The Effect of Storm Water Retention Ponds on Leaf Decomposition

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NSF Research Experience for Undergraduates
The College of William and Mary
Outline

- The Basics
- Measuring Leaf Breakdown
- Statistics and Thoughts
The Background: Why Decomposition?

- Decomposition is a functional measure of ecological integrity (Gessner and Chauvet 2002).
- Lightly impacted streams had leaf processing rates of a hard-leaf species more than 50% slower than in "intact" streams, fauna diversity was not lowered (Moulton and Magalhães 2003).
- Physical abrasion and microbial activity govern mass loss in developed streams, whereas processing was governed mainly by microbial and invertebrate activity in forested streams (Bird and Kaushik 1992).
Background: Decomposition

- Two possible sources of energy in freshwater streams:
  - Instream: photosynthesis by algae, moss, and higher aquatic plants
  - Imported (allochthonous): Autumn leaf fall
- Leaves are broken down by microbial activity, shredders, and physical fragmentation.
Questions

- Do storm water retention ponds affect leaf decomposition?
- If yes, what accounts for that change?
- What does decomposition tell us about ecosystem integrity?
Research Sites

Mulberry Place
- Diverse riparian zone (trees, low vegetation)
- Lightly Developed
- Narrow Floodplain
- "Soft" substrate
Research Sites

Ironbound Village
- Diverse riparian zone (trees, low vegetation)
- Urbanized
- Wide floodplain
- “Course” substrate
Research Sites

William and Mary Campus
- Riparian zone rich in trees
- Highly developed area
- Diverse substrate
Experimental Design

- 50 gram mixed leaf litter bags
- Sets of five **upstream** and **downstream** of retention ponds
- Collect after 2 and 5 weeks.
Experimental Design

- Dry leaf litter for re-weighing
- Survey Invertebrates
- Ash leaf litter for AFDM
Results: Summary

- **Decay Rates**
  - Upstream: -3.91 g/week
  - Downstream: -2.12 g/week
  - Significant: NO

- **Invertebrate Survey**
  - Upstream: 10583
  - Downstream: 1380
  - Significant: NO
  - Invertebrates correlate with decay (overall)
Results: All Ponds

Decomposition Upstream Retention Ponds

\[ y = -3.9126x + 42.634 \]

\[ R^2 = 0.6421 \]

Leaf Litter Mass (grams)

Week
Results: All Ponds

Decomposition Downstream Retention Ponds

\[ y = -2.1174x + 36.77 \]
\[ R^2 = 0.3582 \]

Leaf Litter Mass (grams)

-2.3494

Week

n=25
Results: Decay Significance

*Paired two sample t-test comparing leaf masses after 5 weeks, $p = 0.1085$
Results: Invertebrates

<table>
<thead>
<tr>
<th>Site</th>
<th>Upstream</th>
<th>Downstream</th>
<th>*Paired two sample t-test, p=0.197258</th>
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</thead>
<tbody>
<tr>
<td>Ironbound Village</td>
<td>93</td>
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<tr>
<td>Mulberry Place</td>
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<td>210</td>
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<td>Crimdell</td>
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<td>394</td>
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<tr>
<td></td>
<td>10583</td>
<td>1380*</td>
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</tr>
</tbody>
</table>
Results: William and Mary (Yates)

Upstream Leaf Litter Breakdown at W&M 2

\[ y = -0.1495x + 3.7677 \]
\[ R^2 = 0.8809 \]

Downstream Leaf Litter Breakdown at W&M 2

\[ y = -0.0484x + 3.5513 \]
\[ R^2 = 0.4582 \]

9785 invertebrates
*Higher decay

223 invertebrates
Lower Decay
Upstream Leaf Litter Breakdown at Ironbound Village

\[ y = -0.3288x + 4.0342 \]

\[ R^2 = 0.9 \]

93 invertebrates
*Higher decay

Downstream Leaf Litter Breakdown at Ironbound Village

\[ y = -0.0719x + 3.6595 \]

\[ R^2 = 0.8839 \]

224 invertebrates
Lower Decay
Discussion

- Do storm water retention ponds affect leaf decomposition?
  - On average no, but it varies with basins.

- If yes, what accounts for that change?
  - Changes in Invertebrate Communities
  - Storm Water Discharge
Conclusion

- What does decomposition tell us about ecosystem integrity?
  - Difficult to say – many factors
  - Baseline data is important
  - Improve Design
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