Atmospheric PAH Deposition to Rhode Island Soils Along an Urban to Rural Gradient

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Abstract. Many contaminants, including polycyclic aromatic hydrocarbons (PAH), stem from fossil fuel combustion, automotive related releases, and other non-point pollution sources. Some PAH compounds are carcinogens and their presence in the environment has resulted in health concerns for the general public. This influx of PAH contaminants is partially linked to the increased numbers of registered automobiles and fossil fuel consumption over the past years. This has resulted in increased PAH concentrations in the atmosphere, soils, and water resources, particularly in urban areas.

PAHs can enter the environment via dry/wet particle and gaseous deposition, both of which are major non-point pollution sources within the United States. Most soils in New England have a naturally low and location-dependent PAH sorption capacity, which, once exceeded may permit PAH influxes to reach deeper parts of the subsurface, potentially polluting drinking water resources. Because of continuous influx of PAHs from the atmosphere, a general trend of increasing PAH concentrations in soils and sediments is to be expected. In this experiment, four locations throughout Rhode Island - a coastal, rural, suburban, and urban site – have been selected for further analysis. Results from sorption isotherm experiments demonstrate that the PAH concentrations increase with closer distance to urban areas. This information can be useful in establishing the need for best management practices that reduce the amount of PAH loading in stormwater runoff and other non-point sources.

Background /Setting

Six sites in Rhode Island were selected to monitor the atmospheric deposition and subsequent loading of PAHs to soils. The sites have been established along a gradient that covers urban, suburban, rural, and coastal sites (*Figure 1*). The urban site is in Providence, three suburban sites with different characteristics were chosen. They are located in: Kingston, East Greenwich, and Hope Valley. The rural site is located in Pascoag and the coastal site is adjacent to Green Hill Pond in Charlestown, RI.

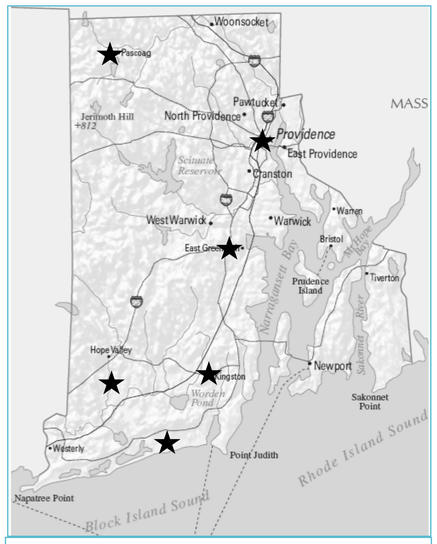


Figure 1. *Map showing sampling locations in RI. At all sites soil concentration and atmospheric deposition of PAHs is collected year round. Here atmospheric deposition and soil concentration of Pascoag and Providence are presented.*

Methods

Atmospheric Deposition

- Passive samplers sampled every 3 months
- Adsorbent material extraction with acetone
- Liquid-liquid extraction of sampler extract with cyclohexane
- Silica gel and aluminum oxide clean up to remove interfering compounds

Soil Sorption

- Sample soils every 5 cm every 6 months
- Homogenize samples to maximum of 2 mm
- Solvent extract with acetone and cyclohexane using ASE
- Sample cleanup using silica SPE PAKs to remove humic acid and other interfering compounds

Sample Analysis.

All samples are blown down to dryness in a water bath at 35°C under a gentle stream of nitrogen and re-dissolved in cyclohexane before analyzing in a Gas Chromatograph/Mass Spectrometer.

Results/Discussion: Soil Sorption

- Shallower soil depths show higher concentrations of PAHs in both locations, though Providence (Fig. 2A) shows more HMW PAHs than Pascoag (Fig. 2B). Pascoag (rural) receives PAHs from regional inputs, thus more LMW compounds are present as these travel further distances in the atmosphere. In Providence (urban) local inputs and proximity to sources allows for HMW compounds to settle out.
- Even low concentrations of HMW compounds present a threat to water resources, as these are the more persistent and toxic compounds.

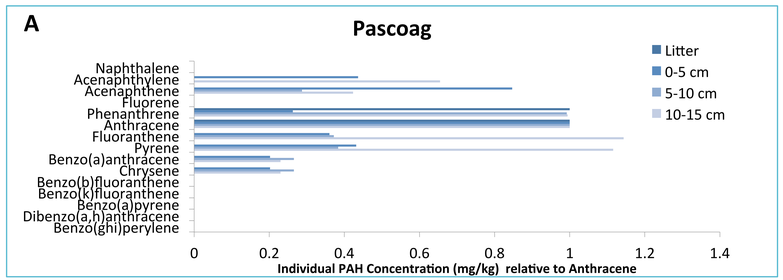
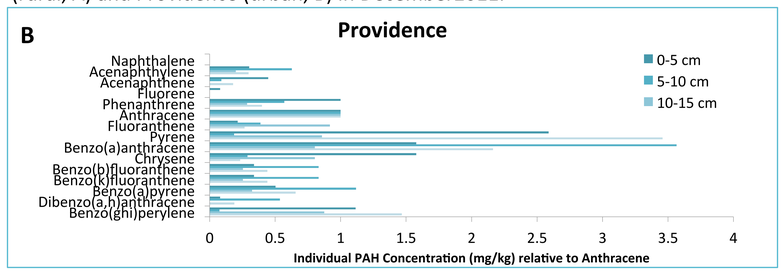


Figure 2. PAH concentration (mg/kg) relative to Anthracene found in soils Pascoag (rural, A) and Providence (urban, B) in December2011.



Results/Discussion: Atmospheric Deposition

- Daily deposition of PAHs for September-December in Pascoag (rural) and Providence (urban; Fig. 3).
- PAH deposition rates were higher in Pascoag than in Providence from September to December 2011.
- Atmospheric deposited in Pascoag contained a range of PAHs from LMW to HMW compounds.
- In Providence atmospheric deposition consisted mainly of LMW compounds.
- In Pascoag, soil concentrations of PAHs mimic atmospheric deposition closely, while in Providence this is not the case.
- Further sampling and analysis will refine annual and spatial trends more clearly.

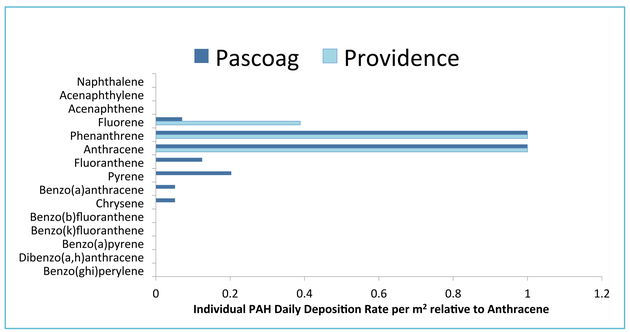


Figure 3. PAH fluxes (µg/dm^2) relative to Anthracene in Pascoag (rural, A) and Providence (urban, B) in from September to December 20111.

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