NORTH CAROLINA
DEPARTMENT OF AGRICULTURE & CONSUMER SERVICES

Summary of Recent Forestry BMP Research

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Goal of this Presentation

- **Provide an overview of recent BMP effectiveness studies**
  - ➢ **Streamside Management Zones**
  - ➢ **Paper survey results**
    - ✓ **Southeastern US BMP implementation rates**
    - ✓ **Stream crossing use & cost**
  - ➢ **Erosion rates and Water quality**
    - ✓ **Truck roads**
    - ✓ **Bladed skid trails**
    - ✓ **Overland skid trails**
    - ✓ **Truck and Skid trail crossings**

Streamside Management Zones (SMZs)

Lang and others (2015) documented vegetation & landform characteristics surrounding sediment paths along SMZs

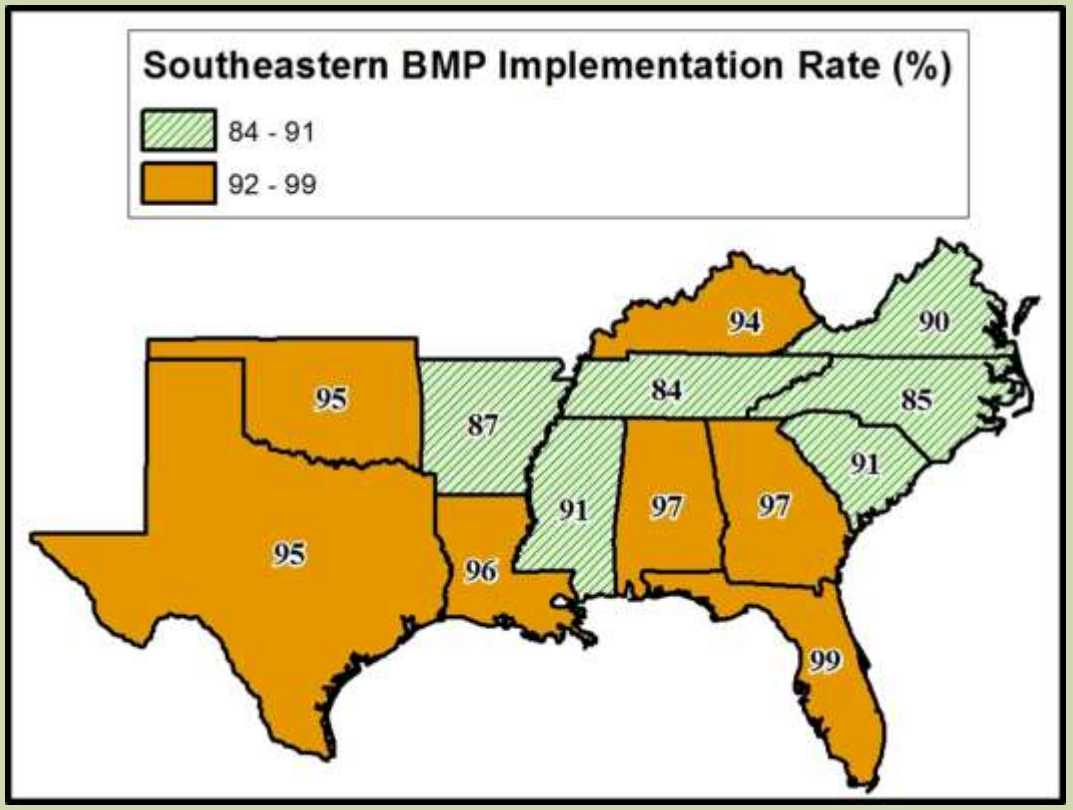
- Evaluated 6.2 miles of SMZ across 16 clearcut tracts
- Sediment pathways leading into and occasionally through SMZ were attributed to:
  - Stream crossings
  - Poor road/skid trail location
  - Reactivated legacy gullies
- Recommended
  - Focus on preharvest planning
  - Eliminate unnecessary crossings
  - Focus use of BMPs along crossing approachways
  - Minimize disturbance within gullies/ephemeral drainages

Lakel and others (2006, 2010, 2015) evaluated 16 streamside management zones with 4 levels of BMPs

- **SMZs evaluated**
  - **25 ft**
  - **50 ft**
  - **50 ft with thinning**
  - **100 ft**
- **All SMZ widths trapped 86% – 97%**
- SMZ failures (sediment reached the stream) were associated with roads, skid trails, and stream crossings

Survey of BMP Implementation Rates in the Southeastern United States

- Cristan and other (2015)
- Southeastern US is mostly quasi-regulatory
- Many states have legislation to enforce WQ standards
- Noted different levels of State harvest inspections
- Implementation rates may be linked to industry standard programs (SFI, FSC)
- States reported lowest BMP implementation rates for
  - Roads
  - Stream Crossings
  - Skid trails
  - Prescribed burning



McKee and others (2010) Surveyed Virginia Loggers Regarding Stream Crossings and BMPs

- Surveyed 70 Virginia loggers
- **Mountain region loggers tended to use culverts**
- Piedmont region loggers tended to equally use portable bridgemats and culverts
- Coastal Plain region loggers tended to use portable bridgemats
- All regions reported significant time and money spent on crossing closure
- **Authors concluded that a greater emphasis on portable bridgemats in the Mountain Region was necessary**

Truck Roads and Skid Trail Stream Crossings
Applied Research Finding

Aust and others (2010) Evaluated Water Quality on Truck Road Stream Crossings

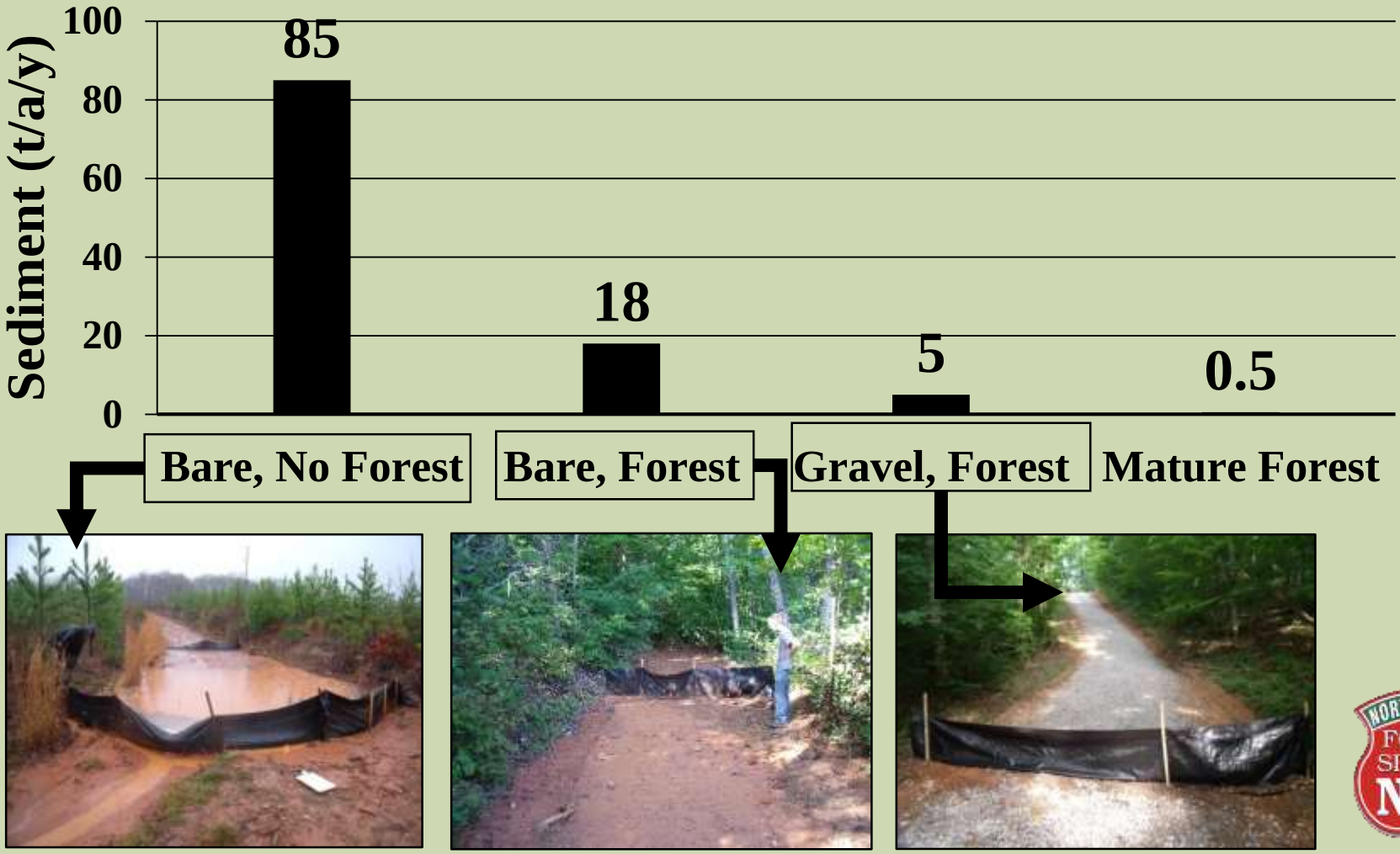
- 24 stream crossings (**culvert, ford, bridge, and pole**) during 4 periods (**before, install, harvest, close**)
- **Approachways** are more of a concern than **type of crossing**
- **Permanent crossings are more problematic** than temporary crossings
- Highest erosion rates on approachways occurred **During Harvest**
- **BMPs should be installed while the operation**

Primary Skid Trails

Bridges < Ford/Pole < Culverts (Sediment During Harvest)

Brown and others (2013a) evaluated sediment contributions from 15 legacy roads in Piedmont.

- Major factors controlling sediment were road area & BMPs (spacing between water controls and gravel).

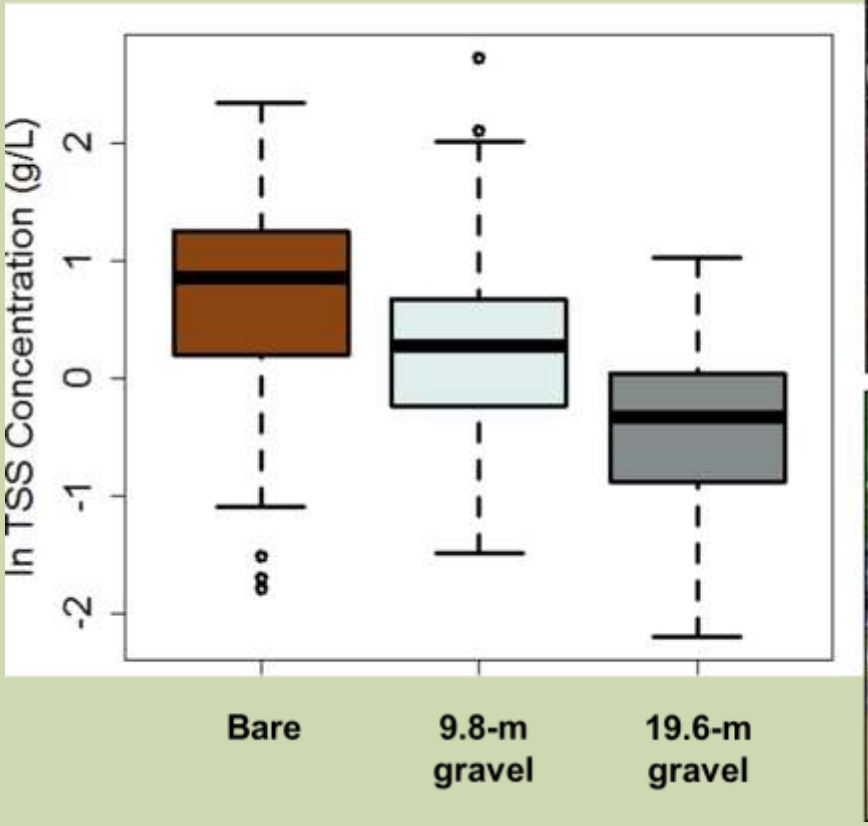


Brown and others (2013b) evaluated road stream crossings and with 3 levels of BMPs

- Rainfall simulations to evaluate sediment contributions from
  - 3 ford crossings (6 approachways)
  - 3 rainfall intensities
    - (High, intermediate, low)
  - 3 levels of BMPs
    - No Gravel
    - 33 ft of Gravel
    - 66 ft of Gravel

Brown and others (2013a) evaluated road stream crossings and with 3 levels of BMPs

- **No gravel**: 7x more sediment than 66-ft gravel
- **33-ft graveled**: 2x more sediment than 66-ft gravel



Morris and others (2013) compared 3 levels of BMPs for 3 Haul Road Stream Crossings in Piedmont

- Compared TSS above and below a bridge, culvert, and geoweb ford
  - 3 levels of BMPs (BMP-, BMP, BMP+)
  - 3 levels of rainfall simulation
- Conclusions:
  - **BMP additions** decreased sediment
  - **Construction phase** produced the most sediment for all crossings
  - **Culvert** produced the most sediment during rainfall events

Wear and others (2013) evaluated 9 skidder stream crossings with 3 levels of closure BMPs

Waterbars and piled slash

Waterbars, fescue, lime, fertilizer, straw mulch

Waterbars, fescue, lime, fertilizer, straw mulch, & silt fence at the stream

Wear and others (2013) concluded

- **Slash** and **Seed & Mulch** treatments were **more effective** for sediment reduction
  - **Choice to use slash is dependent on its availability**
  - **Slash is a longer-term solution (grass survival and ATV traffic)**
- Cost varied 3x with BMP treatment
  - 1x Slash
  - 2x Seed & Mulch
  - 3x Silt Fence
- **Silt fence treatment allowed more sediment into stream and cost the most**
  - **BMP complexity/cost ≠ BMP effectiveness**

Slash = $120

Seed & Mulch = $280

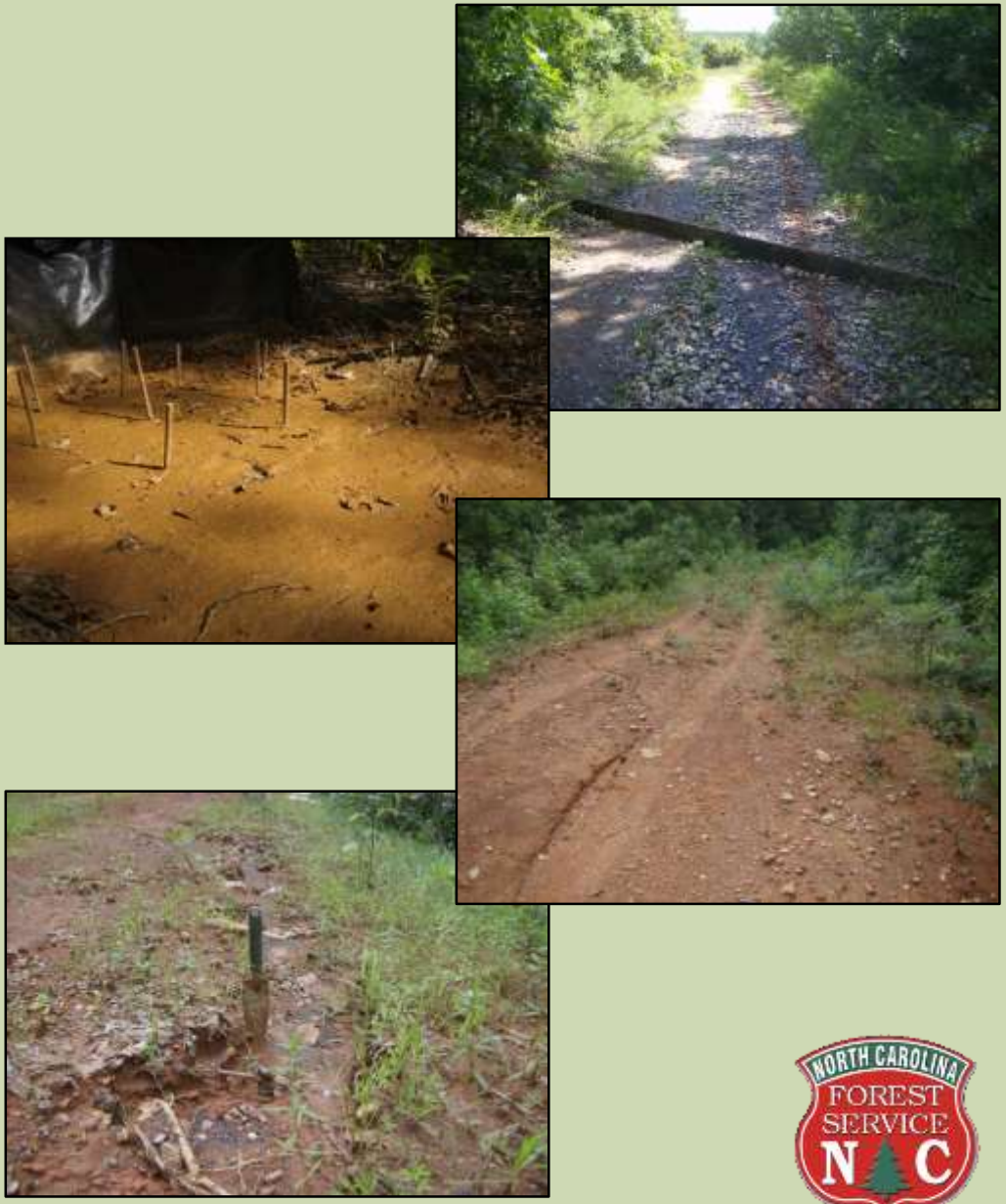
Silt Fence = $345

Nolan and others (2015) evaluated 42 stream crossings

- Using the USLE erosion model, they found BMP+ roads and trails produced less than 1.4 t/a/y
- Difference between BMP- and BMP+
  - Truck roads = 14 t/a/y
  - Skid trails = 21 t/a/y
- Cost of improving from BMP- to BMP-standard
  - Truck roads = $450
  - Skid trails = $150
- Cost of improving from BMP-std to BMP+
  - Truck roads = $480
  - Skid trails = $50

Lang (2016) evaluated 37 truck road approachways

- Observational study
- Collected sediment for a year
- Sediment collected ranged from <0.1 to 1.2 tons
- Poor BMP implementation on two approachways
- Found that 75% of approachways eroded at very low rates (< 0.1 t/a/y)
- Steeper, greater bare soil, and further water control spacing yielded higher amounts of sediment.
- 14% of approachways contributed 80% of the total sediment caught



Lang et al. (2018) evaluated 5 road ditch BMPs and sediment for 60 truck ditch segments.

- Seed, Mat, and Rock BMPs reduced erosion, but erosion **Mat was most cost effective**
- Check dam anomaly
- **Cover BMPs cannot replace adequate water control**
- **Extensive management**

	US$ per 50 ft	% increase above Bare
Bare	$674.00	-
Seed	$680.01	0.9
Mat	$695.33	3.2
Dam	$745.43	10.6
Rock	$815.08	20.9

Take-home Points from Truck Road & Skid Trail Stream Crossing Approach Studies

- BMPs are important for both truck roads and skid trails, however additional or enhanced BMPs is often warranted for permanent roads
- Stream crossing type can potentially affect water quality, but each crossing type may be suitable for a particular situation
- All BMP treatments (rock, seed, mulch, etc.) can reduce erosion rates
- BMPs should be applied during operations. Not just after the work is finished.
- Crossings can be one of the most expensive components of your road system, so avoiding them altogether is of benefit to your pocketbook and water quality

General Soil Erosion on Skid Trails (not at crossings)

Wade et al. (2012) evaluated bladed skid trail closure treatments in the Piedmont

Control
(waterbars only)

Seed

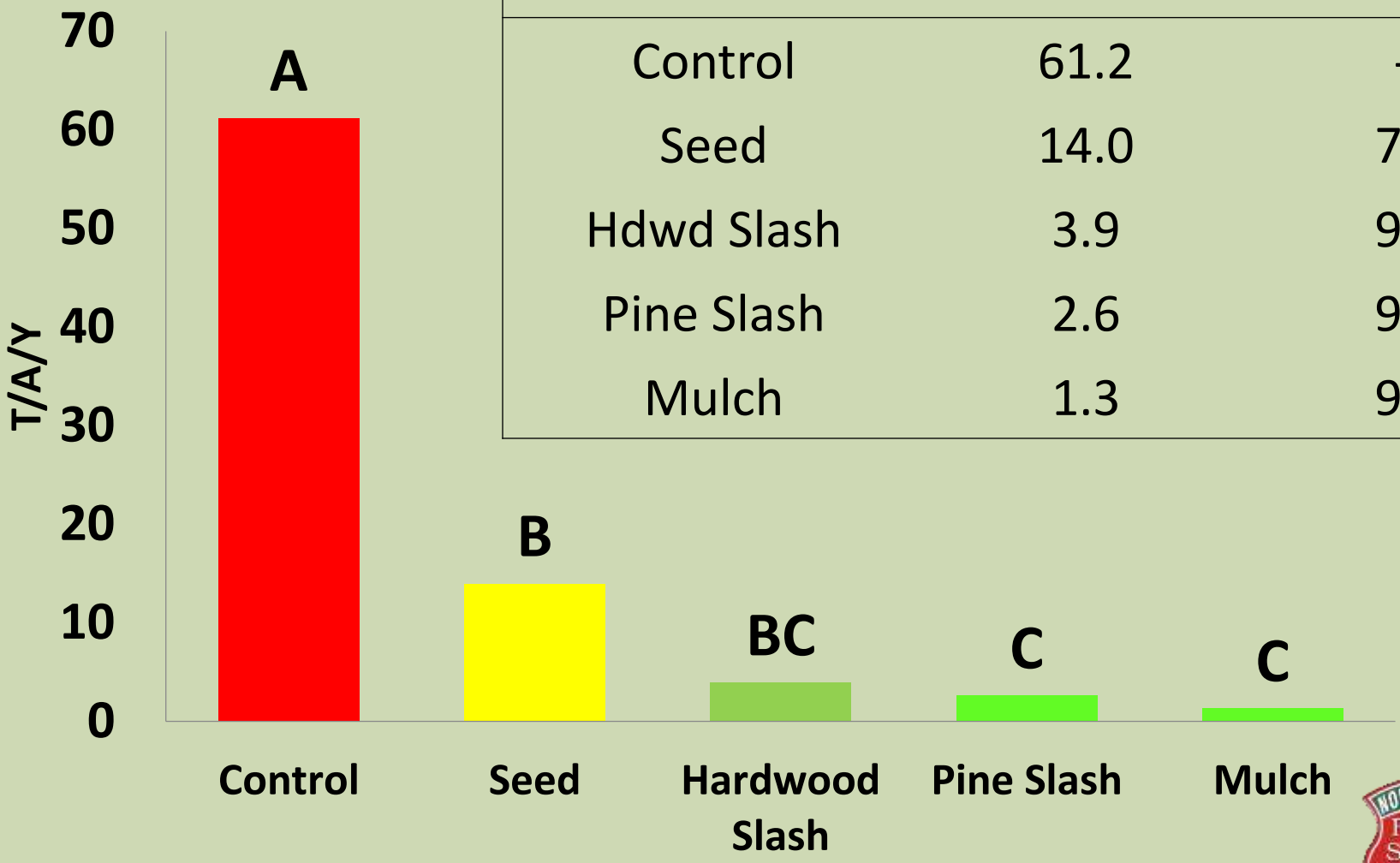
Mulch

Hardwood Slash

Pine Slash

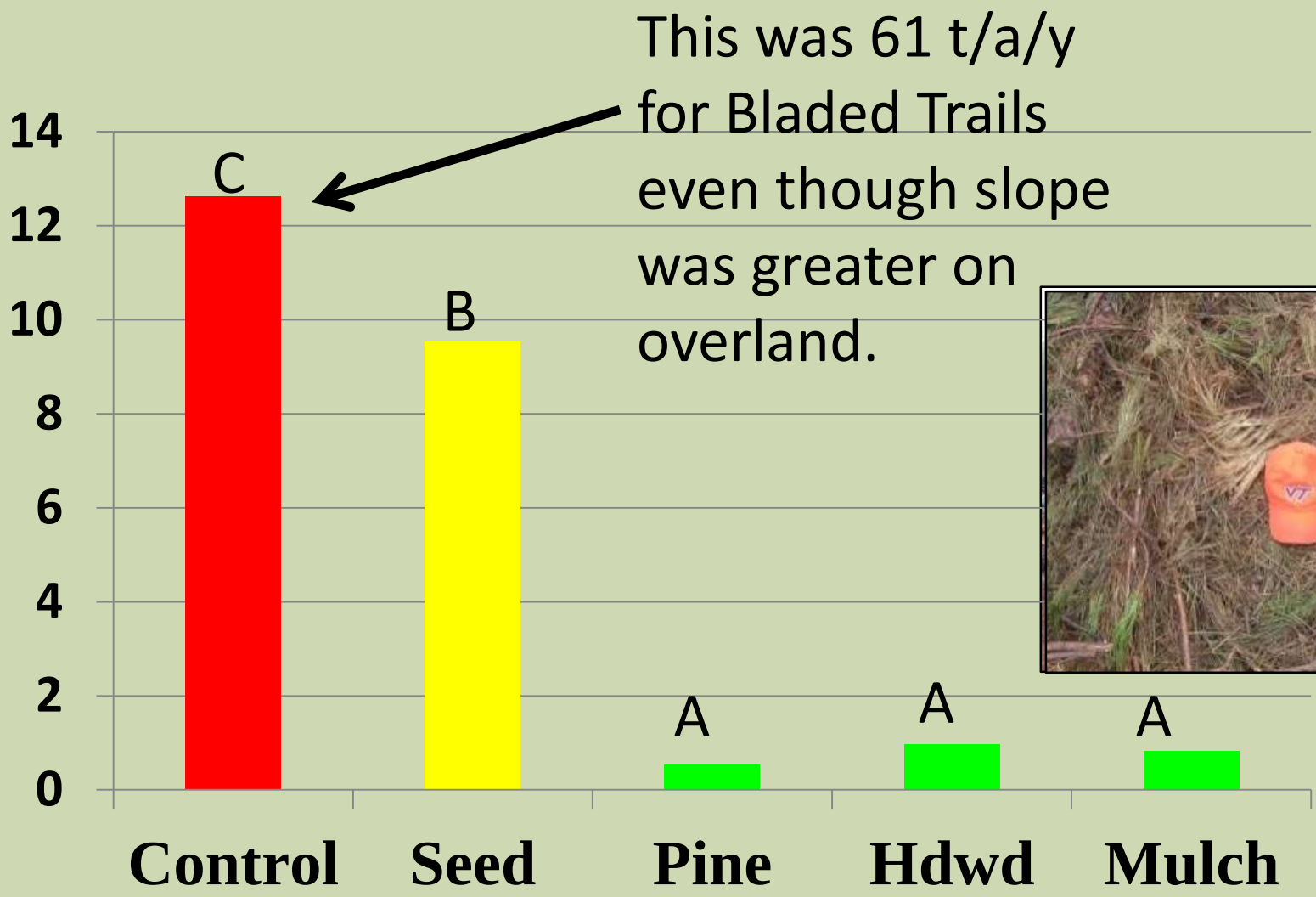
Overall Erosion on Bladed Skid Trails

Treatment	Actual t/a/y	% Reduction
Control	61.2	-
Seed	14.0	77
Hdwd Slash	3.9	94
Pine Slash	2.6	96
Mulch	1.3	98



Sawyers et al. (2012) performed a similar evaluation for overland skid trail closure

Total Annual Erosion (t/a/y) by Treatment (p=0.0001)



Overland Skidding Cost Calculations

Closure Treatment	Closure Costs for 29 acre site	Closure Costs per mile	Closure Costs/Ton of erosion prevented	Closure Cost /Ton of wood
Control (WB)	$2250	$1980/ mi	NA	$0.91/ ton
Seed (WB, S, L, F)	$4375	$3850/mi	$907/ton	$1.77/ton
Mulch (WB, S, L, F, M)	$4738	$4172/mi	$293.08/ton	$1.92/ton
Hdwd & Pine Slash (Vendor)	$6920	$6090/mi	$367.68/ton	$2.80/ton
Integrated Slash	$1022 ??	$900/ mi	$61.70/ton ??	$0.41/ton

Vinson et al. 2016 evaluated bladed skid trails in the Ridge and Valley of VA

- Six replications
- Slash and mulch performed better than Seed
- Exposed rock

Treatment	Avg. Erosion Rate (tons/ac/yr)	Minimum Erosion Rate (tons/ac/yr)	Maximum Erosion Rate (tons/ac/yr)
Control	6.8	2.5	15.3
Seed	2.6	0.3	6.4
Mulch	0.5	0.01	1.1
Slash	0.4	0.01	0.6

Treatment	Gentle	Moderate	Steep
	--------(tons/ac/yr)--------		
Control	5.1	34	8.3
Seed	1.6	7.4	6.8
Mulch	<0.1	1.5	0.7
Slash	0.1	0.9	0.6

Take-home Points from Skid Trail Studies

- **Overland skidding produced less sediment even on steeper terrain**
- **For erosion control, Mulch and Slash were excellent erosion control BMPs for all studies**
- **Integrating slash may be the best in terms of effectiveness and cost, but few published studies evaluating this exist**
- **Slash must be driven over to make contact with the road, otherwise runoff will flow unimpeded underneath the cover**
- **Slash also discourages unwanted ATV traffic and provides instant cover**

Overall Conclusions from BMP Research

- **BMP problems are often associated with:**
  - **Poor Quality BMPs (poor workmanship)**
  - **Insufficient number of BMPs (not following what's in the recommended BMPs)**
  - **Poor planning and/or lack of understanding**
- **BMPs can be enhanced to reduce sediment associated with forest roads, trails, and stream crossing**
- **BMPs can work well if they are applied correctly and enough of them are implemented**
- **Previous land abuse (particularly in the Piedmont Region) is still causing erosion problems. Proactive measures may be necessary to ensure continued land recovery under forest land use.**
- **Research, education, and outreach should continue to focus on BMPs for stream crossings, truck roads, and skid trails.**

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