Spatial and Temporal Differences in Atmospheric Deposition of Contaminants in the Green River Watershed

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Science Seminar
October 24, 2013

Study Objectives

- Compare bulk atmospheric deposition rates in areas of different land use within the Green/Duwamish River Basin

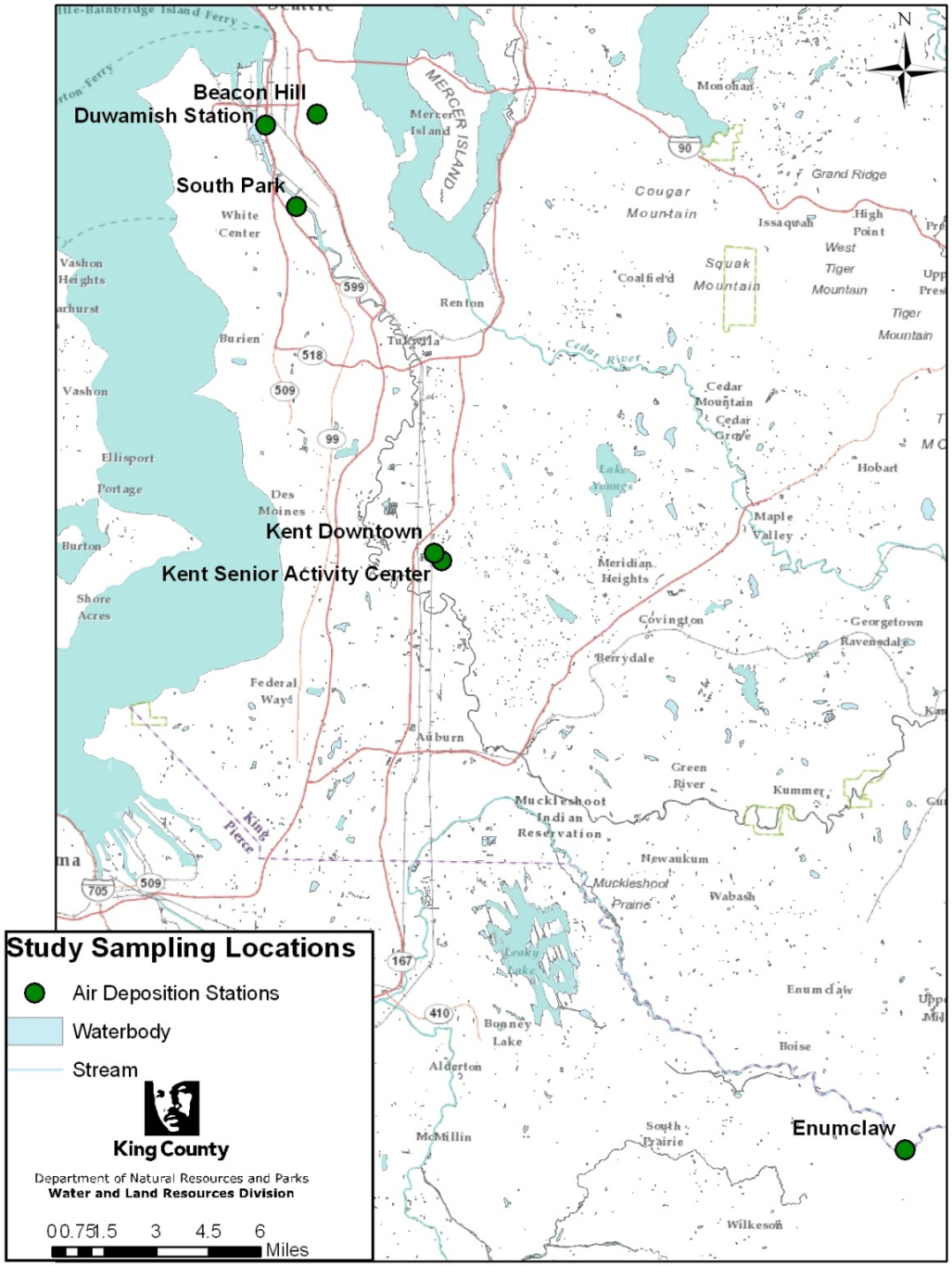
- To provide information to assist in understanding atmospheric sources to the Lower Duwamish Waterway

Bulk Atmospheric Deposition

- Bulk = particles (dry) and rainfall (wet)
- Atmospheric Deposition = solid or liquid that falls onto earth's surface
- Atmospheric Deposition rate (flux) = mass/unit area/time ($\mu g/m^2/day$)

Study Design

Site	Land use
Duwamish	Industrial & urban
Beacon Hill	Regional urban, residential
South Park	Suburban, industrial, residential
Kent downtown	Suburban & commercial (with rail)
Kent Senior Center	Suburban & commercial (without rail)
Enumclaw	Rural



Study Design

Passive Sampler

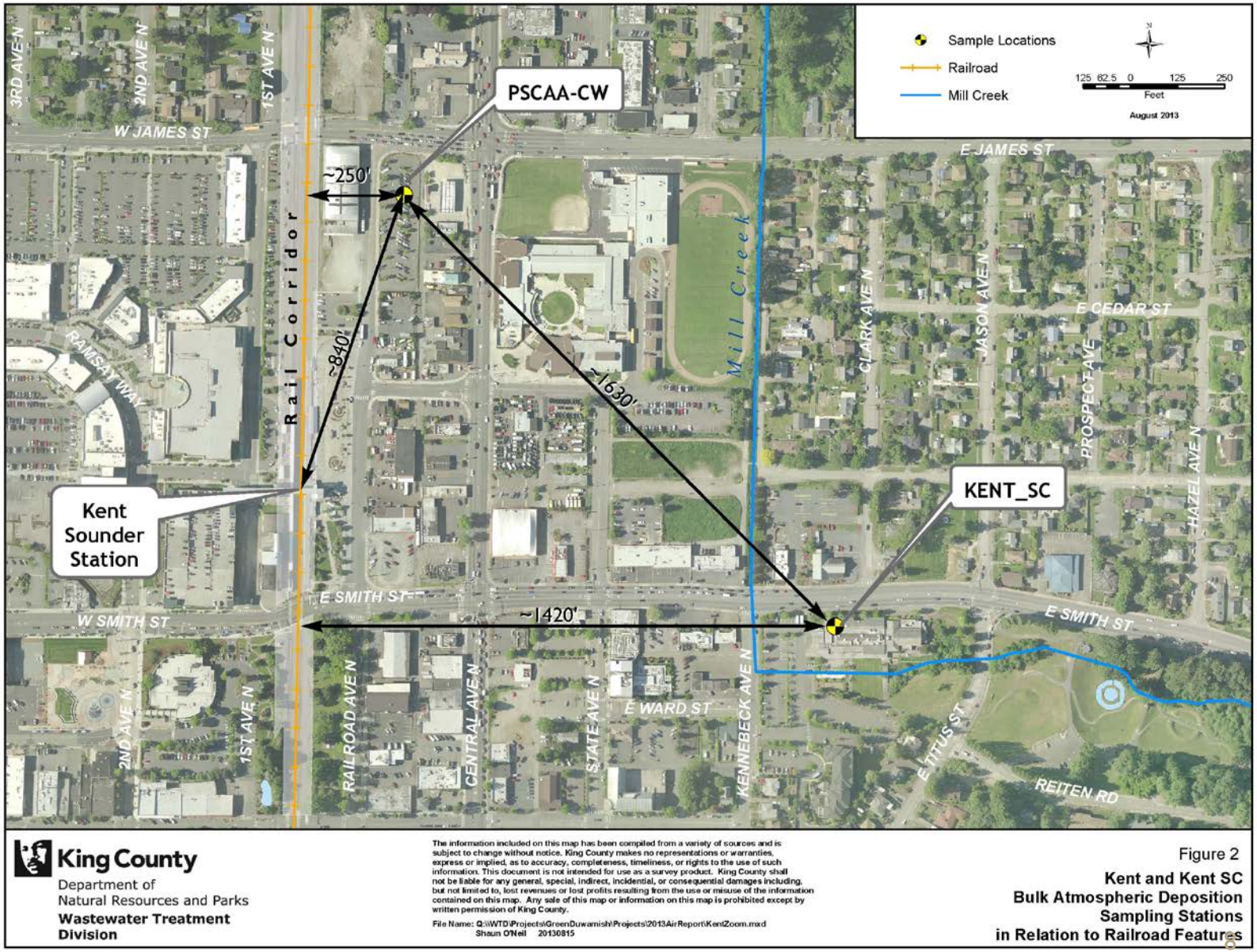
Study Design

- Analytes: metals (including mercury), PAHs, PCB congeners, dioxin/furan congeners
- Schedule
  - Metals, mercury, PAHs: continuous sampling August 2011 for approx 14 months.
  - PCBs, Dioxin/furans: intermittent due to high analytical cost; over same time period
  - Samples deployed ~2 weeks during wet season, ~4 weeks during dry season.
  - Targeted ending deployment before sample containers overflowed

Study Design Change

- Intermittent results showed high dioxins/furans at Kent station
- Proximal location to rail line suspicious
- Added 2nd station for parallel sampling in summer 2012

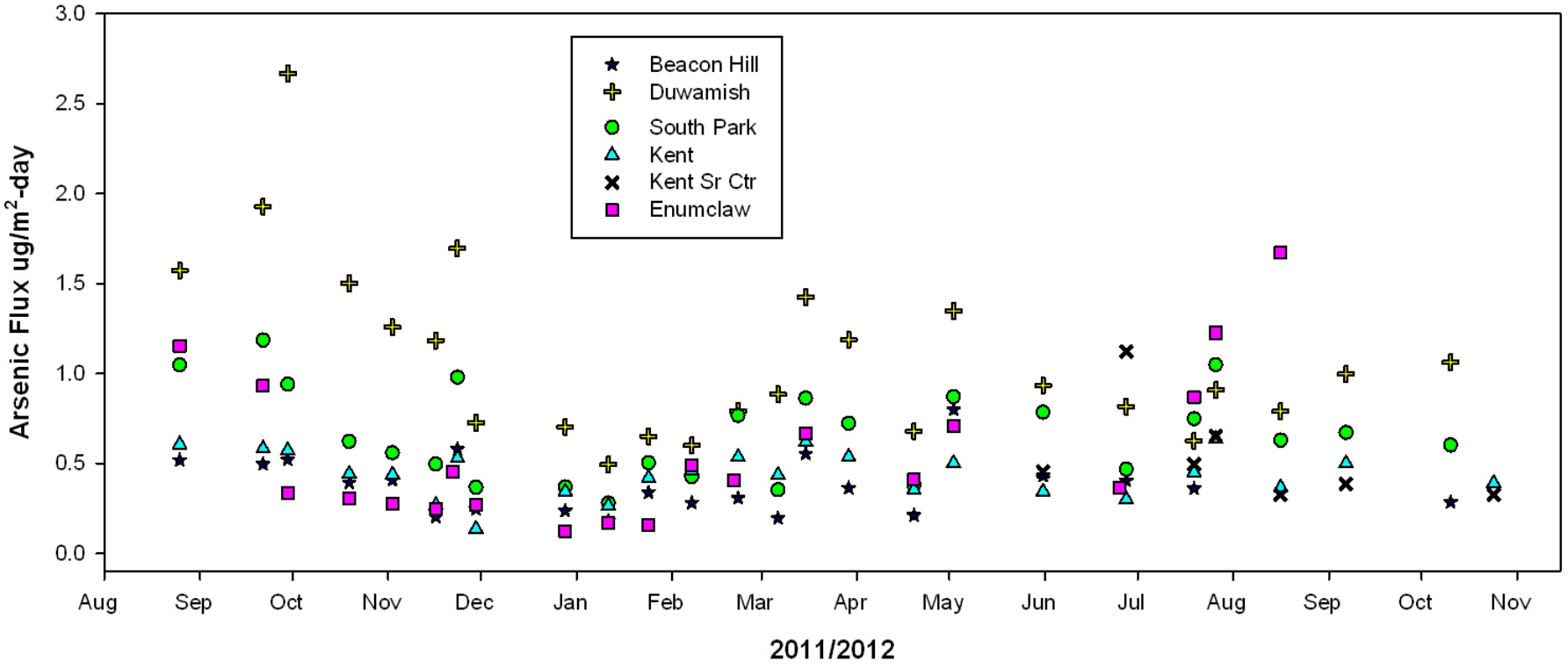
Second Kent Station



Sample Totals

	Beacon Hill	Duwamish	South Park	Kent	Kent_SC	Enumclaw
PAHs	22	27	24	26	7	21
Metals	22	27	26	26	7	20
Mercury	22	25	25	25	7	19
PCBs	7	8	10	12	5	7
Dioxins/Furans	7	9	10	12	5	7
Totals	**80**	**96**	**95**	**101**	**31**	**74**

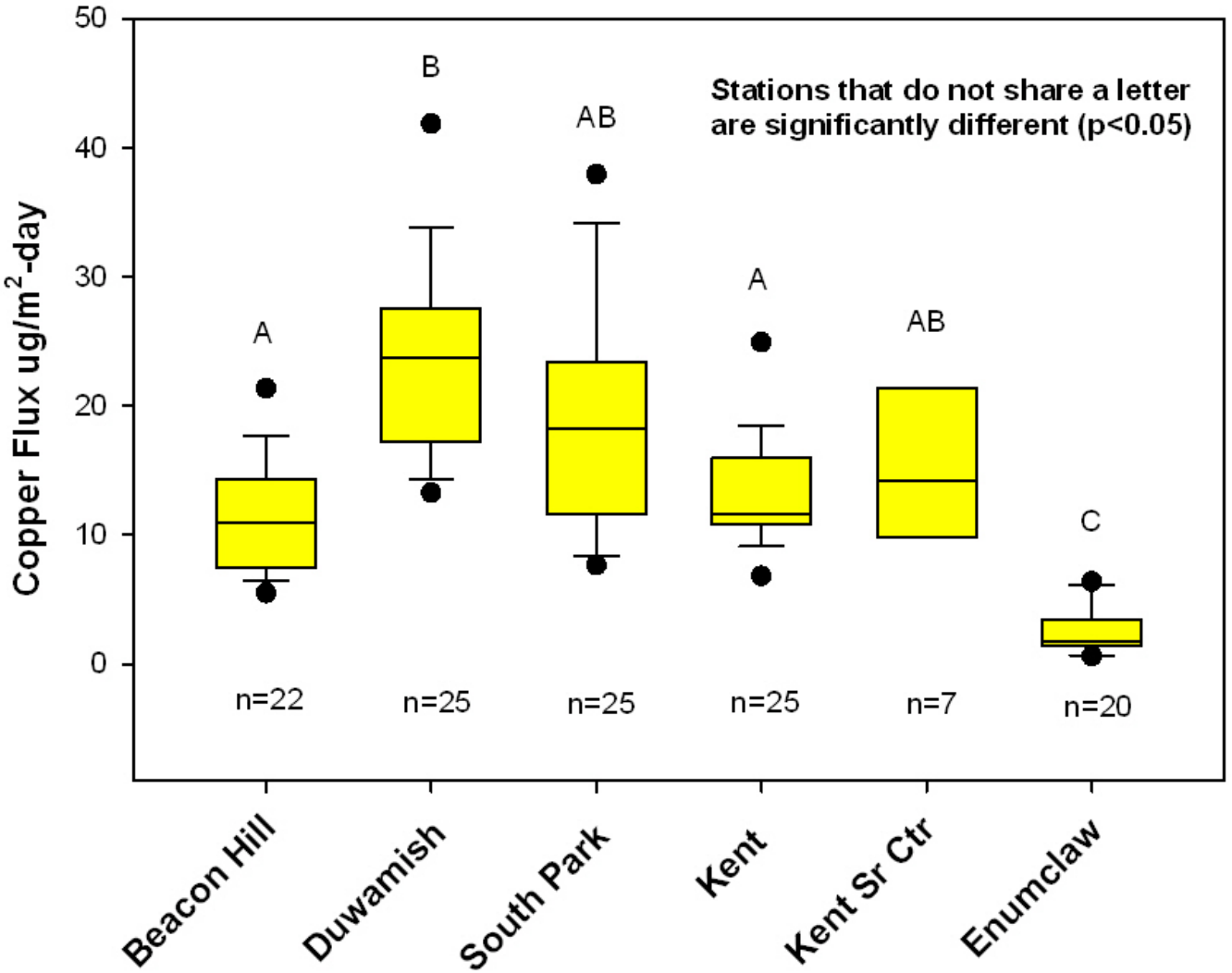
Temporal Differences



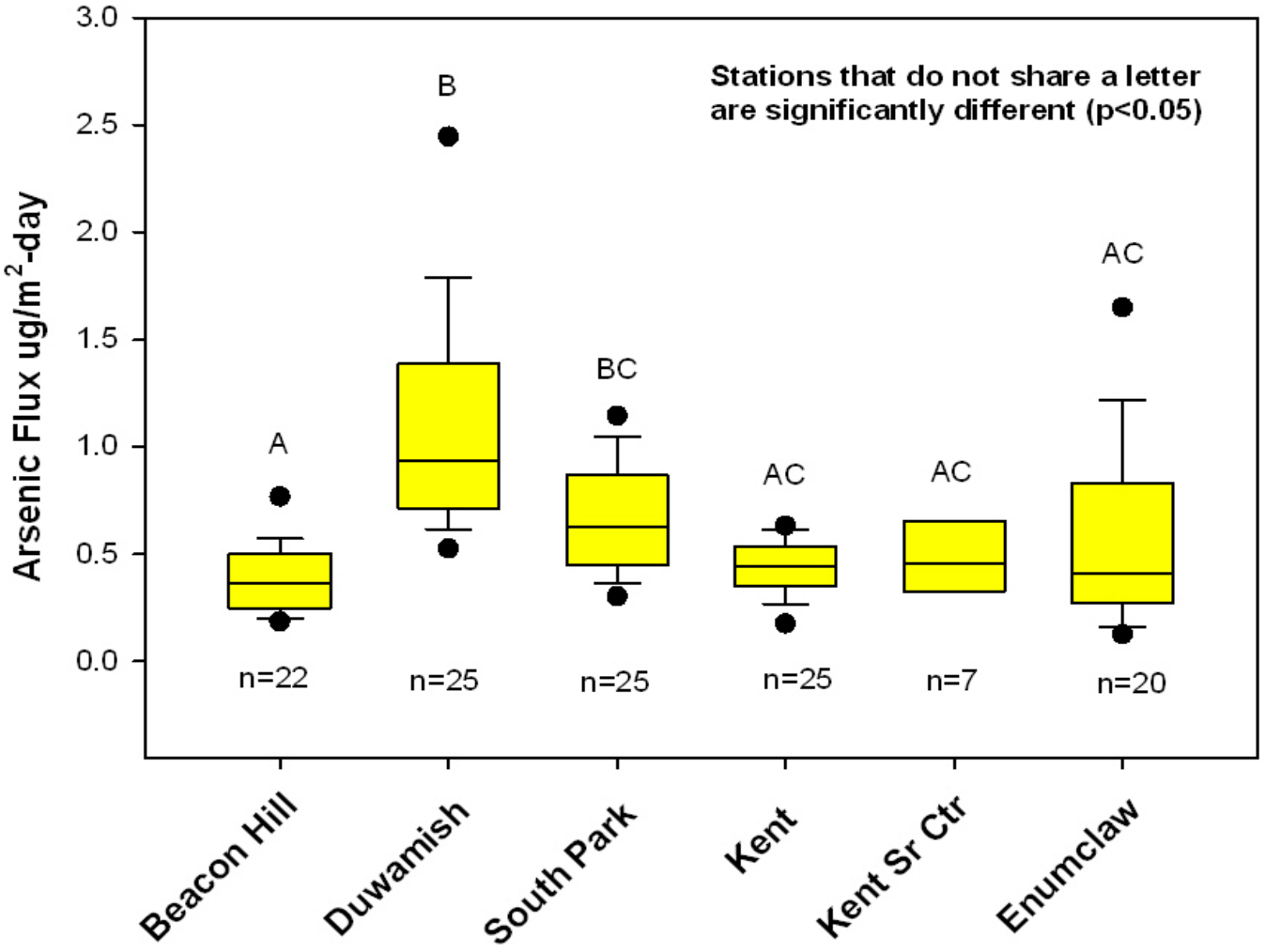
Temporal Trends

- Nonparametric testing determined that fluxes were significantly higher ($p<0.05$) in the dry period (June through September) for all metals except cadmium, mercury and silver.

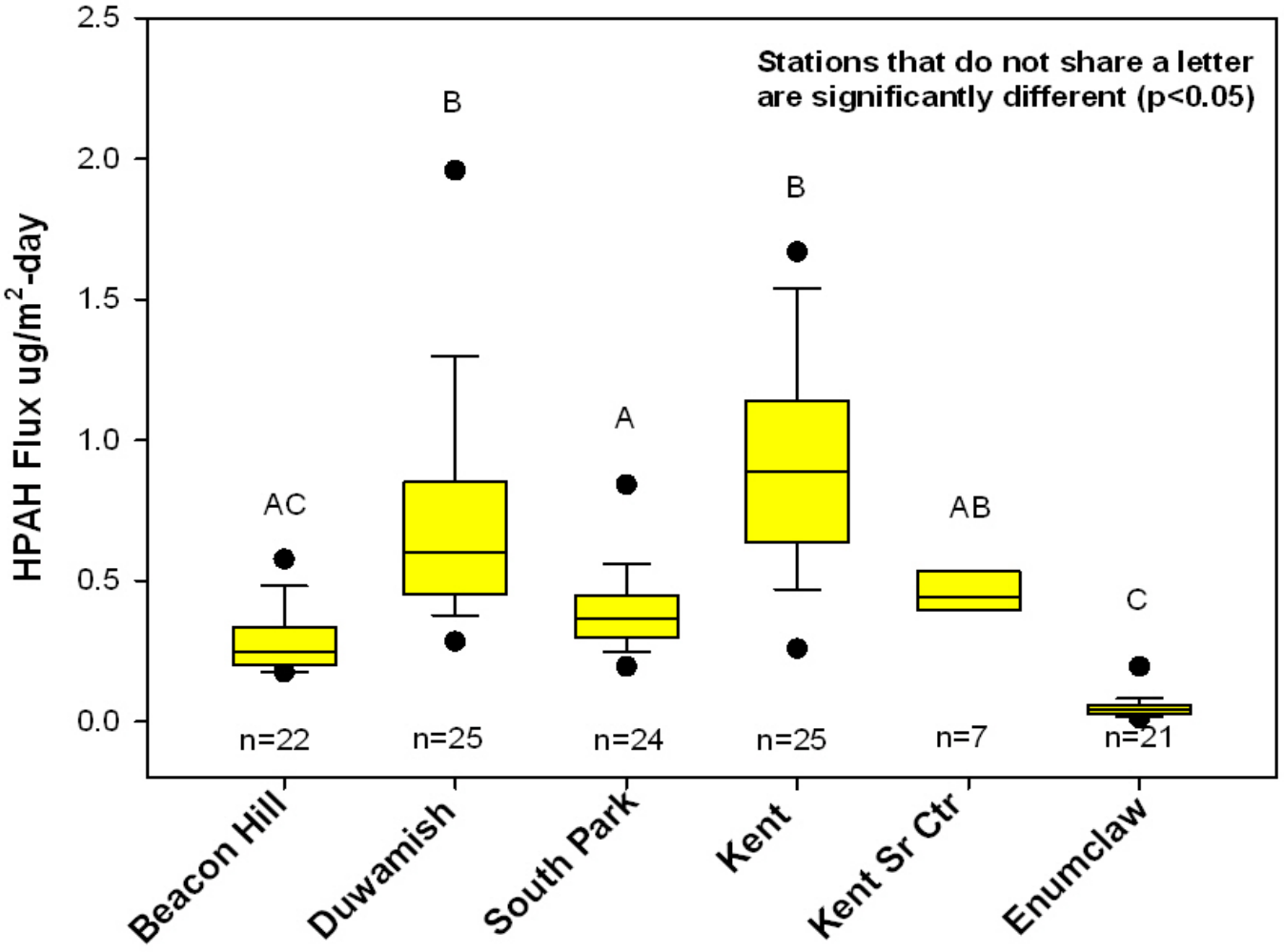
Spatial Trends – Metals: Copper



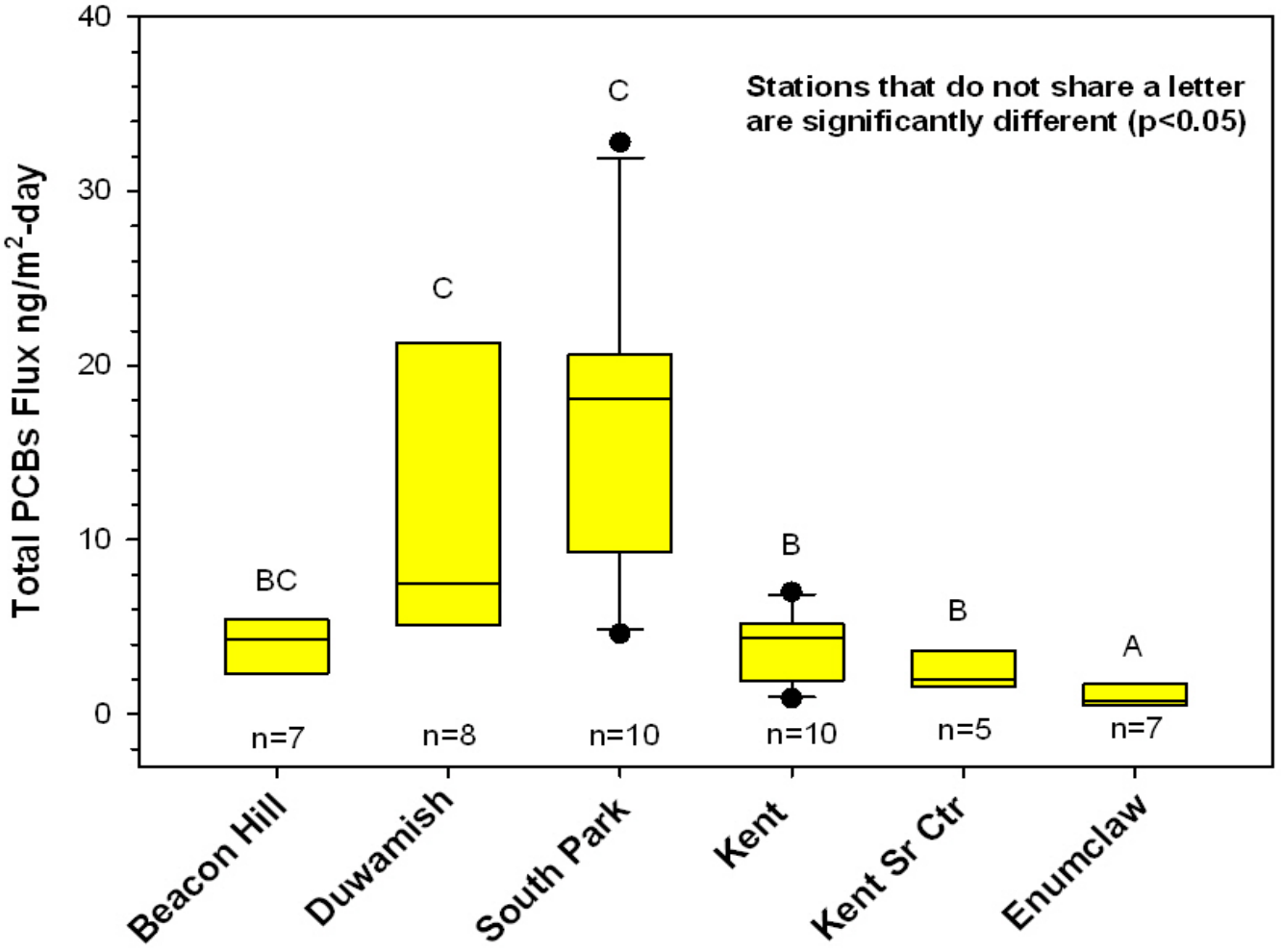
Spatial Trends – Metals: Arsenic



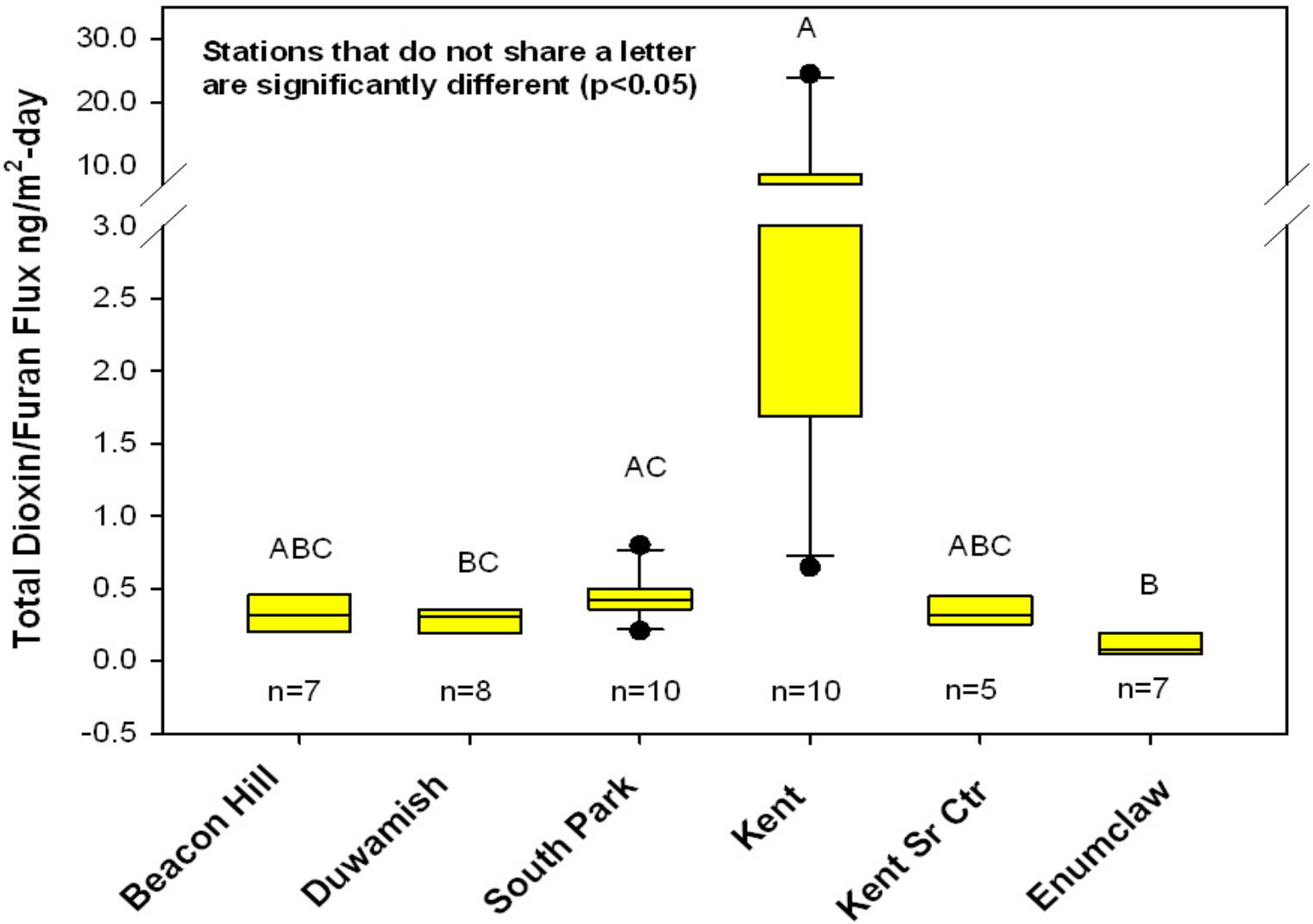
Spatial Trends - HPAHs



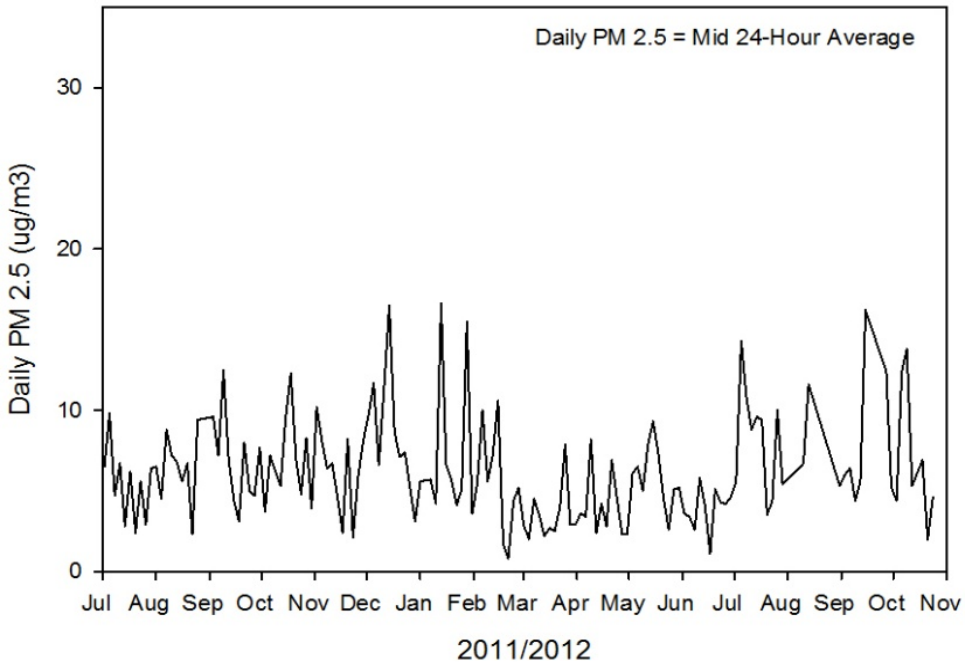
Spatial Trends - Total PCBs

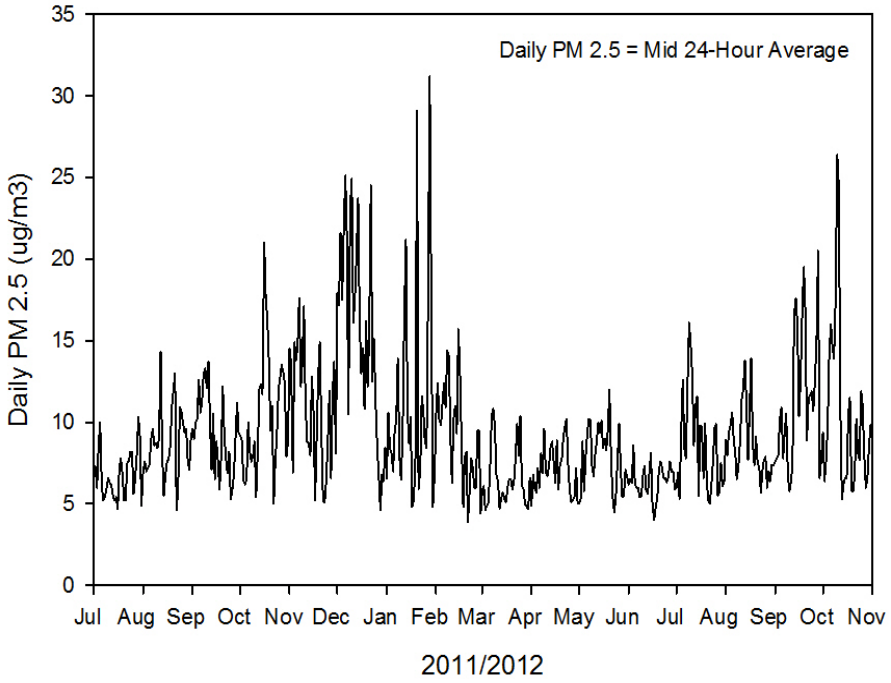


Spatial Trends - Dioxin/Furan



Small Particle Concentrations
(Data from PSCAA)

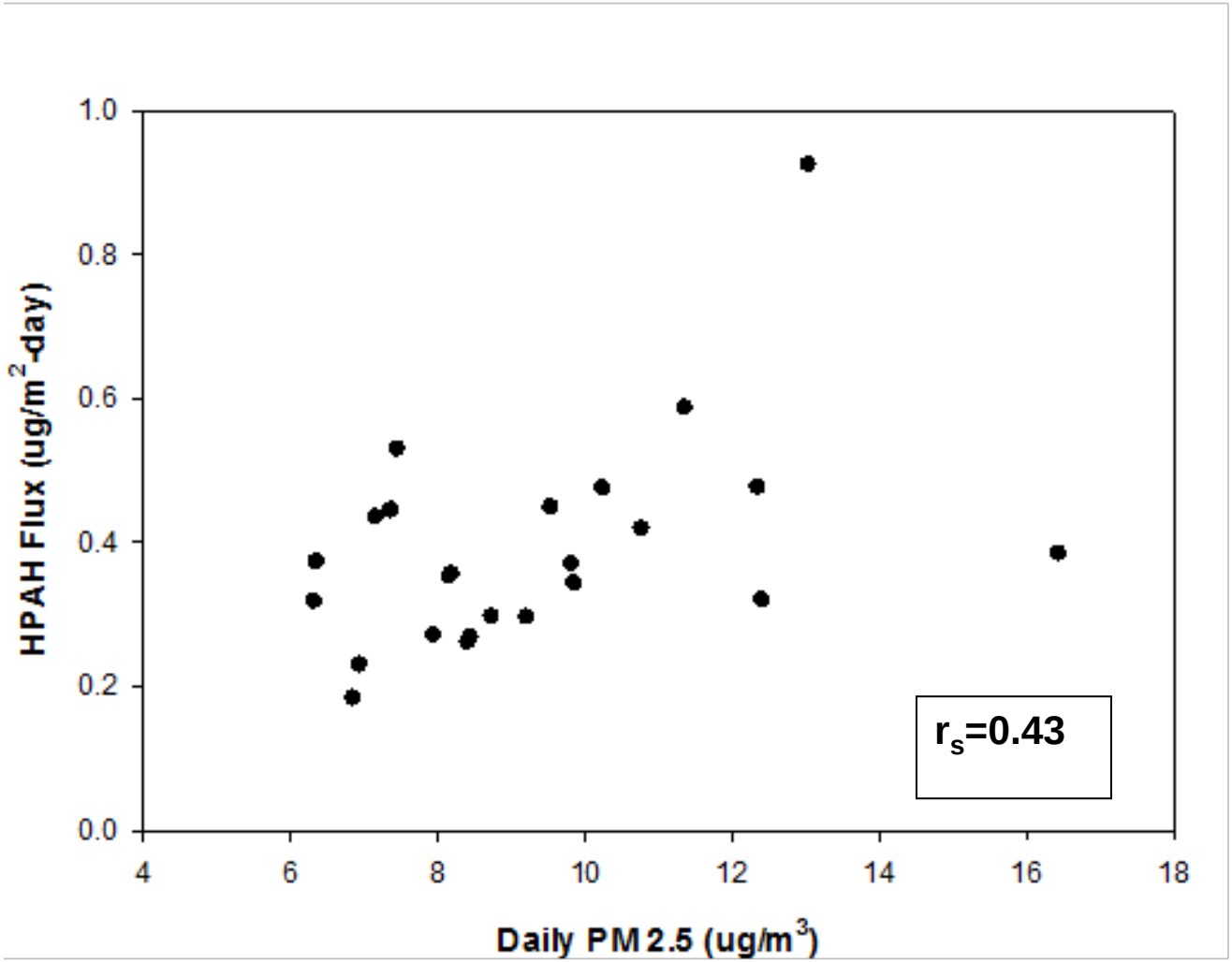




Beacon Hill

South Park

HPAH Flux with PM 2.5 at South Park



Findings

- Metals and organics fluxes relate to degree of urbanization
- Metals and organic fluxes at Duwamish or South Park often highest, Enumclaw lowest
- Microscale effects seen in dioxins and HPAHs at Kent due to local source
- PCB fluxes highest at Duwamish and South Park; South Park were >2X higher than Duwamish
- Metals fluxes significantly higher in the dry season and decreased during early wet season.

Bulk Air Deposition Study

- Acknowledgements:
  - *KC Field Sciences Unit*: Bob Kruger, Jim Devereaux, Ben Budka
  - *KC Environmental Lab*: Fritz Grothkopp, Diane McElhany, Susannah Rowles & Michael Muramoto
  - *PSCAA*: Adam Petrusky
  - *Ecology*: John Williamson
  - *South Park Community Center:* Bill Pease
  - *KC Science Section*: Scott Mickelson, Debra Williston
  - *KC Industrial Waste*: Bruce Tiffany
  - *KC Wastewater Treatment Division*: Jeff Stern
  - AXYS Analytical