Supporting Site Restoration via Research Translation and Trans-Disciplinary Partnerships

James W Rice

&

Students: Erik Christiano, April Rodd, Darcy Young, Jakob Shenker
PIs: Eugene Bernat, David Hibbet, Yongsong Huang, Eric Suuberg

Brown University School of Engineering, Providence, Rhode Island
Fisherville Mill Site, Grafton, MA

- Site of former textile mill
- Bounded by Blackstone River, which flows into RI
- Fire completely destroyed mill in 1999
- EPA “completed” cleanup in 2005
- Fisherville Redevelopment Corp. purchased site

No deep pockets for expensive remediation

Engaged developer wants to restore site for town benefit

Contaminants of Concern
- Petroleum – Current contaminant of concern in canal
- Heavy metals – In sediment and floodplains
- Chlorinated organic solvents - Subsurface
- Asbestos – removed in Emergency Action
An engaged community...

Attended by:

- The developer (a local hero)
- The community
- Town staff and policy makers
- EPA (Reg. 1 Administrator Curt Spalding)
- MA Dept. of Environmental Protection
- Local watershed associations, Blackstone Headwaters Coalition
- Brown U, Clark U, JTED
- Local media outlets
Organics-containing MGP waste and subsurface VOCs create challenges for RI DEM:
• Vapor Pressure of SVOCs
• Aqueous solubility of tars and NAPLs
• Vapor Intrusion

RI Impact: We are downstream of the Fisherville Mill Site.
Window into science that we were not yet engaged in: Fungal degradation study with Clark University, MA
Real field impact: Bioremediation field-study at Fisherville Mill, MA


Rhode Island: State-based approach to complex exposures
How We Became Involved

**Sept. 2011**
Voicemail from property owner, Gene Bernat, requesting analytical support:
- TPH Measurements
- Certified labs expensive and results hard to interpret
- No pending/forthcoming litigation

**Oct. 2011**
Conference call with JT. Ecological Design. Validation Study begins.

**Dec. 2011**
Bench-top study with Clark U begins.

**June 2012**
Mill Villages Park opens with ribbon cutting ceremony

**Oct. 2012**
MET Grant Proposal

**June – Sept 2012**
Field Study with JTED

**May. 2012**
John Todd Ecological Design’s “Eco-Machine”

- Uses white-rot fungi for degradation of Bunker-C heating oil in canal.
- Flow Diagram for JTED system:
John Todd Ecological Design’s
“Eco-Machine”

Island Restorer

Bioremediation Cells

Bottom Filter

White-rot fungi
Field Study with JT. Eco Design

- Is the Eco-machine removing bunker-C oil from the canal?
  - Yes: Aliphatic compounds reduced from average 200 ppb in canal to 6 ppb in Eco-machine.
  - Yes: PAHs reduced from average 43 ppt in canal to 0.7 ppt in Eco-machine.
  - But: Unclear which feature (or combination thereof) is doing the job.
  - Challenge: Are flow-rates through Eco-machine low compared to that of canal? Hydrogeology of canal not yet understood.
Do white-rot fungi degrade bunker-C oil?
  – Yes, several components. Likely through formation of oxidative enzymes.

Which components are most susceptible to degradation?
  – Degradation of complex oil compounds (e.g. PAHs) takes longer than degradation of simpler compounds (e.g., alkanes).

Can we observe changes in gene expression during growth on Bunker C oil and on two different wood substrates?
  – Transcriptome analyses suggest differential gene expression in the presence of Bunker C oil.
Future Opportunities

• Massachusetts Environmental Trust Grant Proposal
  – Leader: Blackstone Headwaters Coalition (BHC)
  – Proposed development of a living classroom and applied water resource
    research laboratory and associated curriculum
  – Consortium: BHC, Mosakowski Institute, Clark U., Brown U. SRP, UVM,
    JTED, Town of Grafton, Fisherville Redevelopment Company, etc.
  – “The Brown University Superfund Research Program will provide certain
    analytical services and contribute to experimental design, public outreach
    activities, and curriculum development.”

• Continued operation and analysis of the Eco-Machine by JT Eco. Design

• Basic and applied research opportunities for Brown SRP
  – Many complicated questions remain unanswered
  – Onsite Green Remediation?
What Have We Learned?

• Remediation drives risk assessment process.
  – Aliphatics in water at concentrations approaching (but below) MA DEP regulatory limits.
  – TPH in sediment generally exceeds MA DEP Soil Category Standards.

• Leveraging resources of multiple stakeholders was key to success.
  – Especially when facing limited funds

• Easier for Brown SRP Research Translation Core to become involved at Fisherville Mill site than many others because it was “closed” with no pending or forthcoming litigation.

• Communication was key.
  – Conference calls, emails, meetings, and events

• Field studies are complicated!
  – Is the remediation system working? (Black-box approach). How is the remediation system working? (Basic science approach)
  – The Brown SRP is not an EPA-certified laboratory. What help can appropriately be offered?

• Brown SRP Role: Scientific backup, Looking at new opportunities

Thank You. Questions?