Seasonal Trends in Water Quality in a Treated Acid Mine Drainage Impaired Stream

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What can continuous monitoring tell us about how AMD impaired streams behave seasonally?
Project Area
Hewett Fork

• Drainage area of 104.89 square kilometers
• 79.6 percent forest cover
• Headwater stream and second largest tributary to Raccoon Creek at 24.8 km long.
• The headwaters of Raccoon Creek are among the worst mine-related problems in Ohio
• Approximately 1,200 acres of abandoned mines and coal refuse piles are located within the drainage basin.
• Currently being actively remediated by lime doser
Selected Field Sites

• Two major AMD inputs are treated at a single location in Carbondale, OH, and discharges into Hewett Fork at field site **HF129**.

• **HF090** is 4.5 km (2.3 miles) downstream of HF129, and represents the downstream extent of the mixing zone where limited biological recovery can be seen.

• **HF039** is 11.4 km (7 miles) downstream of HF129, and represents the zone in which water quality and biological metrics are both being met.
What is Storm Response?

• Purging and Sparing

• Sparing – removal of oxygen from the reaction site due to flooding

• Purging – flushing of accumulated oxidation products by storm run-off

• Is that it?
  • Mixed mechanism
  • Consistent concentration
Long-term monitoring of storm response
Seasonal variation in water depth and conductivity 20 m downstream of doser discharge
Seasonal water quality 4.5 km downstream from doser
Seasonal water quality 11.4 km downstream from doser
Case study in Little Raccoon Creek – seasonal patterns in pH and conductivity
Little Raccoon Creek
Behavior of metals during storm events
Water Year 2016
# Precipitation Conditions for Each Storm

<table>
<thead>
<tr>
<th>Storm Date</th>
<th>Season</th>
<th>Total</th>
<th>Max</th>
<th>Min</th>
<th>Std. Dev.</th>
<th>HF039</th>
<th>HF090</th>
<th>Prior Dry Days</th>
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</thead>
<tbody>
<tr>
<td>4/30/16-5/1/2016</td>
<td>Spring</td>
<td>1.194</td>
<td>0.381</td>
<td>0</td>
<td>0.095</td>
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<td>5/20/16-5/21/2016</td>
<td>Spring</td>
<td>1.270</td>
<td>0.533</td>
<td>0</td>
<td>0.131</td>
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<td>High</td>
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<td>6/4/16-6/5/2016</td>
<td>Spring</td>
<td>1.067</td>
<td>0.635</td>
<td>0</td>
<td>0.135</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>6/22/16-6/23/2016</td>
<td>Spring</td>
<td>5.410</td>
<td>2.337</td>
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<td>0.540</td>
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<tr>
<td>7/28/16-7/29/2016</td>
<td>Summer</td>
<td>0.508</td>
<td>0.203</td>
<td>0</td>
<td>0.051</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>9/28/2016-9/29/16</td>
<td>Summer</td>
<td>0.540</td>
<td>0.200</td>
<td>0</td>
<td>0.047</td>
<td>Low</td>
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<td>10/20/2016-10/22/16</td>
<td>Fall</td>
<td>4.470</td>
<td>0.610</td>
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<td>0.147</td>
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<td>12/5/16-12/6/2016</td>
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<td>0.305</td>
<td>0</td>
<td>0.098</td>
<td>High</td>
<td>Low</td>
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</tbody>
</table>
Hysteresis diagrams for metal response to storms

April 2016

June 2016

October 2016

4.5 km downstream of the doser
11.4 km downstream of the doser
Conclusions

• For much of the year, there is a direct relationship between stage and pH and an inverse relationship between stage and conductivity
• Spring storms show significant variability in water quality including an indirect relationship between pH and stage and a direct relationship between stage and conductivity
• Less pronounced response further downstream
• Metal concentrations vary by an order of magnitude between seasons
• Differing patterns of hysteresis between sampling locations
Thanks!

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