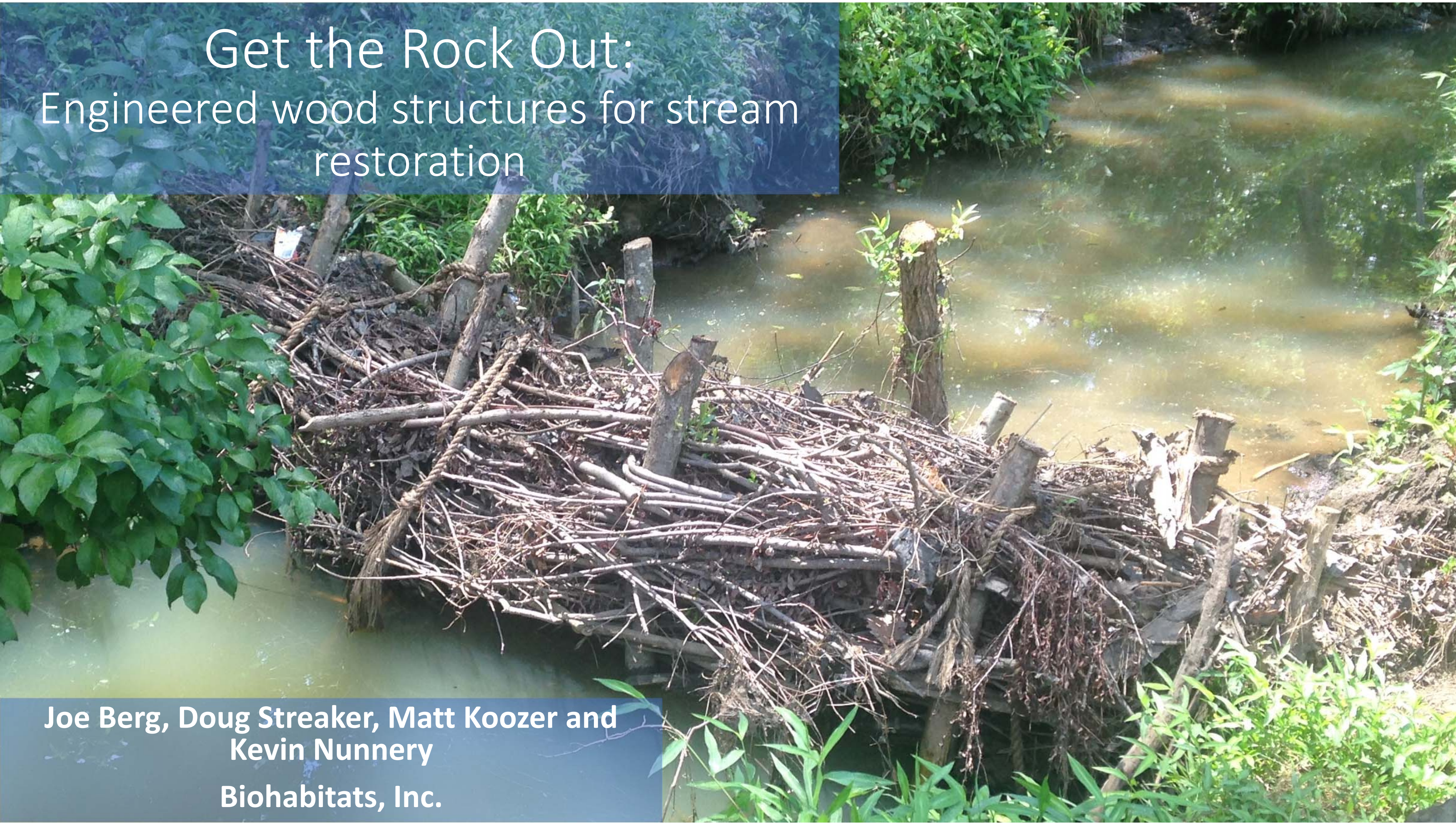


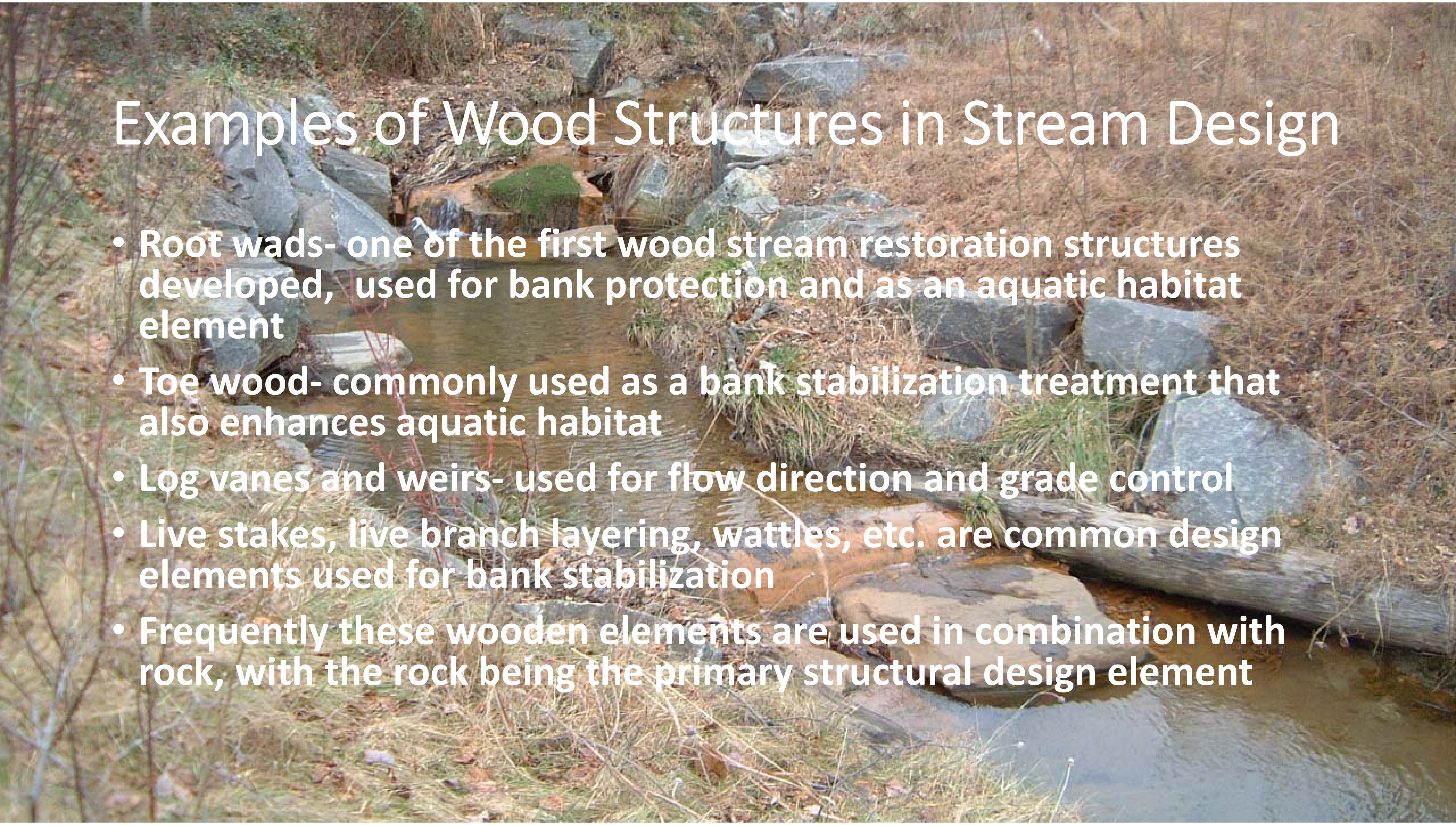
Get the Rock Out:

Engineered wood structures for stream restoration

Joe Berg, Doug Streaker, Matt Koozer and Kevin Nunnery

Biohabitats, Inc.

Examples of Wood Structures in Stream Design

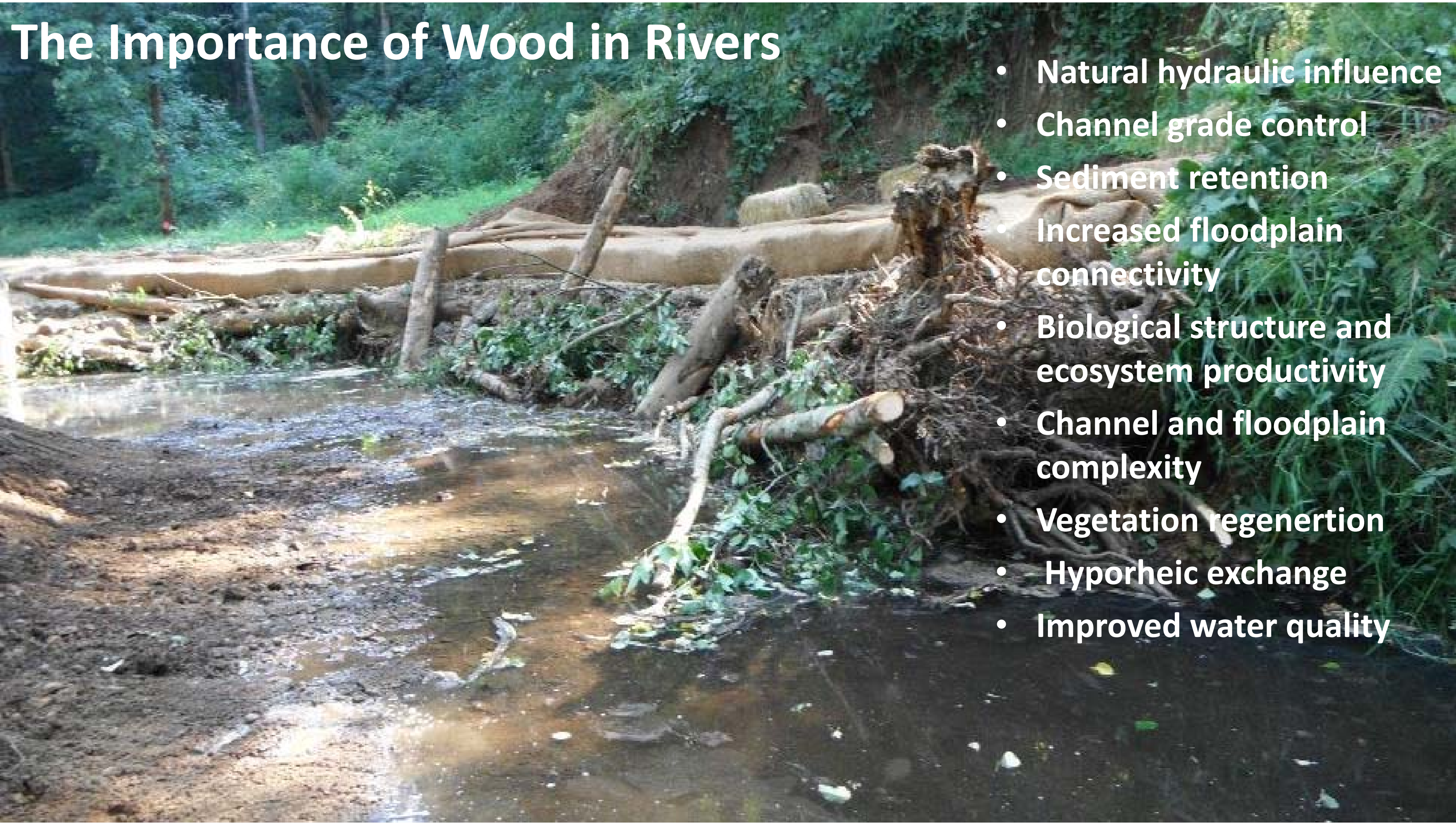


- Root wads- one of the first wood stream restoration structures developed, used for bank protection and as an aquatic habitat element
- Toe wood- commonly used as a bank stabilization treatment that also enhances aquatic habitat
- Log vanes and weirs- used for flow direction and grade control
- Live stakes, live branch layering, wattles, etc. are common design elements used for bank stabilization
- Frequently these wooden elements are used in combination with rock, with the rock being the primary structural design element

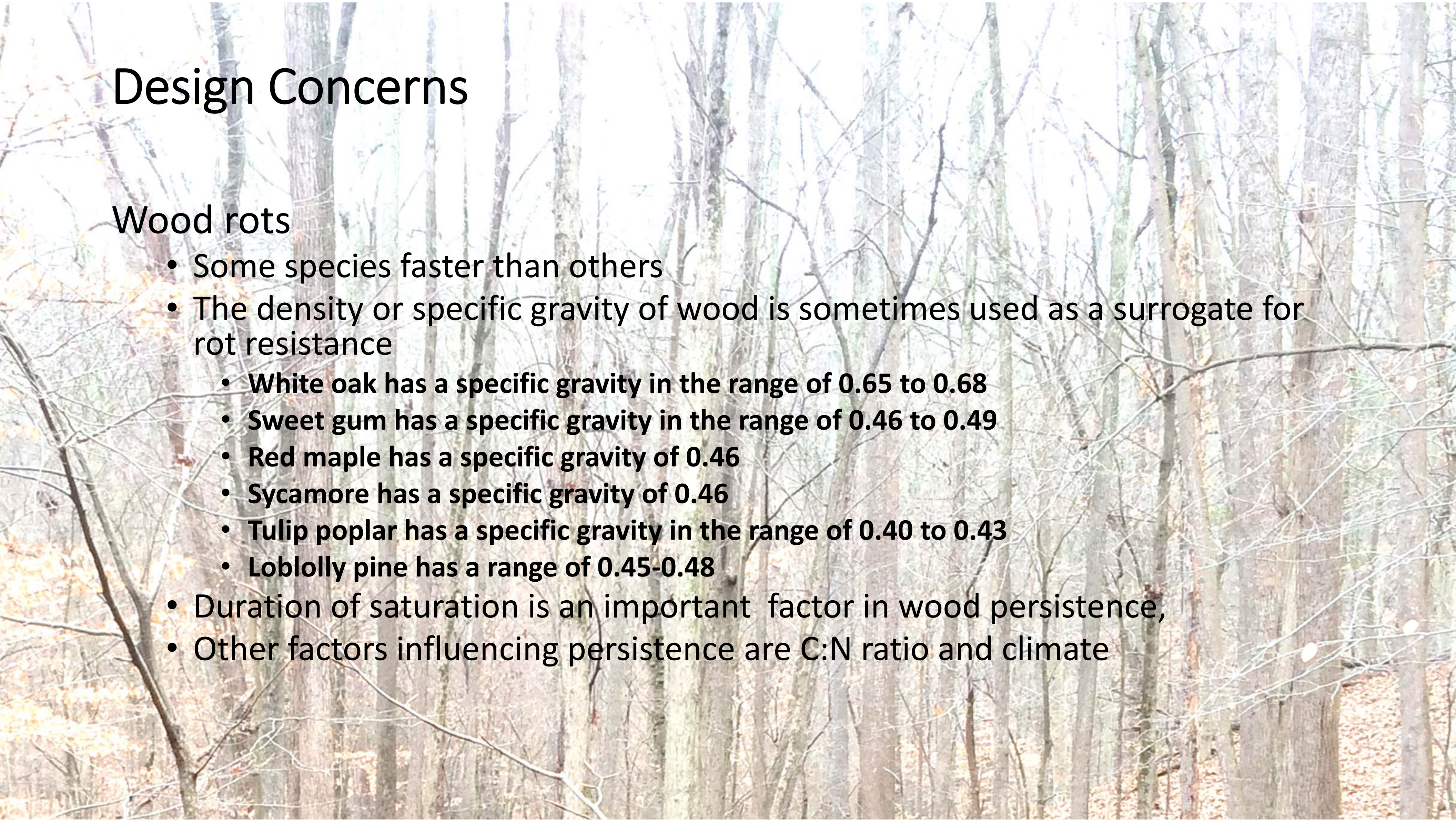
Why Push for Wood?

- It is a natural control in many stream systems
- Often readily available and easy to work with
- Sustainable, regenerative, and renewable
- Supports in-stream hydraulic complexity and biodiversity
- Aids in creating in-stream refugia and habitat

The Importance of Wood in Rivers



- Natural hydraulic influence
- Channel grade control
- Sediment retention
- Increased floodplain connectivity
- Biological structure and ecosystem productivity
- Channel and floodplain complexity
- Vegetation regenertion
- Hyporheic exchange
- Improved water quality



Design Concerns

Wood rots

- Some species faster than others
- The density or specific gravity of wood is sometimes used as a surrogate for rot resistance
  - **White oak has a specific gravity in the range of 0.65 to 0.68**
  - **Sweet gum has a specific gravity in the range of 0.46 to 0.49**
  - **Red maple has a specific gravity of 0.46**
  - **Sycamore has a specific gravity of 0.46**
  - **Tulip poplar has a specific gravity in the range of 0.40 to 0.43**
  - **Loblolly pine has a range of 0.45-0.48**
- Duration of saturation is an important factor in wood persistence,
- Other factors influencing persistence are C:N ratio and climate

Design Concerns

- Wood moves
  - In large watercourses, where channel width is greater than log length by a factor of 2 or more
  - Wood does not move much in small streams, where channel width is a fraction of log length
  - Buoyancy is an critical characteristic to wood retention in large systems

Design Advantages

- Wood accumulates
  - In a well connected riparian area, wood accumulates in the channel, and as these “structures” decay, they are regenerated elsewhere in the channel
  - On many sites wood production exceeds wood decomposition
  - Fine wood and leaf litter are contributed on an annual basis
  - Large wood contributes to increased channel hydraulic complexity = enhanced habitat
- Wood supports aquatic life
  - High surface area to volume and effectively traps leaf material, supports invertebrates
  - Provides shelter and feeding areas for fish, reptiles and amphibians

Expanding Research Exploring Wood in Streams

North American Journal of Fisheries Management 19:687–695, 1999
© Copyright by the American Fisheries Society 1999

Effects of Immersion in [illegible]
Five Species of Trees Used for Habitat Enhancement Projects

Robert E. Bilby,*[1] John T. Heffner, Brian R. Fransen, and
James W. Ward

Weyerhaeuser Company, Western Forestry Research,
WTC 1A5, Tacoma, Washington 98477-0001, USA

Peter A. Bisson

U.S. Forest Service, Pacific Northwest Research Station, Olympia Forestry Sciences Laboratory,
3625 93rd Avenue South West, Olympia, Washington 98512-9193, USA

NRC Research Press

PERSPECTIVE

Wood placement in river restoration: fact, fiction, and future direction

Philip Roni, Tim Beechie, George Pess, and Karrie Hanson

Ecological Applications, 11(1), 2001, pp. 191–202
© 2001 by the Ecological Society of America

THE RESIDENCE TIME OF LARGE WOODY DEBRIS
IN THE QUEETS RIVER, WASHINGTON, USA

Timothy L. Hyatt[1,3] and Robert J. Naiman[2]

Using Beaver Dams to Restore Incised Stream Ecosystems

MICHAEL M. POLLOCK, TIMOTHY J. BEECHIE, JOSEPH M. WHEATON, CHRIS E. JORDAN, NICK BOUWES,
NICHOLAS WEBER, AND CAROL VOLK

J. N. Am. Benthol. Soc., 2004, 23(2):189–197
© 2004 by The North American Benthological Society

Breakdown rates of wood in streams

Bernd Spänhoff[1] and Elisabeth I. Meyer[2]

Freshwater Biology (2002) 47, 601–619

Large wood and fluvial processes

A. M. GURNELL*, H. PIÉGAY†, F. J. SWANSON‡ and S. V. GREGORY§

Environmental Manageme
DOI 10.1007/s00267-008-

ENVIRONMENTA

Rehabilitating Agricultural Streams in Australia with Wood: A Review

Rebecca E. Lester · Andrew J. Boulton

Breakdown and invertebrate colonization of dead wood in wetland, upland, and river habitats

A. Braccia and D.P. Batzer

Can. J. For. Res. 38: 2697–2704 (2008)

Recent advances quantifying the large wood dynamics in river basins: New methods and remaining challenges

Virginia Ruiz-Villanueva[1,2], Hervé Piégay[3], Angela M. Gurnell[4], Richard A. Marston[5], and Markus Stoffel[1,2,6]

Design Considerations

- Two Approaches
  - Higher number of more simply engineered wood structures
  - Smaller number of highly engineered wood structures
- In small channels, a greater number of simple structures can yield better results
  - Any one structure is less likely to fail, each is supported by adjacent structures
  - Projects are more robust and resilient
  - Channel has greater habitat complexity
- In large channels, highly engineered structures are necessary to accumulate more wood and withstand the channel's ability to transport logs

National Large Wood Manual

Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure

January 2016

U.S. Department of the Interior
Bureau of Reclamation

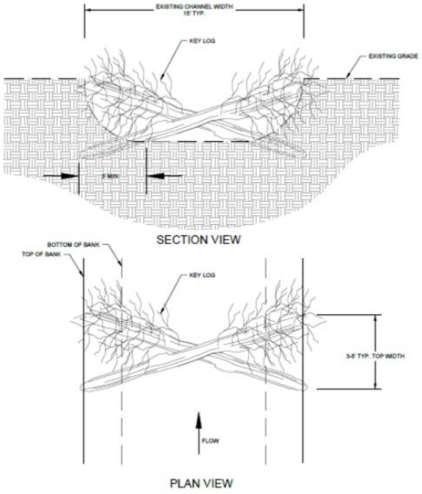
US Army Corps of Engineers®
Engineer Research and Development Center

Hickey Run, National Arboretum, DC

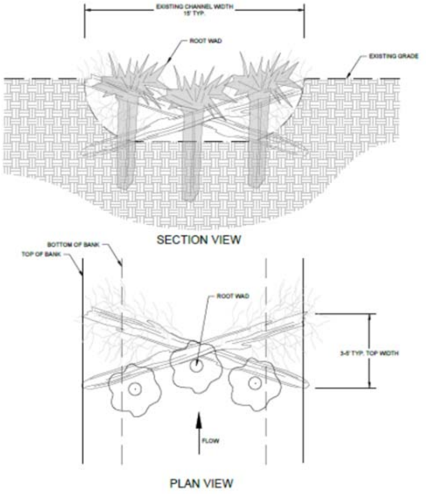
- Using wood pile and stone riffle structures to:
  - minimize forest debris from blocking culvert openings
  - Reconnect riparian area to storm flows
  - increase aggradation of sediments to protect sewer infrastructure

Bacon Ridge
Anne Arundel County, MD

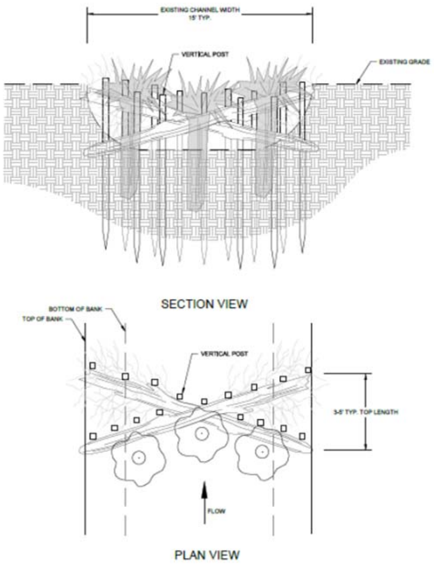
- ~4,000-lf stream restoration using ~54 engineered wood structures
- 1st and 2nd order stream channels in a more rural County Park



LOG JAM

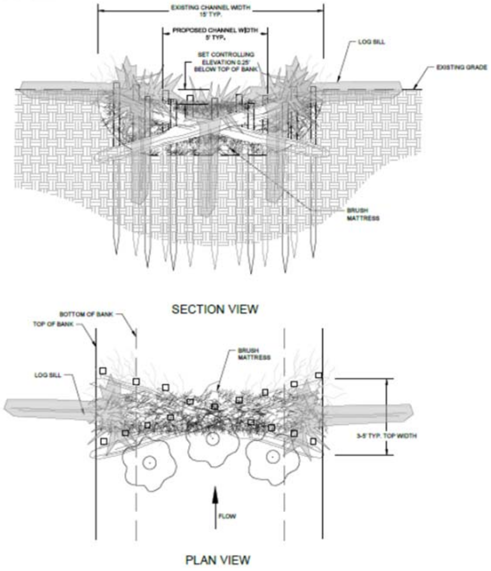


LOG JAM



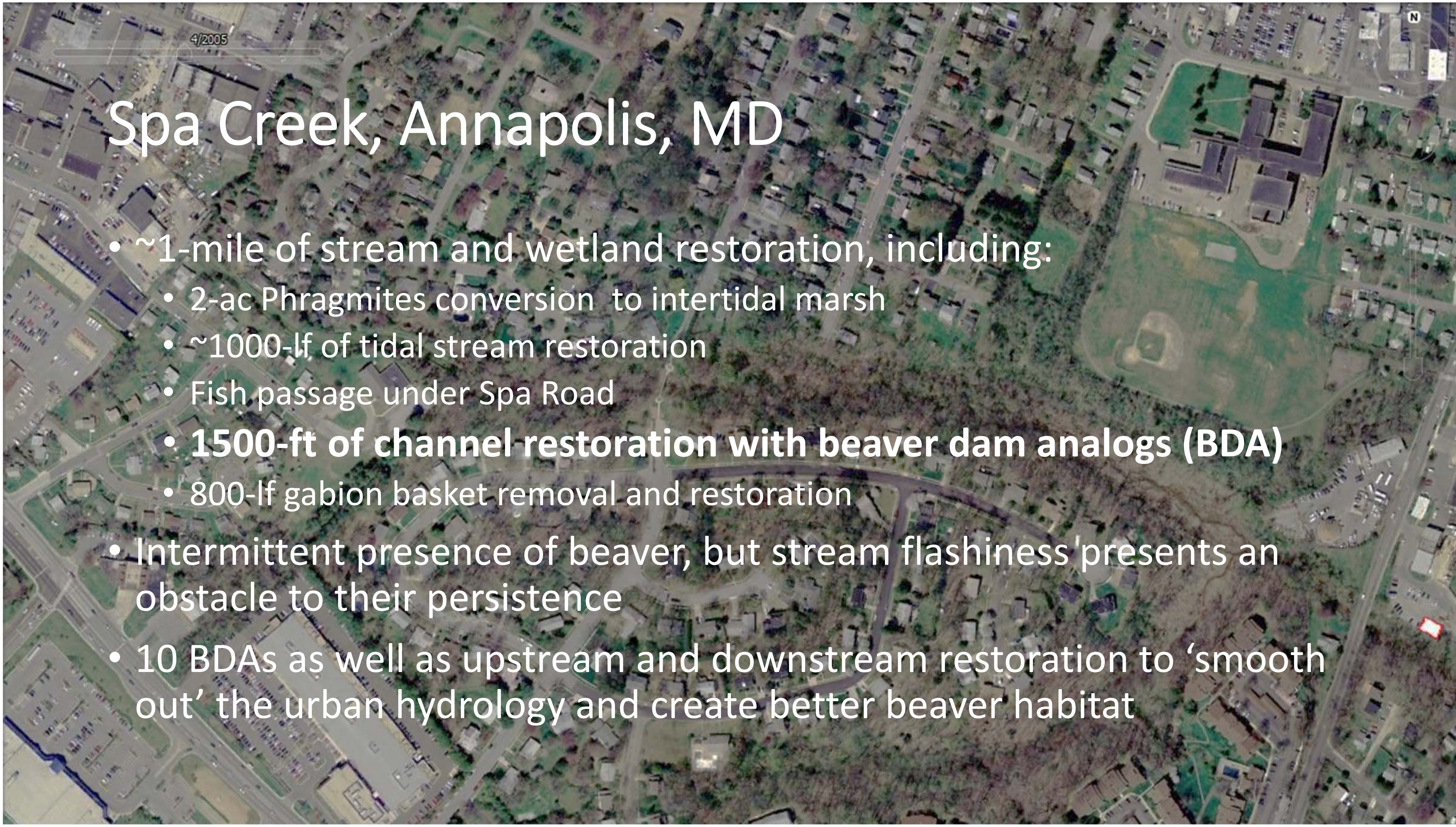
LOG JAM
3. INSTALL VERTICAL POSTS

NOT TO SCALE



LOG JAM
4. INSTALL SILLS & BRUSH MATTRESS

NOT TO SCALE



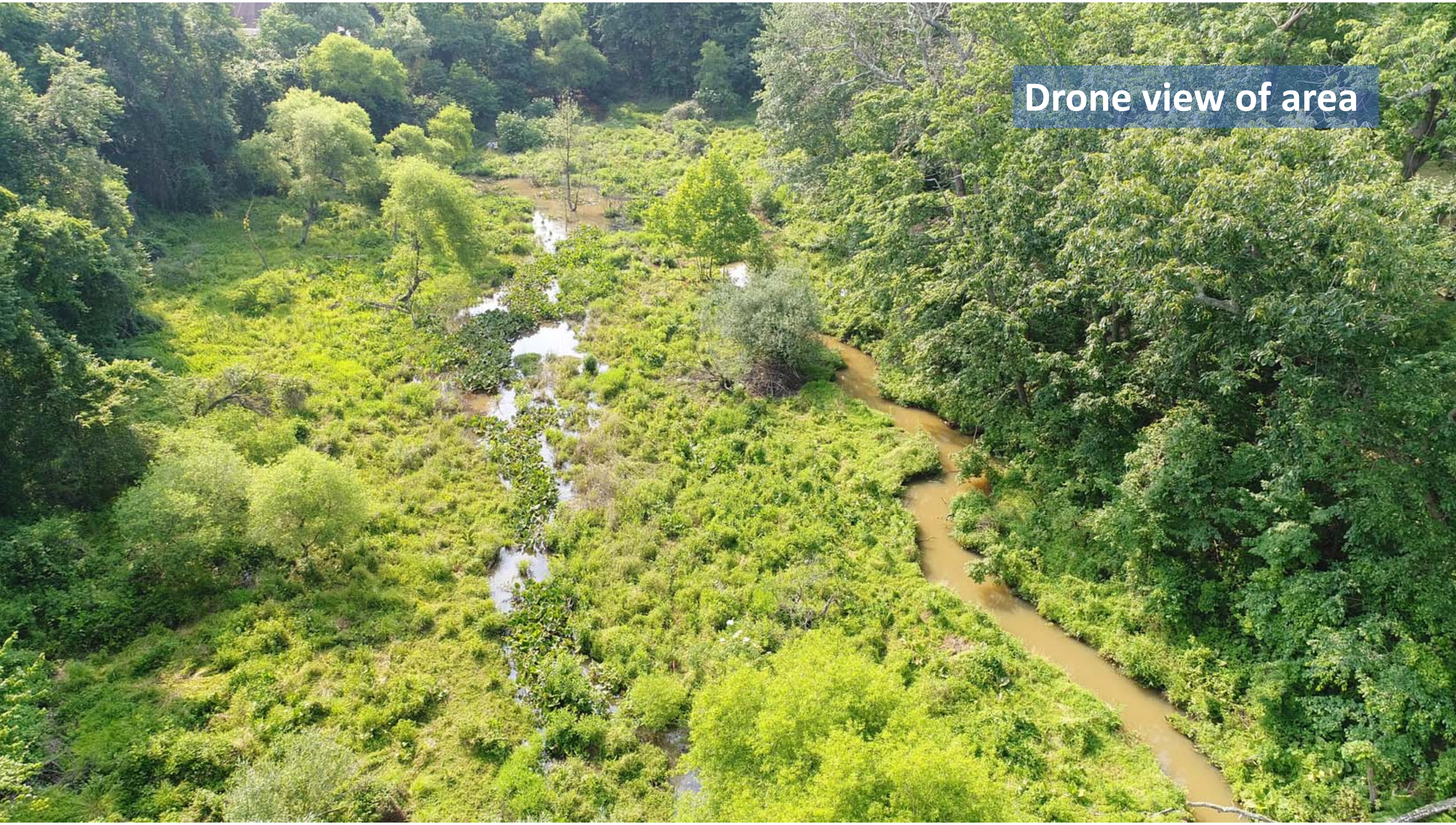
Spa Creek, Annapolis, MD

- ~1-mile of stream and wetland restoration, including:
  - 2-ac Phragmites conversion to intertidal marsh
  - ~1000-lf of tidal stream restoration
  - Fish passage under Spa Road
  - **1500-ft of channel restoration with beaver dam analogs (BDA)**
  - 800-lf gabion basket removal and restoration
- Intermittent presence of beaver, but stream flashiness presents an obstacle to their persistence
- 10 BDAs as well as upstream and downstream restoration to ‘smooth out’ the urban hydrology and create better beaver habitat


CAMERA 1
11 DEC 2016 07:21 pm
CAMERA 1
11 DEC 2016 10:03 pm

Newly installed in 5-ft incised channel

One month later, water surface 3-ft higher



Drone view of area

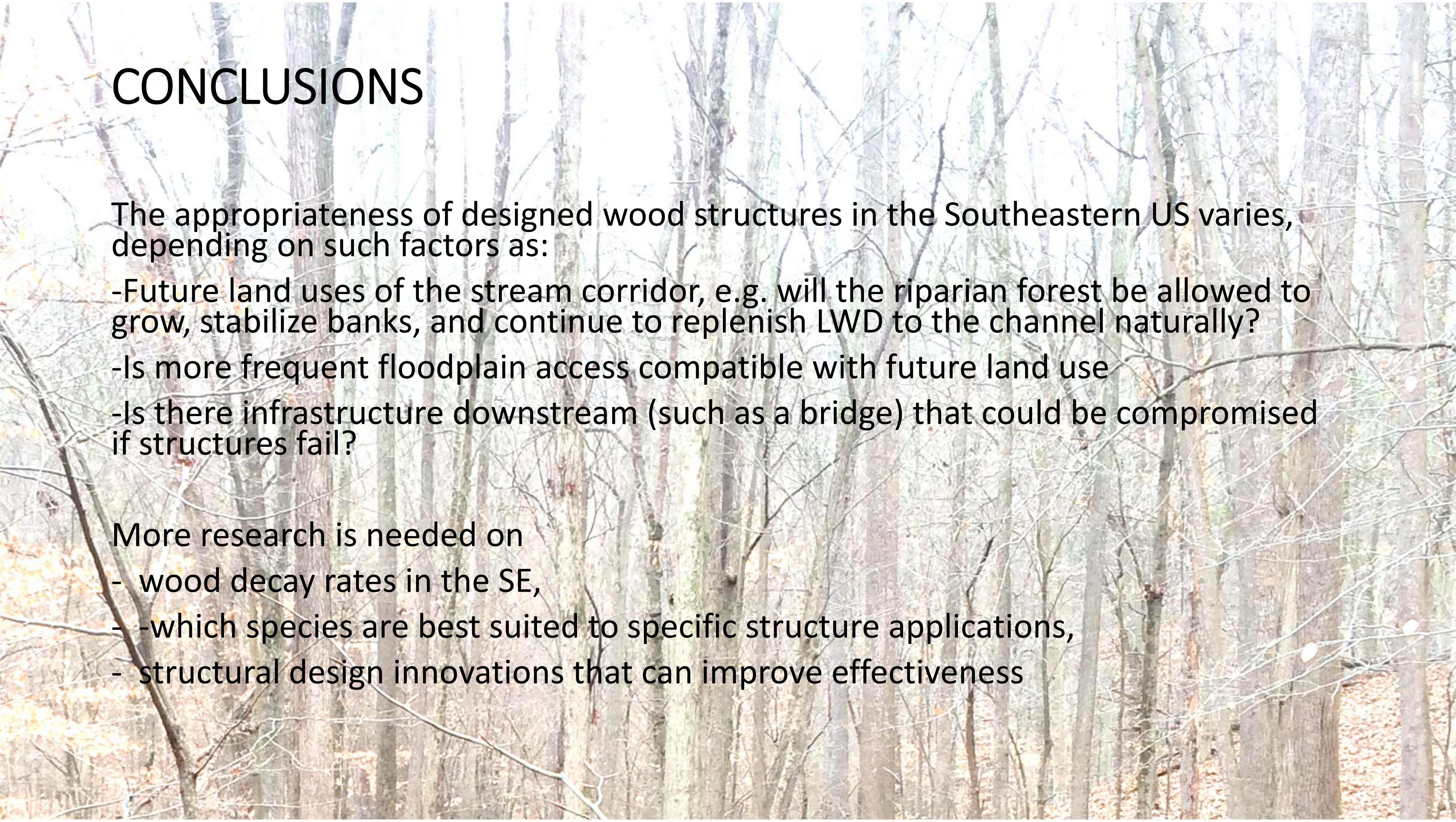
Costs

Traditional Rip Rap/Gabion Treatments

- $259 per linear foot
- Includes excavation, geotextile fabric, granular rock bedding, rip rap, installation, plating, DOT specs

LWD/Natural Bank Design

- $186 per linear foot
- Includes excavation, logs, boulders, hardware, coir fabrics, vegetation



CONCLUSIONS

The appropriateness of designed wood structures in the Southeastern US varies, depending on such factors as:

-Future land uses of the stream corridor, e.g. will the riparian forest be allowed to grow, stabilize banks, and continue to replenish LWD to the channel naturally?

-Is more frequent floodplain access compatible with future land use

-Is there infrastructure downstream (such as a bridge) that could be compromised if structures fail?

More research is needed on

- wood decay rates in the SE,
- -which species are best suited to specific structure applications,
- structural design innovations that can improve effectiveness