Accumulation of Potential Fly Ash Contaminants by Aquatic Invertebrates Downstream of the Tennessee Valley Authority Kingston Fossil Plant

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Introduction

On December 22, 2008, a dike failure at the Tennessee Valley Authority's (TVA) Kingston Fossil Plant (KIF) released an estimated 5.4 million yd^3 of fly ash into the Emory River. A comprehensive assessment of the consequences of the spill to the aquatic ecosystem was initiated soon after the release. Included in this assessment was a study of contaminant (i.e., metals) exposure to aquatic invertebrates in summer 2009.

Objectives

Evaluate the magnitude and spatial extent of contaminant exposures to aquatic macroinvertebrates.

Study Area

- Five core sampling sites:

- Downstream of KIF: Emory River (ERM 2.5 and ERM 1.0) and Clinch River (CRM 1.5)
- Upstream reference sites: Emory River (ERM 6.0) and Clinch River (CRM 6.0)
- Additional reference site: Little Emory River (LERM 1.0)
- Additional downstream site: Tennessee River (TRM 567.6)

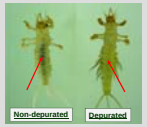
Map of invertebrate sampling sites.

Materials and Methods

Two widespread and abundant aquatic invertebrate species (a mayfly and snail) were collected and analyzed for a suite of metals. The nymph and adult stages of the mayfly were included in the analysis to provide information on the contribution of emerging insects to terrestrial consumers.

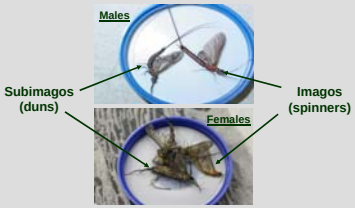
Hexagenia bilineata (burrowing mayfly)

Replicate samples of mayfly nymphs were collected with a Petersen dredge.



Additional replicate samples of nymphs were collected for comparing contaminant concentrations with and without depuration of the digestive system (48 hr).

Replicate adult mayfly samples were collected opportunistically with a sweep net and by hand.



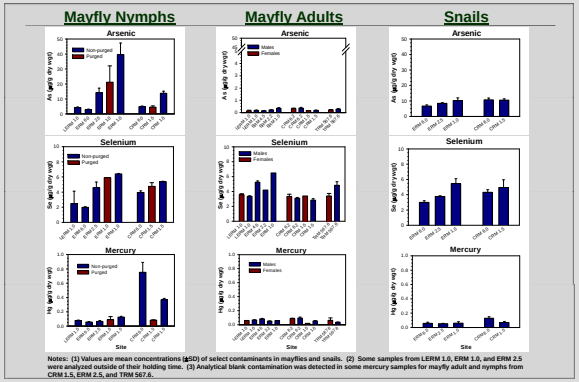
Adults were sorted and analyzed by developmental stage (imago/subimago) and sex to determine if contaminant uptake differed among the groups.

Pleurocera canaliculatum (Silty hornsnail)

Replicate snail samples were collected by hand.

Snail digestive systems were depurated for 72-hr in the laboratory, and then tissue was extracted from the shells before being freeze dried and analyzed.

Results and Conclusions



Notes: (1) Values are mean concentrations (±SD) of select contaminants in mayflies and snails. (2) Some samples from LERM 1.0, ERM 1.0, and ERM 2.5 were analyzed outside of their holding time. (3) Analytical blank contamination was detected in some mercury samples for mayfly adult and nymphs from CRM 1.5, ERM 2.5, and TRM 567.6.

- Some contaminant concentrations were elevated downstream of the ash release site in all three invertebrate groups.
- Highest concentrations of most contaminants were found near the mouth of the Emory River (ERM 1.0) and not adjacent to the ash spill (ERM 2.5).
- Some contaminants (e.g., Hg) were primarily from sources unrelated to the fly ash spill.
- Concentrations for most contaminants were much higher in mayfly nymphs than the adults (as much as one order of magnitude), but the difference between stages was much less for Se, with concentrations in adults sometimes exceeding those in nymphs.
- Concentrations of most contaminants were lower in depurated than non-depurated nymphs (as much as 75%), but for a few contaminants (e.g., Se) there was little difference.
- Limited data suggests that concentrations of some contaminants were higher in adult male mayflies than in females.
- There was insufficient data to determine if contaminant concentrations differed between adult life stages.

Acknowledgements

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