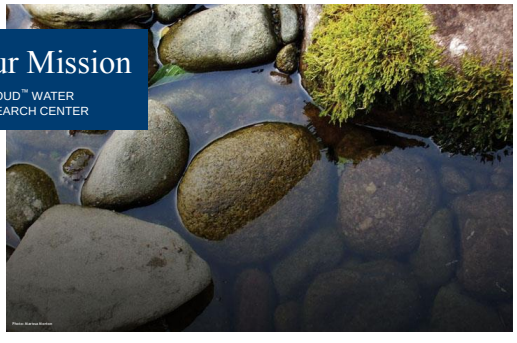
How Streams Work and the Role of Streamside Forests

STROUD™ WATER RESEARCH CENTER

Independent not-for-profit
Research and Environmental Education Center

Our Mission

STROUD™ WATER RESEARCH CENTER

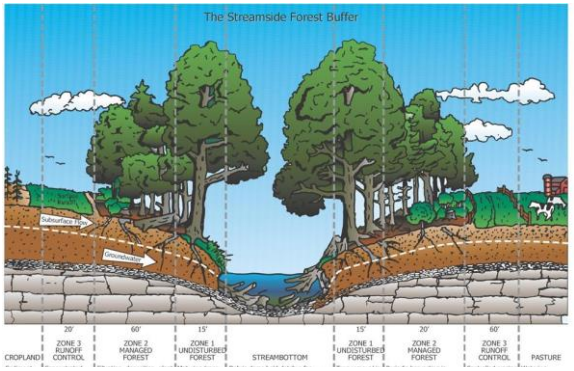


To advance knowledge and stewardship of freshwater systems through global research, education, and watershed restoration

What Are Your Goals?

- Reduce:
  - Sediment
  - Pathogens
  - Nitrogen and Phosphorous Pollution
  - Flooding & Excessive Runoff
- Removal of Impaired Status – Clean Water Act
- Wild Trout

Wild Brook Trout?



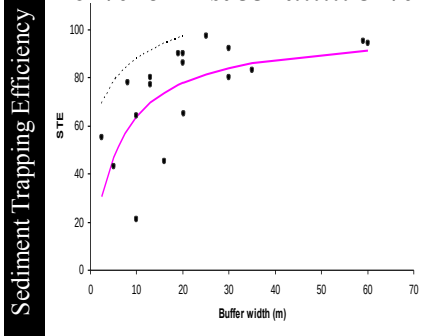
Forest Buffers as Filters

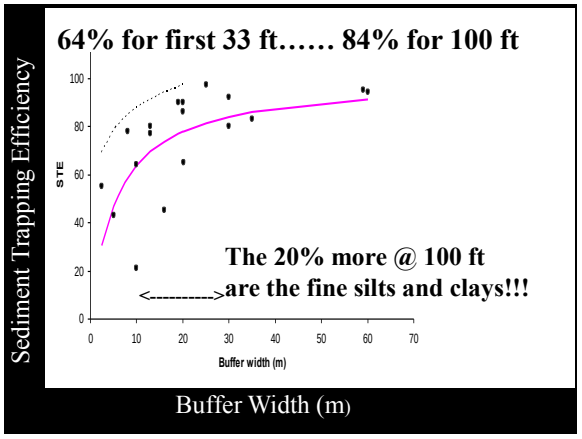
AMERICAN WATER RESOURCES ASSOCIATION
Community, Conversation, Connections

STREAMSIDE FOREST BUFFER WIDTH NEEDED TO PROTECT STREAM WATER QUALITY, HABITAT, AND ORGANISMS: A LITERATURE REVIEW

Bernard W. Sweeney and J. Denis Newbold
Stroud Water Research Center
Avondale, PA

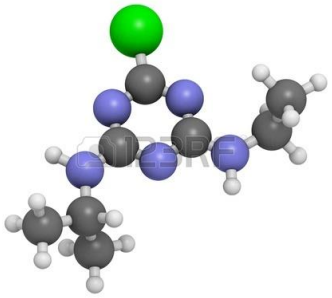
64% for first 33 ft…… 84% for 100 ft

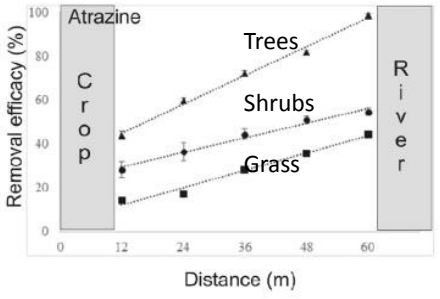




Cryptosporidium spores

Pesticides (e.g., Atrazine)





Aguiar Jr., T. R., F. R. Bortolozo, F. A. Hansel, K. Rasera, and M. T. Ferreira. 2016. Riparian buffer zones as pesticide filters of no-till crops. Environ Sci Pollut Res 22:10618–10626.

Questions on the Role of Forest Buffers

1. **Should we focus forest buffers based on landscape position, i.e.. in flowpaths?**
2. **What if concentrated flows move directly through a buffer?**
3. **What if we do an outstanding job managing the upland? Why bother with a buffer? The potential of a Soil Health focus?**


The Rest of The Story


Small streams matter
• Are “capillaries” of watersheds
• >80% of stream miles
• Often disregarded
• Determine health downstream


Stream organisms…
• Are highly specialized
• Are adapted to forested conditions


Forest Buffers provide
In-Stream services
forested streams…
• remove 2 to 9x more nitrogen pollution
• have 2 to 5x more biological activity


• 2-4x more stream bottom area
• better conditions for biofilm
• more and preferred foods
• shading provides cooler temperatures


The Difference Forests Make
Study by Stroud Water Research Center
• 16 streams in eastern Pennsylvania
• adjoining sections w/ and w/o forest
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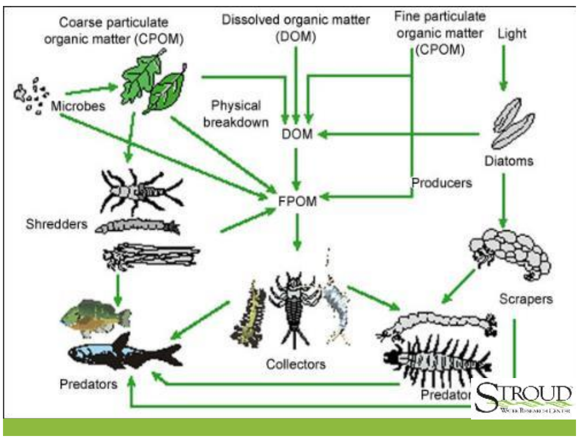
Riparian deforestation, stream narrowing, and loss of stream ecosystem services

Bernard W. Sweeney*†, Thomas L. Bott*, John K. Jackson*, Louis A. Kaplan*, J. Denis Newbold*, Laurel J. Standley*, W. Cully Hession‡, and Richard J. Horwitz§

*Stroud Water Research Center, Avondale, PA 19311; ‡Department of Civil and Environmental Engineering, University of Vermont, Burlington, VT 05405; and §Academy of Natural Sciences of Philadelphia, Philadelphia, PA 19103

Communicated by M. Gordon Wolman, The Johns Hopkins University, Baltimore, MD, August 12, 2004 (received for review December 17, 2003)

A study of 16 streams in eastern North America shows that riparian deforestation causes channel narrowing, which reduces the total amount of stream habitat and ecosystem per unit channel length and compromises in-stream processing of pollutants. Wide forest reaches had more macroinvertebrates, total ecosystem processing of organic matter, and nitrogen uptake per unit channel length than contiguous narrow deforested reaches. Stream narrowing nullified any potential advantages of deforestation regarding abundance of fish, quality of dissolved organic matter, and pesticide degradation. These findings show that forested stream channels have a wider and more natural configuration, which significantly affects the total in-stream amount and activity of the ecosystem, including the processing of pollutants. The results reinforce both current policy of the United States that endorses riparian forest buffers as best management practice and federal and state programs that subsidize riparian reforestation for stream restoration and water quality. Not only do forest buffers prevent nonpoint source pollutants from entering small streams, they also enhance the in-stream processing of both nonpoint and point source pollutants, thereby reducing their impact on downstream rivers and estuaries.



How Streams Work

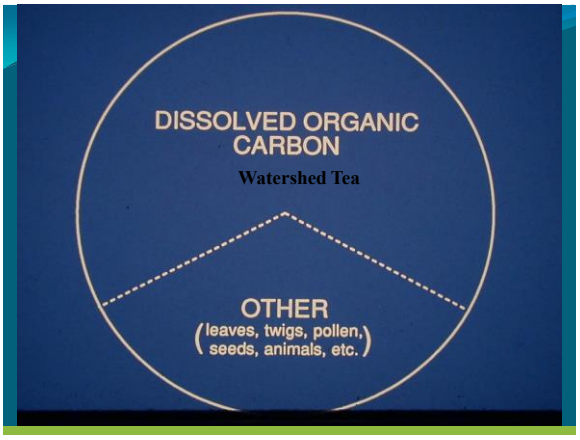
The Hidden Energy of Streams

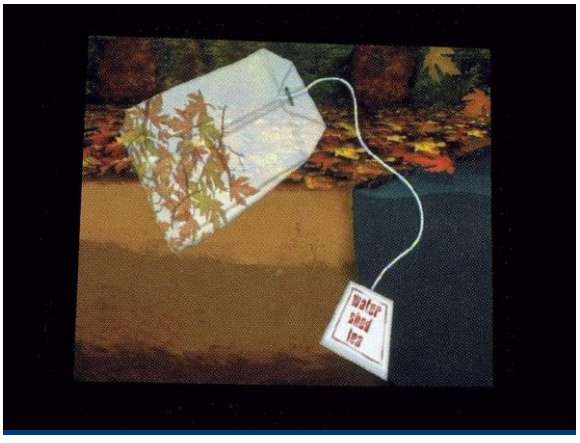

Filamentous algae


Diatoms
• Need shady conditions to thrive
• A preferred food for scrapers
• Small % of food energy in stream


Tree leaves feed streams
• Leaves, twigs, pollen: solid carbon
• Streams collect ~5x more than other areas
• Only ~1/3 of stream's energy

Without Trees ….these are missing


DISSOLVED ORGANIC CARBON
Watershed Tea
OTHER
(leaves, twigs, pollen, seeds, animals, etc.)


Water shed tea


"Watershed Tea"
• dissolved organic carbon
• ~ 2/3 of a stream's food supp
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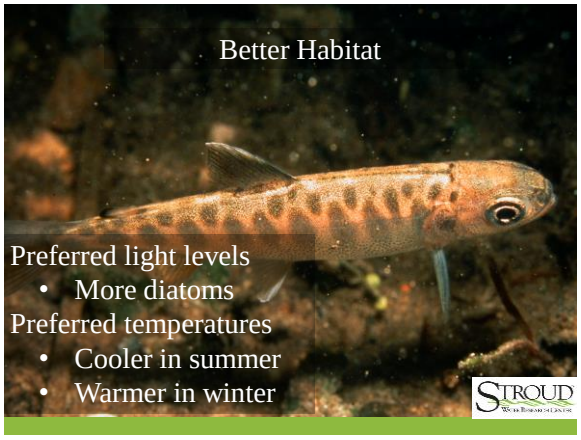
Fish grow on trees


In-Stream Services
Portions of streams with forest…
• Had 3-5x more biological activity
• Removed 2-8x more nitrogen pollution
…than stream areas with healthy grass buffers


Why? BETTER Habitat!
• lots of preferred foods
• better stream bed habitat
• Key: Biofilm on stream bottom


Better Habitat
Preferred light levels
• More diatoms
Preferred temperatures
• Cooler in summer
• Warmer in winter
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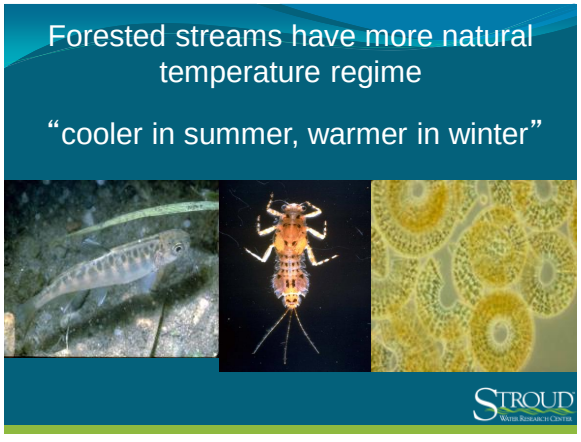
Forested streams have more natural temperature regime
"cooler in summer, warmer in winter"
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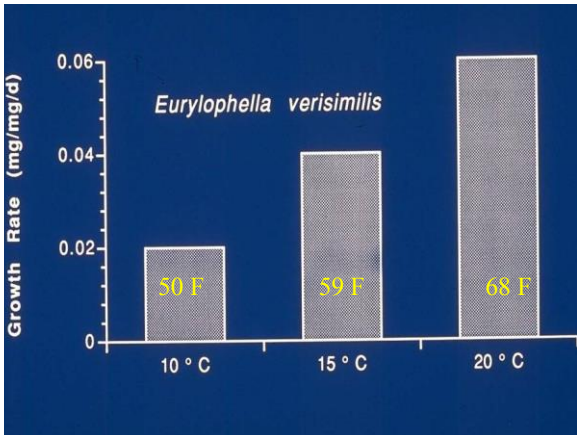
Mayfly:
Eurylophella verisimilis

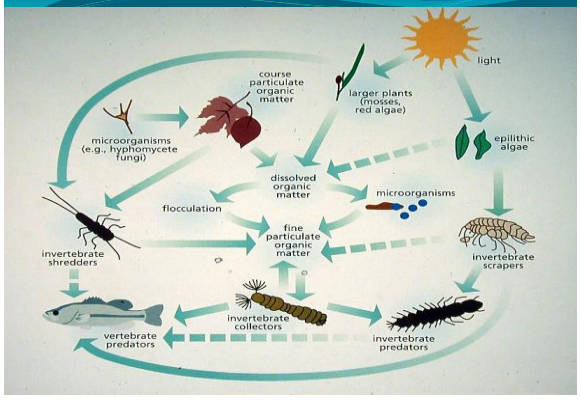


Cold Water Species

"live on the edge"

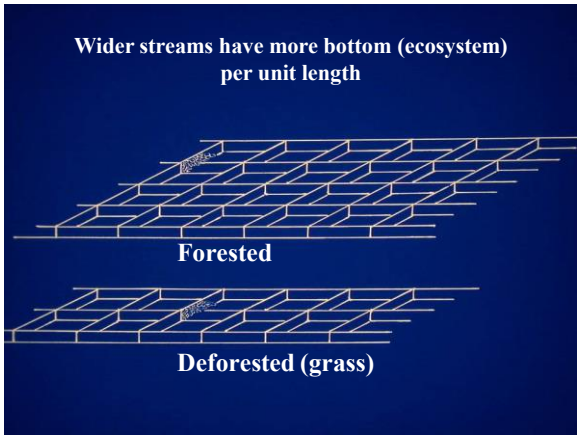
For 1000's of years ….most small streams were shaded and never went above 68 F

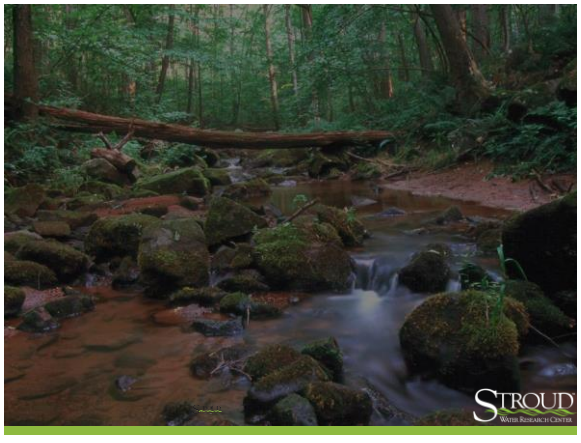
A stream's "ecosystem" is on the bottom



Forested Streams:

- remove 2 to 9x more nitrogen pollution
- have 2 to 5x more biological activity
- 2-4x more stream bottom area
- better conditions for biofilm


Wider streams have more bottom (ecosystem) per unit length
Forested
Deforested (grass)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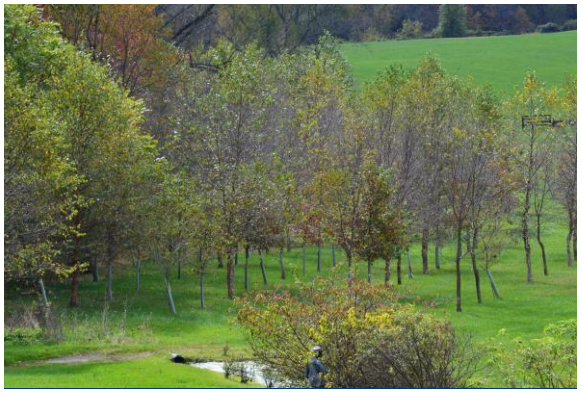
Planted Apr 2007
Photo Aug 2008

Spring 2014




Lititz Run – Before Forest Buffer
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Lititz Run - 18 Year Old Forest Buffer
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Thoughts on Successful Buffer Establishment

Herbicide v 12” Stone Mulch

3’ herbicide spot

93% survival
@ 4 yrs

~$7.70/tree

“2A modified”
stone mulch
(no herbicide)

76% survival
@ 4 years

~$2.50/tree

Center Hole Net Method

- Nets protect birds
- If neglected, nets tangle trees

Center-hole Method

Tassel Method

Center Hole Net Method (Cont.)

- Sweeney: ~75% less tree tangling
  - intentionally neglected nets
  - limited sample size
- But, do birds go in center hole?

Center-hole Method | Tassel Method

damage from tangling in net

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Center Hole Net Method (Cont.)

Center-hole Method | Tassel Method

~10,000 tubes checked 2016-17
- One dead bird found, but net was improperly installed
- Seems ready for adoption

Center hole nets also blow off tube less often than tassel method

Not a recc. to neglect nets

62

multiflora rose competing in tube

Results (by weight of competing veg):

Single shake (Feb/March):
- 42% reduction vs. no Snapshot

Two shakes: (Feb/March):
- 45% reduction vs. no Snapshot

But some oriental bittersweet came through!
Snapshot works for ~ 3 months

Next Tests: Other Options:
- A **second** application in May
- Use of additional active ingredients

63

Rout ™ : additional active ingredients

What a typical application looks like

STROUD WATER RESEARCH CENTER 50 YEARS

Results in 18 months for silky dogwood:

control – no fence
mean height: 26 cm

"biodegradable" fence:
wooden stakes + bailer twine
mean height: 37 cm

welded wire fencing
mean height 91 cm

65 Photos: Matt Gisondi

STROUD WATER RESEARCH CENTER 50 YEARS

Watershed Restoration

Aims to re-establish normal rates and magnitudes of physical, chemical, and biological <u>processes</u> that create and sustain river and floodplain ecosystems

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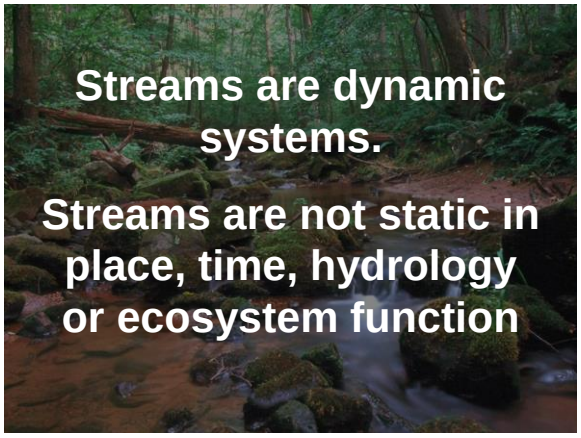

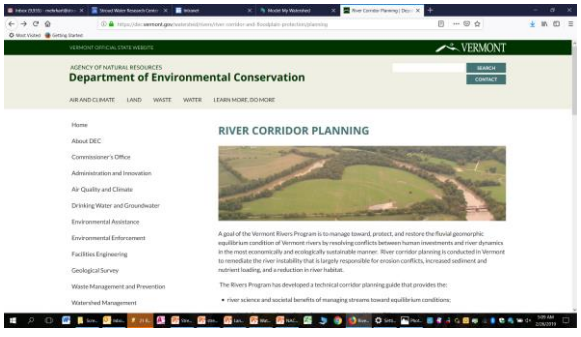

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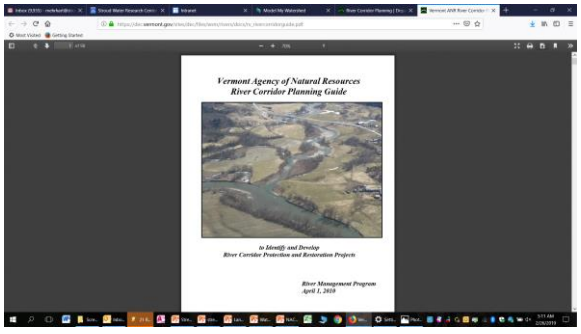

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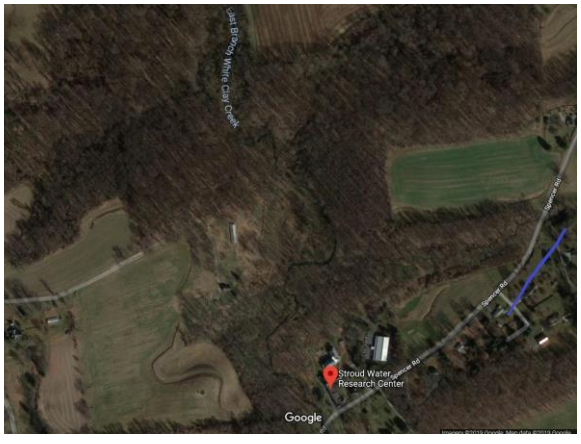
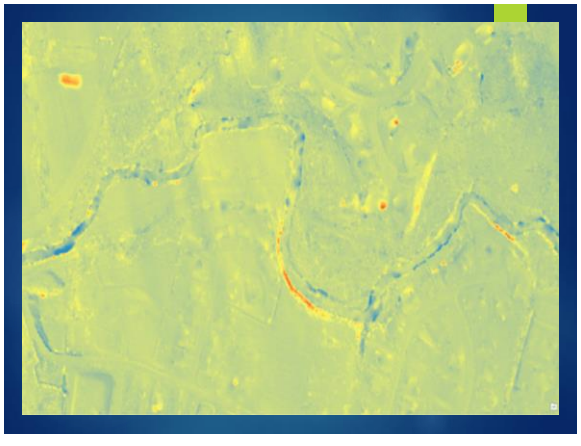
Spencer Rd
McCue Rd
Google


East Branch White Clay Creek
Spencer Rd
Stroud Water Research Center
Google



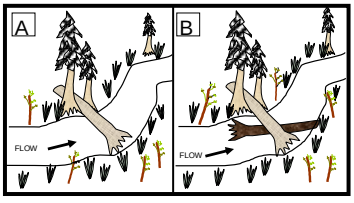
MapShed PRP Default Rate, BANCS Results, and DEM Differencing

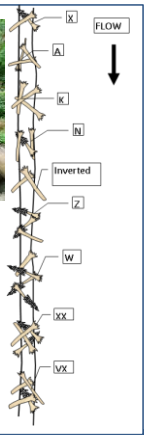
BMP Number	Default Rate Estimated in TMDL Plan at 115 lb/ft (tons/yr)	BANCS Method (tons/yr)	Watershed DEM Differencing Erosion ± Error (tons/yr)	Watershed DEM Differencing Erosion Error Percentage (%)
4	57.5	18.6	6.1 ± 2.4	39.4%
5	66.1	68.9	9.5 ± 2.0	20.8%
9	193.7	206.9	33.4 ± 12.6	37.8%
10	115.0	62.7	-72.2 ± -13.9*	-19.3%*
12	103.5	25.8	10.2 ± 2.8	27.2%

*Net Deposition

Large Woody Debris

- Slow Stormwater Flow
- Improve In-stream Habitat
- Alter Channel Shape






Matthew J. Ehrhart
Director of Watershed Restoration
Stroud Water Research Center
mehrhart@stroudcenter.org
610 268 2153 ext 308
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