Trap Efficiency for Road Storm Runoff Detention in Southern Appalachian Watersheds

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Presentation Outline

- Background
- Methods
- Results
  - Storm Runoff
  - Sediment Control
- Conclusions

Background

- Roads are commonly identified as risk areas for accelerated erosion losses.
- Characteristics of unpaved roads are not optimal for erosion prevention and sediment control.

Background

- Road BMPs have incorporated erosion, sediment, and runoff control principles to minimize road impacts.
  - The lead-off ditch is commonly used to divert and disperse runoff from forest roads.
- Sediment deposition zones can extend into the buffers without some form of sediment control structure.

Background

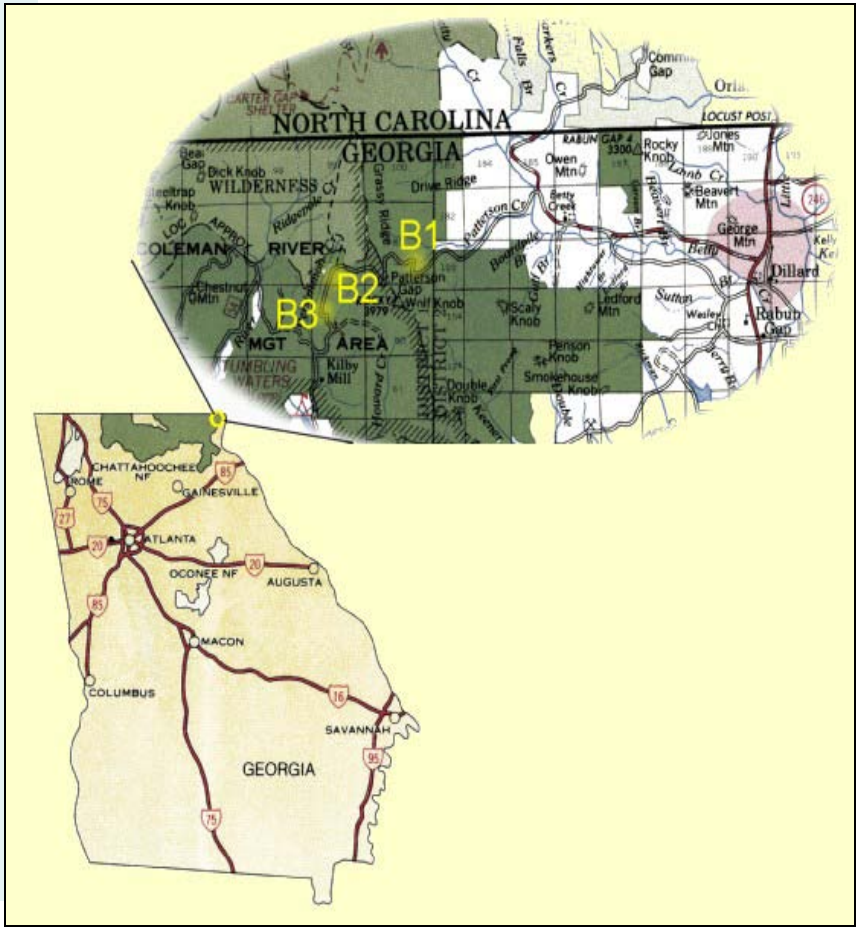
- Structures can trap sediments at the road edge (primary) and reduce the quantity of sediment reaching the forest floor (secondary).
- However, limited work has been undertaken to investigate the influence of road sediment control BMPs on sediment delivery.

Objective

- The objective of this investigation was to determine the trap efficiencies of three sediment control basin designs on an Appalachian road network

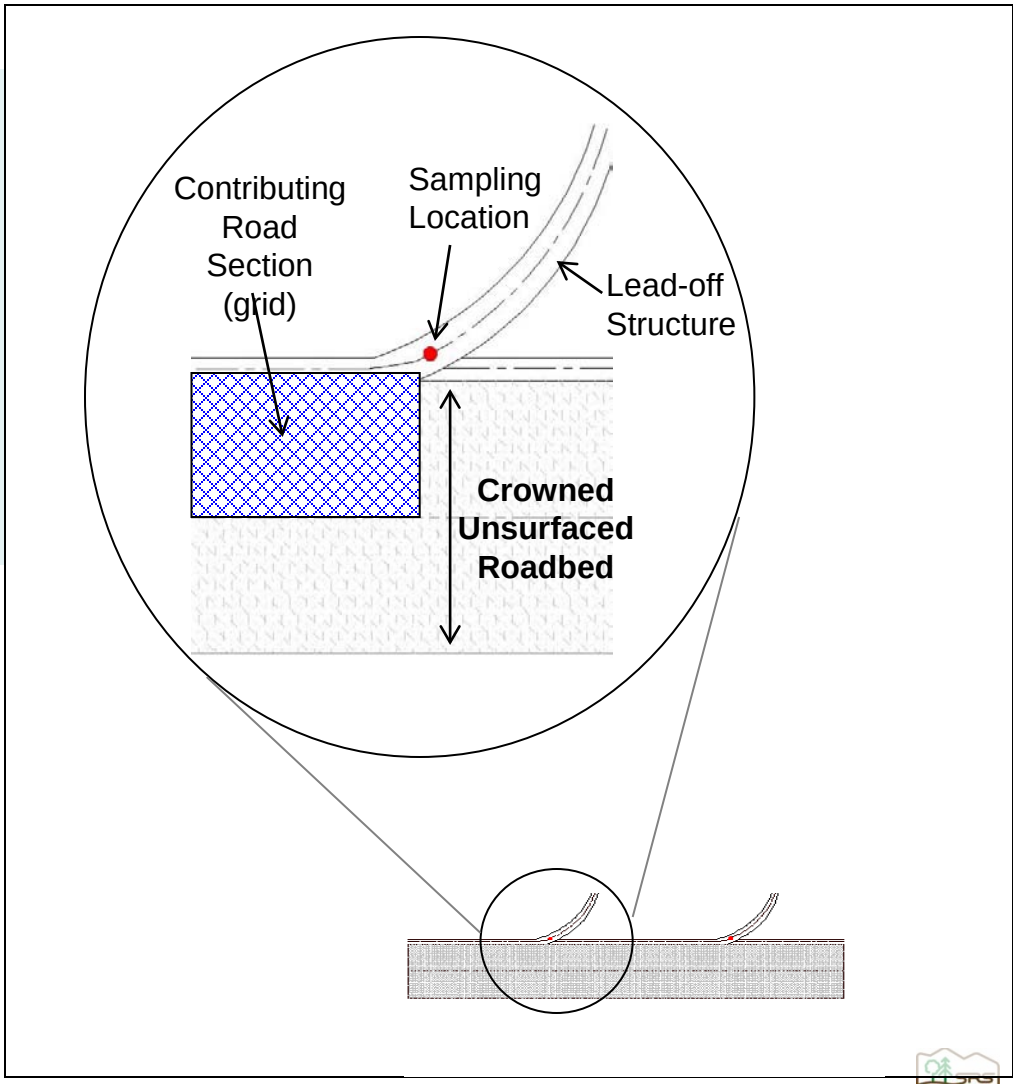
Study Site

- Located within the southern Appalachian Mountains on Chattahoochee National Forest near Dillard, GA
- Elevation = 900 m
- Annual precipitation is 1800 mm
- 25 yr-24hr storm = 220 mm
- Soils were Hayesville series, a fine, kaolinitic, mesic Typic Kanhapludults, surface soil overlaying a clay loam subsoil.



Study Road Sections

- Road Width = 4-6 m.
- Plot length = 50 m.
- Lead-off constructed to drain the road section lengths.
- Peak flow 60 m^3 hr^{-1}.



Monitoring Grading


Site in Winter,
With lead-off breached


Spring Greenery
Lead-off ditch
Rain gage
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Sediment Basin Designs

- Hay-bale check (HB) – bales located perpendicular to the flow path.
- Sediment basin (SB) with rock weir
  – 25 yr - 24hr design capacity.
- Sediment basin w/ riser control (SBR)
  – 25 yr - 24 hr design capacity
  w/ 150 mm riser
- Treatment areas seeded and fertilized

Storm Monitoring (Inlet)

- Structures
  - Trapezoidal Flume: 0.3 m 60^{o} V with a 1.8-m approach section.
- Inlet Flow Measurement
  - Level recorded at 5 min. intervals.
  - Inlet storm water sampler activated with a flow depth of 1 cm to collect composite runoff samples.


Sediment Basin with Riser
Flume with sampler & pressure sensor
2007 . 10 . 15


Sediment Basin with Rocked weir outlet
Pressure Transducer
Pump sampler

Storm Monitoring (Outlet)

- Outlet Flow Measurement
  - 5-to-1 flow divider in combination with a runoff tipping bucket.
  - Accumulated tips recorded at 5-min. intervals with a event logger connected to a magnetic switch mounted at bucket pivot point
  - Storm water samplers activated with a flow depth of 1 cm to collect composite runoff samples.


Hay bale treatment

Observed Precipitation

Exceeded capacity of instruments

Hurricanes Hugo & Ivan

Intensity, mm hr^{-1}

Cumulative Precipitation, mm

0 10 20 30 40 50 60 70 80

0 1000 2000 3000 4000 5000 6000

l/2004 6/1/2004 10/1/2004 2/1/2005 6/1/2005 10/1/2005 2/1/2006 6/1/2006 10/1/2006 2/1/2007 6/1/2007 10/1/2007 2/1/2

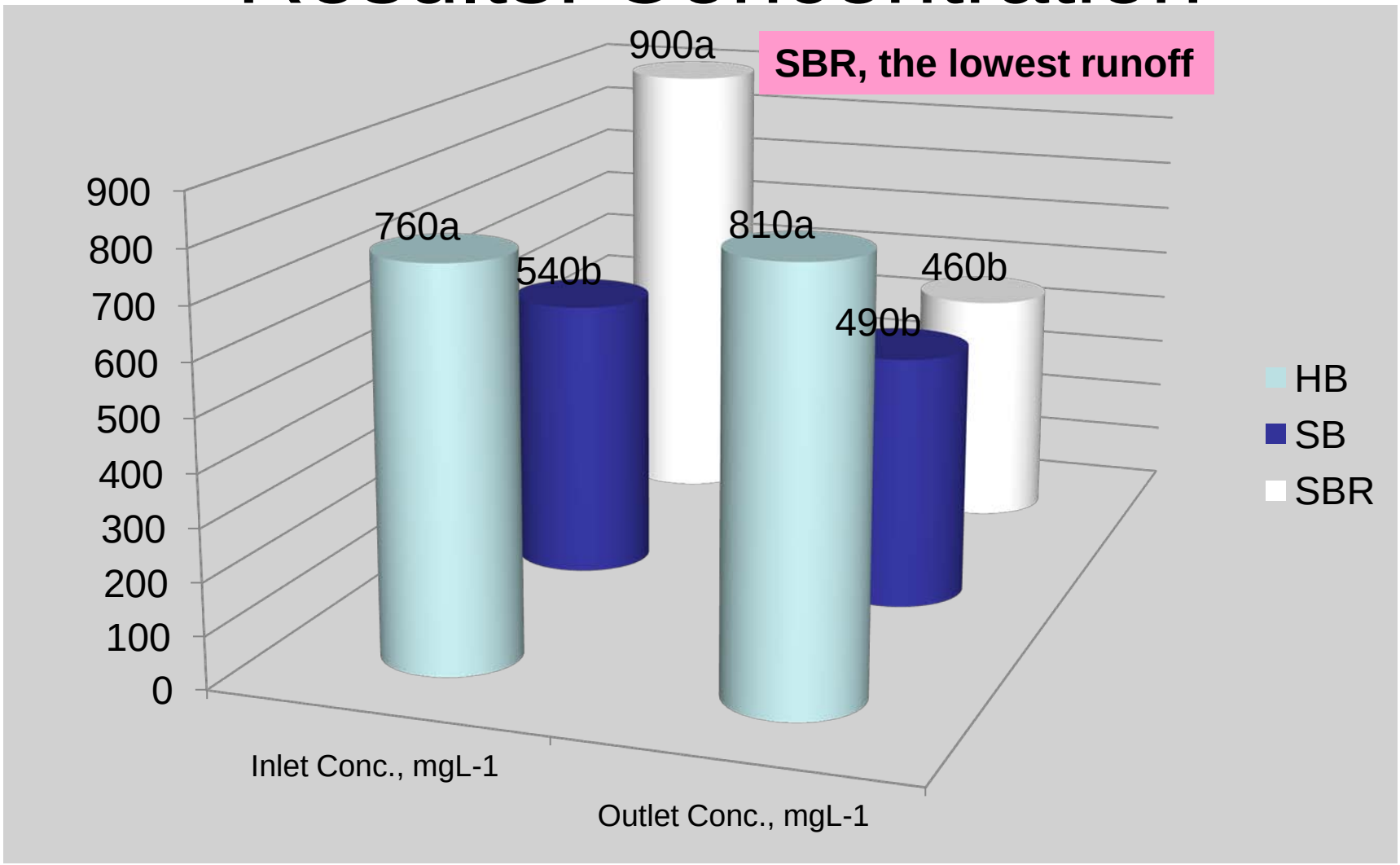
Oct 1, ‘03

Feb 1, ‘08

Results: Runoff

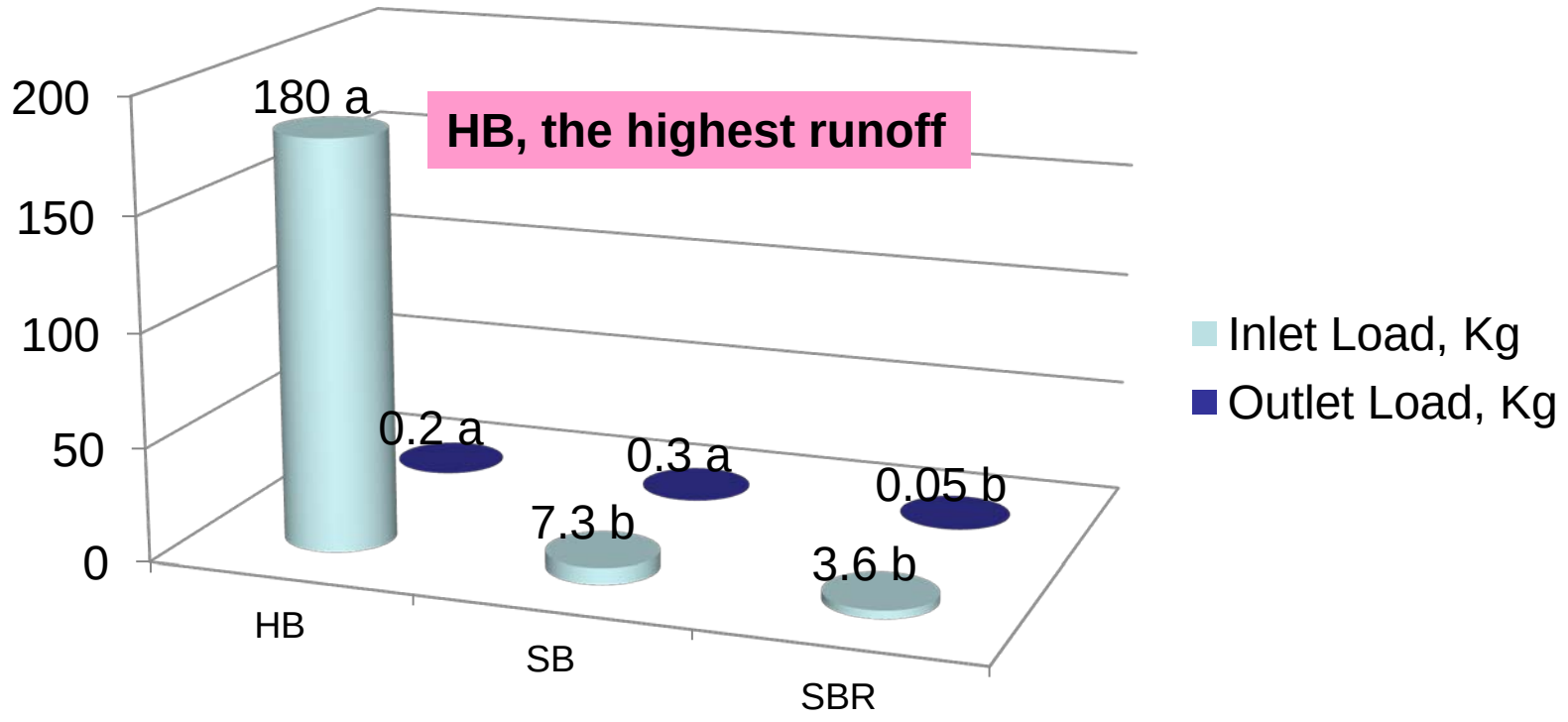
Treatment	Road Runoff / Precip	Inlet Runoff m^3	Outlet Runoff m^3
HB	0.17 (0.26)a	12.9 (104)a	0.39 (2.1)a
SB	0.17 (0.25)a	6.4 (34.8)b	0.54 (1.7)a
SBR	0.17 (0.27)a	4.8 (22.5)b	0.06 (0.3)b

Results: Concentration



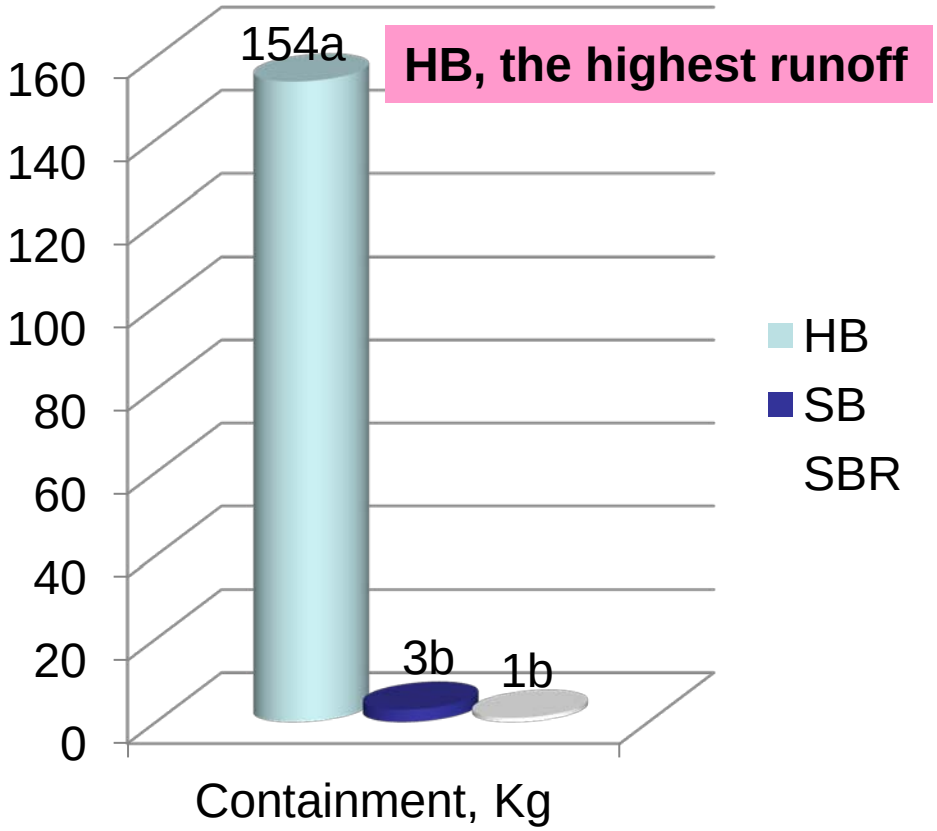
Means with a different letter within a given column were detected as significant at the 0.05 significance level

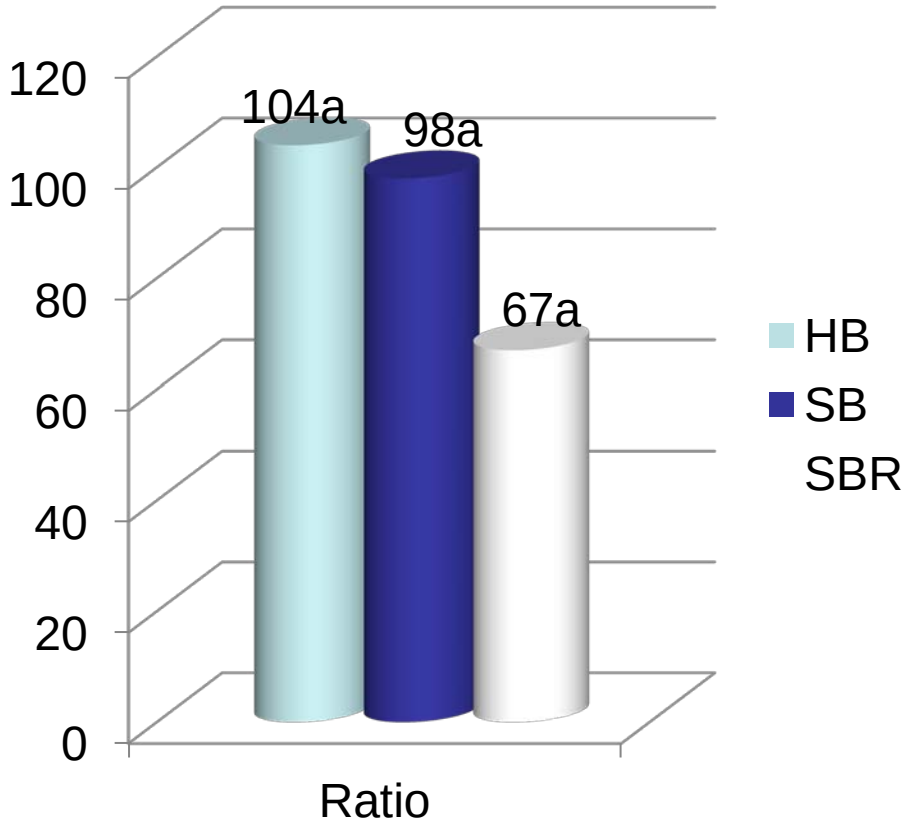
Results: Sediment Delivery



Means with a different letter within a given column were detected as significant at the 0.05 significance level

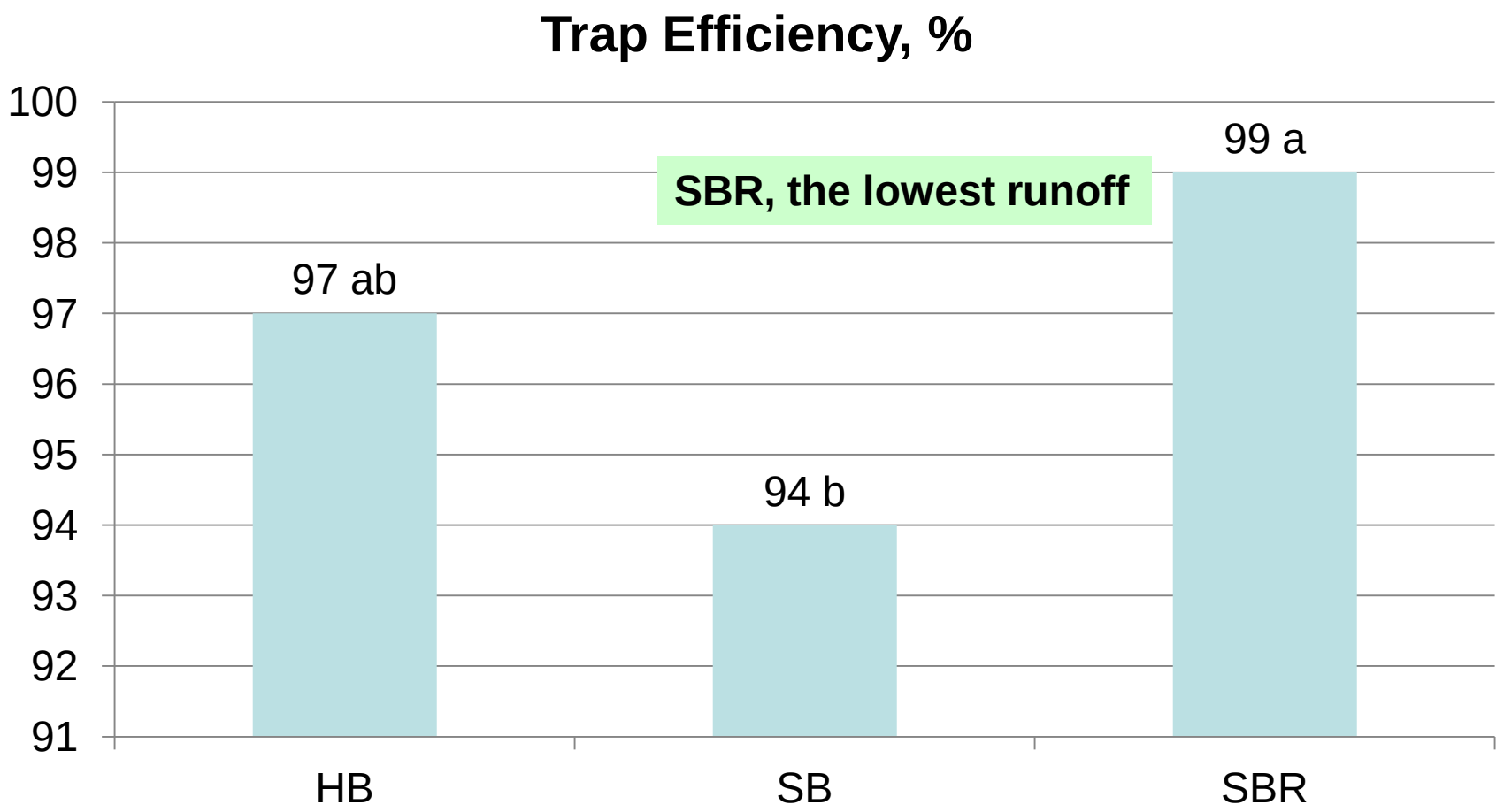
Results: Sediment and Runoff Reduction (Inflow:Outflow)





Means with a different letter within a given column were detected as significant at the 0.05 significance level

Results: Trap Efficiency



Means with a different letter within a given column were detected as significant at the 0.10 significance level

Conclusions

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- Outflow from the sediment basins was less than 2 percent of the inflow.
- Trap efficiencies greater than 90 % were observed on all treatments.
- We conclude that all designs did an outstanding job of reducing road runoff and sediment loads to forest buffers.

What's Next?

- What is needed now?
  Some modeling support.
  - Sources of runoff
  - Effectiveness of WEPP's sediment basin routines

Questions?

Forest Operations Research

G.W. Andrews Forestry Sciences Laboratory

Research & Development

USDA Forest Service