

Fish Health and Bioaccumulation Studies for Evaluating Fly Ash Exposure and Effects in Aquatic Ecosystems

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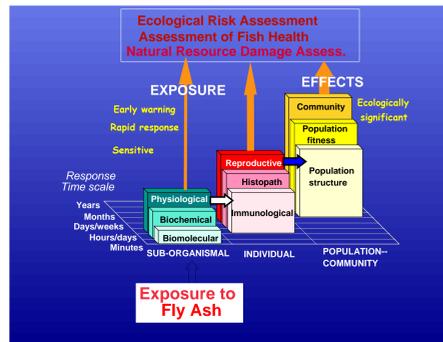
Introduction

On December 22, 2008, a significant release of fly ash (coal ash) occurred from the TVA Kingston Fossil Plant to the Emory River in Tennessee. A major environmental concern with the release of fly ash into aquatic systems is the potential effects of heavy metals in the ash on crucial resources such as downstream fisheries. Bioaccumulation of selenium, a metal commonly associated with fly ash, is known to cause a variety of chronic toxic responses in fish. This study, initiated 2-3 months after the fly ash release, investigated the relationship between the bioaccumulation of metals in muscle, liver, and ovarian tissue of fish and various indicators of metal exposure and health in fish. Investigating causal relationships (if any) between environmental stressors such as toxic metals and biological responses is important for prioritizing both research studies and remediation strategies.

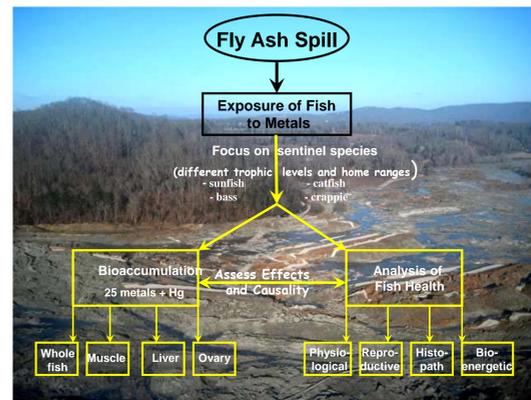
Objectives

- Determine if fly ash exposure is causing short-, intermediate-, and/or long term health effects on representative (sentinel) fish populations downstream of the fly ash release
- Evaluate possible relationships between levels of metals in fish tissue and various indicators of fish health

Concept



Approach



Overall Concept for Bioaccumulation and Fish Health Studies

Field and Lab Procedures

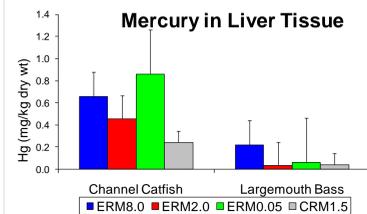
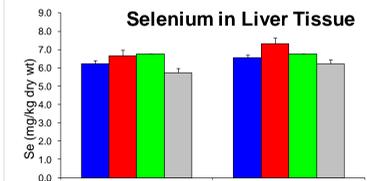
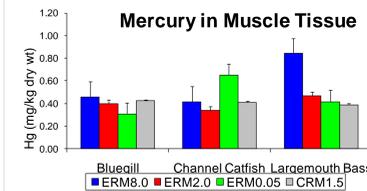
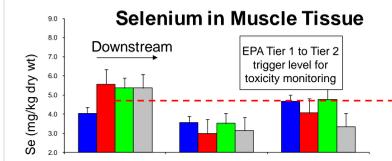


- Adult bluegill sunfish, largemouth bass (LMB), and channel catfish (8 each) were collected from 5 sites in the Emory and Clinch Rivers by electrofishing or gillnetting (the latter only with catfish)
- Immediately upon capture a blood sample was taken from each fish and the fish tagged with unique 5 digit ID number for later processing
- In the laboratory, fish were processed for a suite of health indicators including blood chemistry, histopathology of organs, bioenergetic indicators, feeding & nutrition, and the fish health assessment index (HAI)
- Muscle, liver, and ovary tissue (if sufficiently available) were obtained from 6 individuals of each species for bioaccumulation analysis
- Subsamples from all tissues were freeze-dried to express bioaccumulation results as percent dry weight

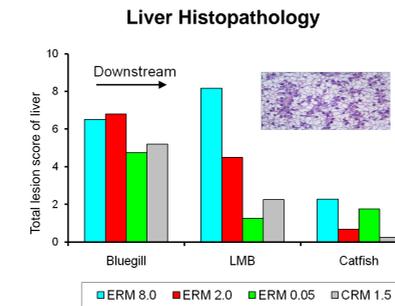
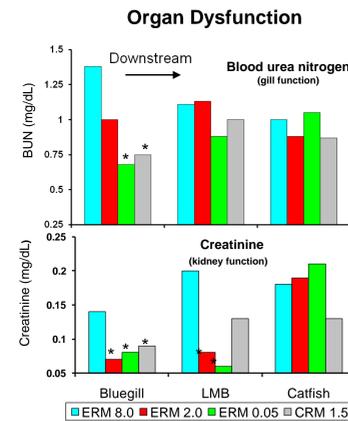
Results

Initial Fish Bioaccumulation and Health Studies

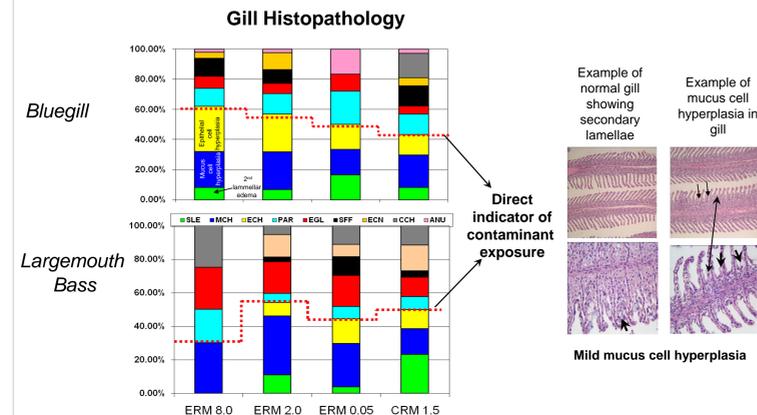
Bioaccumulation



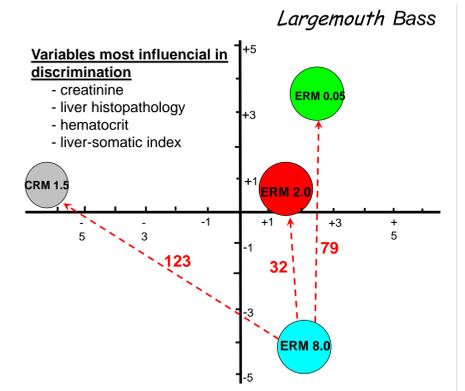
Fish Health Indicators



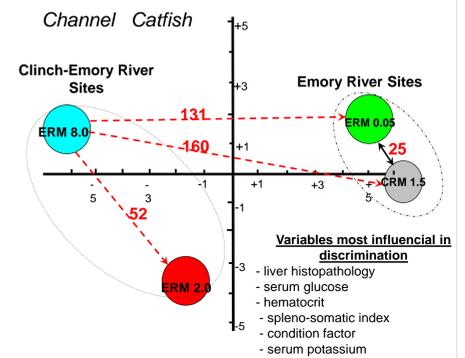
Selected Examples of Specific Fish Health Indicators



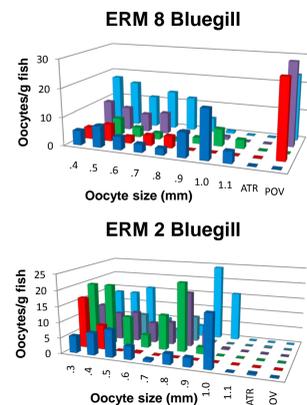
Integrated Health Assessment



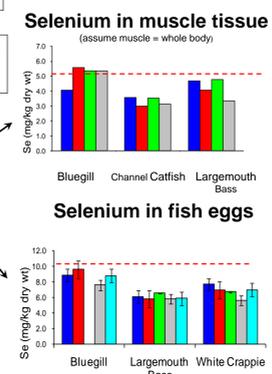
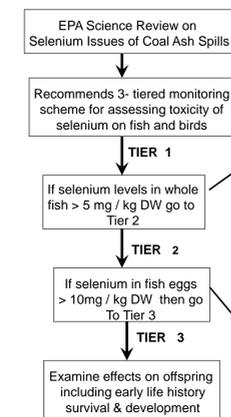
Integrated Fish Health Assessment Using Discriminant Analysis of Entire Suite of Indicators



Preliminary Fish Reproduction Results



- Bluegill, bass, crappie, and catfish were sampled in spring/summer 2009 from 5 sites
- Female bluegill downstream of the spill (ERM 2) were slightly less-developed reproductively than reference fish (no post-ovulatory follicles [POVs])
- Oocyte atresia (ATR) was slightly more prevalent at ERM 2 (but not apparent in figure because of relatively low ratio of ATR/normal oocytes)



Summary/Conclusions

- Selenium is elevated in muscle and other tissues of certain fish species sampled downstream of the fly ash spill
- Although there were differences between sites in some indicators of exposure and effects in these fish collected 2-3 months after the spill, there were no consistent relationships between metal bioaccumulation and indicator responses
- Female fish collected at and downstream of the spill in spring/summer 2009 had no obvious significant reproductive abnormalities, although analyses of samples continue
- Based on elevated selenium in tissues and the EPA's 3-tiered approach for assessing the effects of selenium on wildlife, future studies will be focused at the Tier 2 and 3 levels (and include larval fish studies)
- Results emphasize the importance of a weight-of-evidence approach for assessing relationships between multiple environmental stressors and the health of biological systems