52
Total	20,916	13506.9	0.65

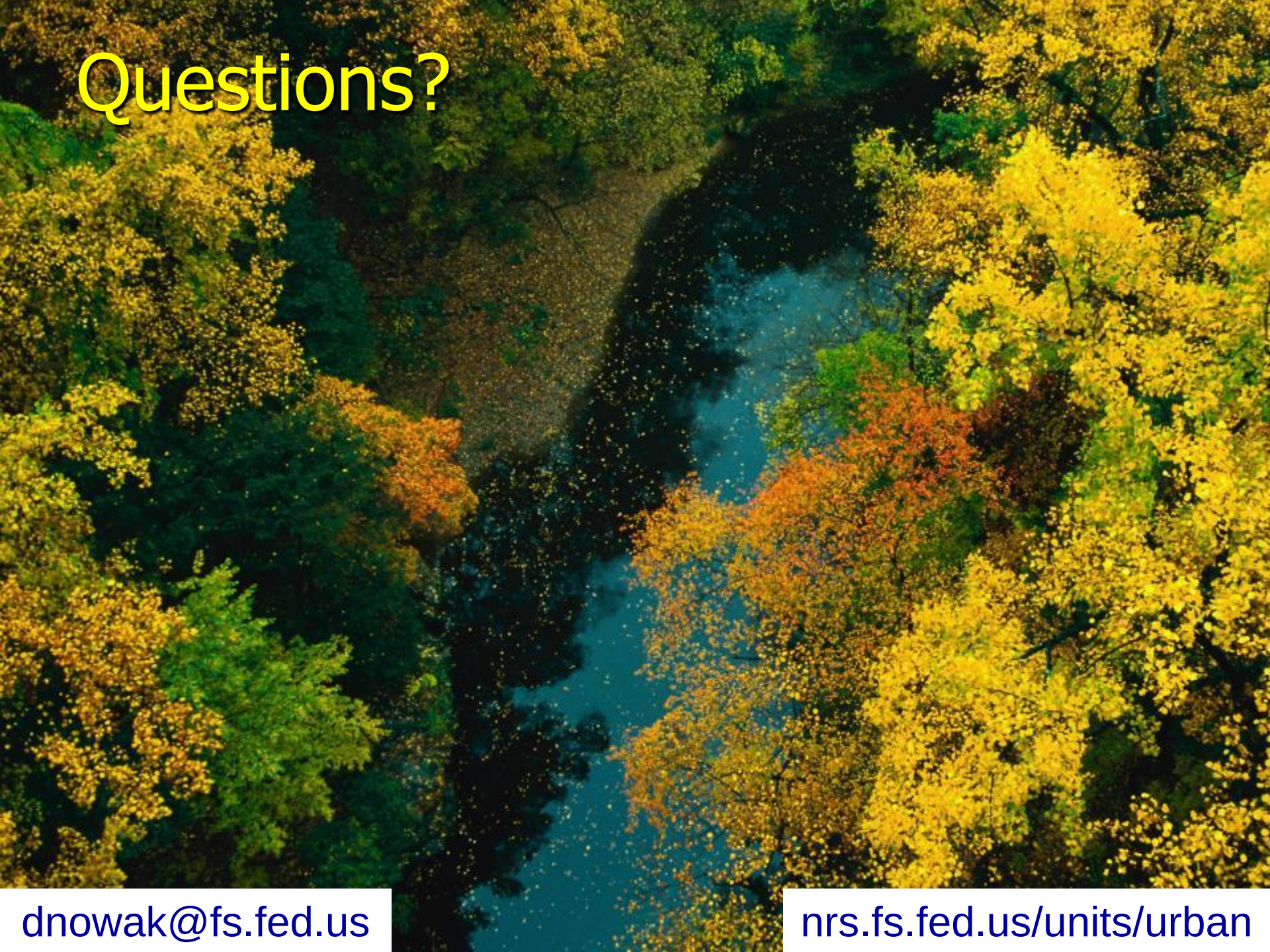
77.5% deciduous leaf biomass

Leaf Chemistry

Chemical	% Leaf DW
C	59.02
N	1.42
Ca	0.96
K	0.58
Mn	0.37
Mg	0.17
P	0.14
Na	0.04
Fe	0.02

Leaf Chemical in Baltimore

Chemical	city total (t)	kg/ha cover
C	7,972.1	1,337.4
N	192.1	32.2
Ca	130.3	21.9
K	78.2	13.1
Mn	49.4	8.3
Mg	22.8	3.8
P	19.6	3.3
Na	5.3	0.9
Fe	2.2	0.4
Total leaf DW	13,506.9	2,265.9



dnowak@fs.fed.us

nrs.fs.fed.us/units/urban