STREAM SYSTEMS TECHNOLOGY CENTER

STREAM NOTES

To Aid In Securing Favorable Conditions of Water Flows

Rocky Mountain Research Station **January 2005**

A Guide to Identification of Bankfull Stage in the Northeastern U.S.

Consistent identification of bankfull stage is essential for stream evaluations, stream restoration, fish habitat assessments, and stream-related design and construction. To help with this critical task, the Stream System Technology Center has just issued new training material presented in a series of learning modules on four CD-ROM disks. The ***Guide to Identification of Bankfull Stage in the Northeastern United States*** is available from the Rocky Mountain Research Station as General Technical Report RMRS-GTR-133-CD (figure 1).

The bankfull stage training program demonstrates basic techniques of bankfull identification on a range of stream types typically found in the northeastern United States. The material is presented in the format of a narrated PowerPoint slide show that has embedded video clips recorded at 20 different stream sites.

The CD-ROMs include a historical perspective on the origin of bankfull concepts from Luna Leopold. It reviews the fundamental scientific principles behind bankfull discharge, and since much of the material is presented in the context of the Rosgen Stream Classification System, provides a brief overview. Finally, uses of bankfull stage information are demonstrated in practical field applications, such as stream-related construction and natural channel design. The CD-ROM ends with a summary of important concepts and a catalogue of stream sites that the user can use as a self-test to see how well bankfull identification skills have been learned.

The principal technical presenter of this material is **Elon S. "Sandy" Verry**, retired Research Hydrologist, North Central Research Station, who organized and developed the majority of the material. Retired USGS Research Hydrologist **Bill Emmett**, provided technical review and a number of Forest Service personnel from Research Stations and National Forests provided geographically focused demonstrations in the field. Forest Service presenters include hydrologists **Dale Higgins**, Chequamegon-Nicolet NF, **Barry Edgerton**, Monongahela NF, **Pam Stachler**, Wayne NF, **Mark Riedel**, Southern Research Station, and aquatic biologists **Steve Roy**, Green Mountain and Finger Lakes NF, and **Scott Snelson**, Superior NF.

STREAM NOTES *is produced quarterly by the Stream Systems Technology Center located at Rocky Mountain Research Station, Fort Collins, Colorado.*
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John Potyondy, Program Manager

The **PRIMARY AIM** *is to exchange technical ideas and transfer technology among scientists working with wildland stream systems.*

CONTRIBUTIONS *are voluntary and will be accepted at any time. They should be typewritten, single-spaced, and limited to two pages. Graphics and tables are encouraged.*

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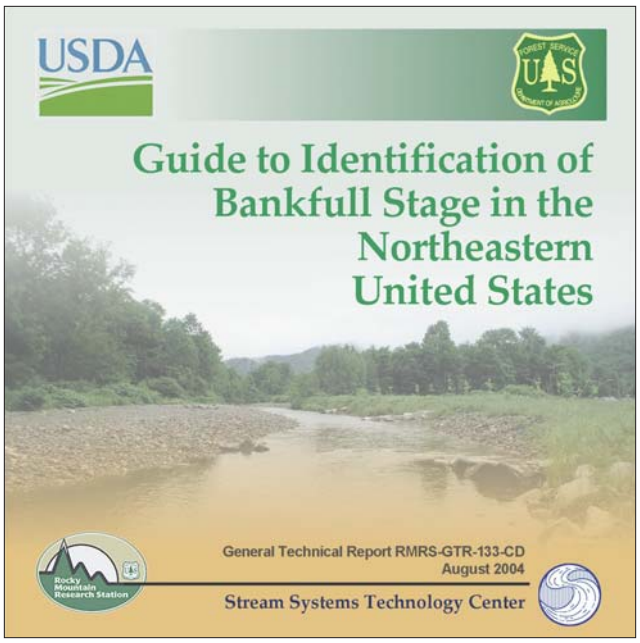

Figure 1. The CD-ROM cover design for the bankfull identification guide.

After viewing the material the viewer should have the following essential bankfull identification skills:

- Ability to get a "big picture" of the topography of a watershed with respect to bankfull;
- Ability to understand past and present land uses on the watershed and how this effects bankfull determinations;
- Ability to make use of available data to know where to look for bankfull indicators before heading for the field;
- Skills of observation in recognizing and differentiating bankfull depositional features in the field; and
- Ability to collect and evaluate data to confirm the correctness of field bankfull identification.

The training material progresses from the identification of bankfull stage in simple setting, where fundamental concepts are illustrated (figures 2 and 3), to more difficult and challenging settings such as incised channels, bankfull stage in channels undergoing land use changes, bankfull features at stream confluences, and the identification of bankfull stage at sites below dams and reservoirs. The material provides cautions, advice, and suggestions for identifying the correct bankfull surfaces and demonstrates how to do this in the field in short video clips.

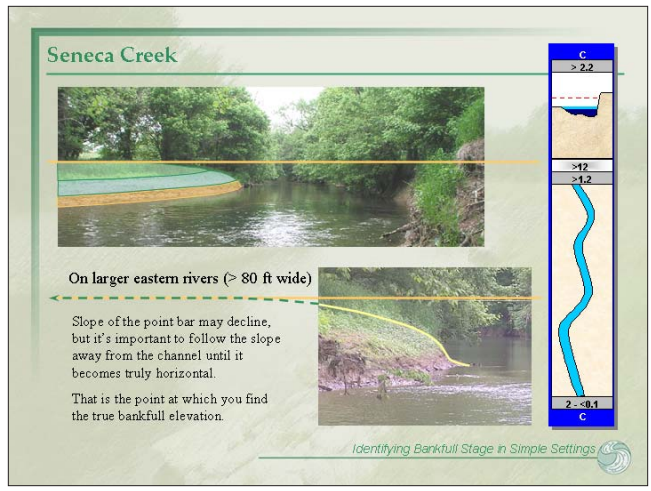

Figure 2. Seneca Creek near Rockville, Maryland, is used to illustrate how to identify bankfull stage in a simple channel having classical alluvial features. The sidebar shows a typical cross-section, plan view, and characteristics of a meandering Rosgen C-channel type. C channels are alluvial channels that readily build point bars and floodplains by deposition. In these channel types, the flat horizontal depositional surface at the top of a point bar corresponds to bankfull discharge and bankfull stage is located well back in the trees and vegetation where the surface becomes completely horizontal.

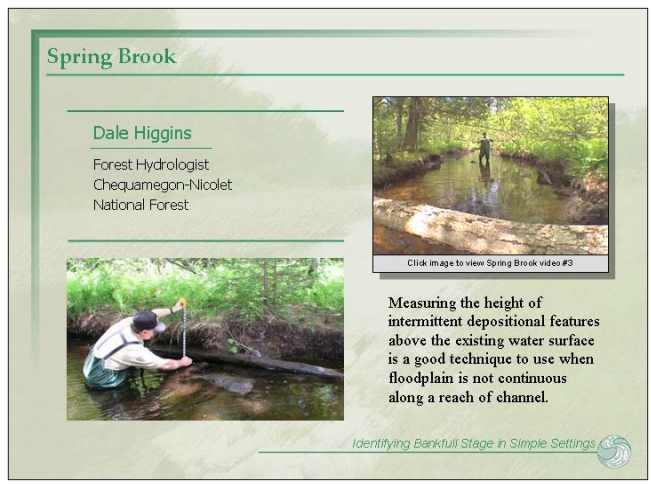

Figure 3. Forest Hydrologist Dale Higgins demonstrates how to determine bankfull stage in a sand-bedded wetland stream, Spring Brook near Ashland, Wisconsin. The procedure involves measuring up from the existing water surface to the most consistent flat depositional surface intermittently found along the hummock and hollow topography typical of these wetland streams. The procedure typically requires removing streamside grasses to reveal the sandy depositional features below.

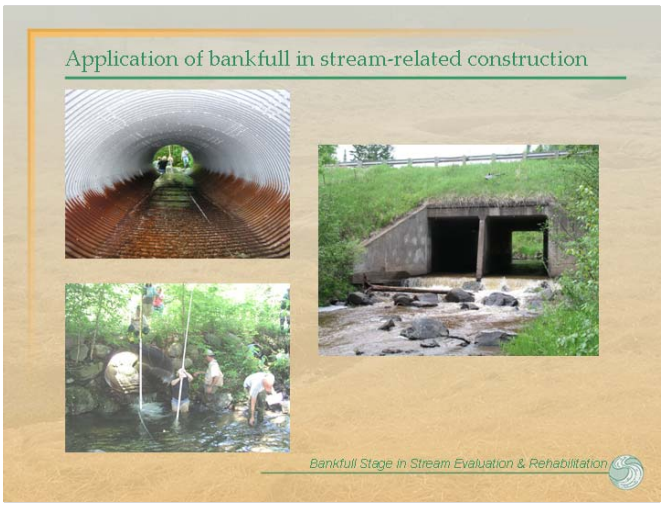

Figure 4. One of the CD-ROMs provides guidelines for the use of bankfull stage in stream-related construction activities.

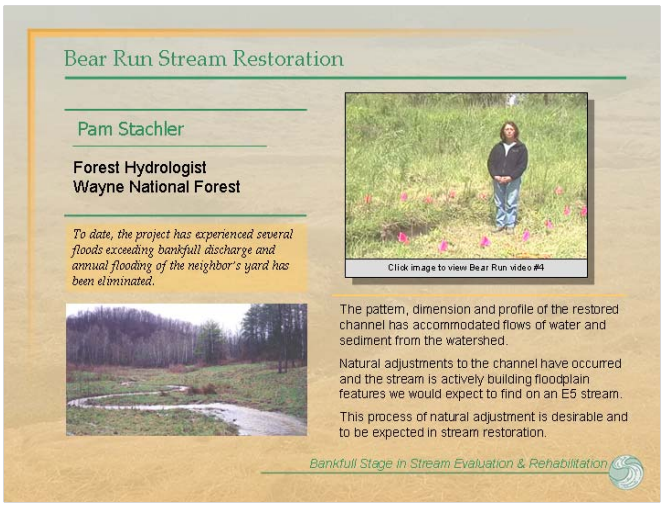

Figure 5. Forest Hydrologist Pam Stachler discusses how bankfull information was applied to the restoration of Bear Run, a stream heavily impacted by excessive sediment and aggradation that was restored to a more stable pattern, dimension, and profile using natural channel design principles.

Figure 6. A short section near the end of the CD-ROMs summarizes and reviews all of the important bankfull concepts discussed in previous sections.

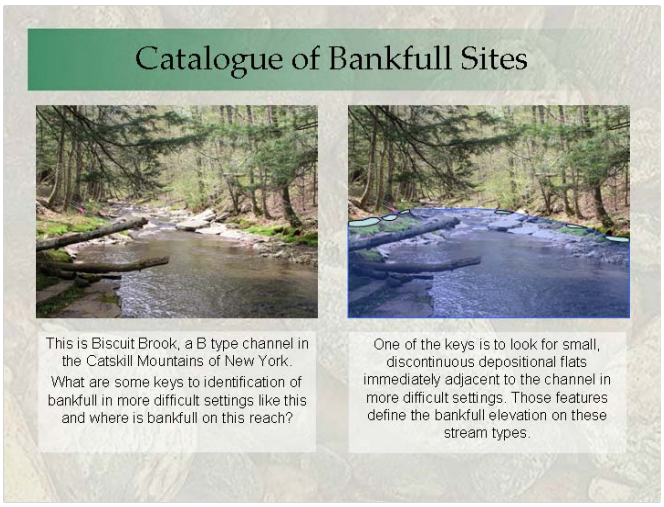

Figure 7. A catalogue of bankfull sites at the end of the CD-ROMs can be used as a self-test of how well bankfull identification has been learned. Viewers are shown a stream channel, asked a question, and can then instantly see if they have correctly identified the bankfull surfaces.

The CD-ROMs also discuss application of bankfull stage in stream-related construction activities (figure 4), natural channel design (figure 5) and ends with a summary of key concepts (figure 6) and a self-test of bankfull identification skills (figure 7).

The program will play on any IBM multimedia PC with a CD-ROM drive, sound card, and a mouse. The program is structured on 4 CD-ROMs so that it can be played individually at the pace of the viewer or viewed in its entirety at one time. The CD-ROM set is intended as a complement to the Stream Systems Technology Center video, **Identifying Bankfull Stage in Forested Streams in the Eastern United States** (U.S. Forest Service 2002).

Copies of the CD-ROMs have been mailed to National Forests and Research Stations. Copies are also available upon request from STREAM by e-mailing your name and mailing address in label format to rmrs_stream@fs.fed.us.

Large Wood for Stream Habitat Restoration in Sand-bed Channels: Harder Than It Looks!

by F. Douglas Shields, Jr. and Scott S. Knight

Structures made from large wood (LW) material have been used for controlling stream erosion for many decades and are increasingly being used to restore or rehabilitate stream habitats. Incising, sand-bed streams provide a particularly rigorous test of the large wood approach due to widely varying flows and rapid erosion and sedimentation common to such systems.

Warmwater streams in the Southeastern United States have remarkably high levels of biodiversity and are important ecological resources, but much of the fauna is imperiled by habitat degradation. Channel incision, a worldwide problem occurring in both urban and rural landscapes, is one of the most pernicious drivers of current stream habitat degradation. In the absence of bedrock or large bed material, incision triggers explosive channel erosion, with width rapidly increasing three- to six-fold, and elevating watershed sediment yield by an order of magnitude (Shields et al. 1995). Fish communities shift toward patterns typical of small, hydrologically unstable headwater streams, with populations dominated by small-bodied, short-lived opportunists (Shields et al. 1998).

Stabilization of incising, warmwater streams can prompt partial recovery of fish communities, particularly when the structures and methods used are designed to address habitat-limiting factors (Shields et al. 1998). LW exerts a major influence over stream morphology in unmanaged fluvial systems and is an important component of aquatic habitat in warmwater streams.

Stabilization of eroding banks or habitat rehabilitation using structures composed entirely or partially from LW has been described for streams in many parts of the U.S., Canada, and Australia (Shields et al. 2004). However, placing structures in incised, sand-bed channels of smaller streams presents a different set of challenges. In addition to basic differences in ecology, available wood tends to be smaller. Material coarser than fine gravel for ballast is unavailable and channel

Figure 1. Typical meander bend along Little Topashaw Creek, Mississippi shown just prior to, during, and six months after placement of large wood structures.

erosion rates (relative to channel width) are higher. Channel width-depth ratios are an order of magnitude smaller (typically <10), so storm flows tend to be deep, and structures are more frequently submerged. Since LW rapidly decomposes in humid, temperate climates (Roni et al. 2002), long-term success is contingent upon the creation of suitable habitat for plants that will secure and stabilize the channel margins over the longer term (Jacobson et al. 1999).

In order to test concepts for low-cost rehabilitation of habitats associated with a severely incised, meandering sand bed stream, we constructed 72 LW structures along eroding banks of an incised, sand-bed stream (figure 1). We monitored fishes and their habitats before and after construction within the modified reach, upstream, and downstream for a total of five years. We also monitored the response of the stream channel and the status of the LW structures. Findings should be relevant to those interested in restoring similar and less severely disturbed stream systems.

Methods

We selected a 2-km reach of Little Topashaw Creek, a 37 km^2 fourth-order stream in north central Mississippi to meet the criteria of rapid bank erosion driven by incision processes, sandy bed material, an abundant supply of bed material from upstream, sources of LW for construction, sufficient channel width, nearby sources of native plant and animal colonists, and an aquatic ecosystem clearly limited by lack of pool and woody debris habitat components. One of the most important criteria was that the reach had to be in an advanced stage of incised channel evolution (Simon 1989), which implied that bed erosion processes would be relatively minor and that deposition of sediments derived from upstream incision would occur adjacent to eroding banks, especially when encountering introduced LW.

Seventy-two LW structures were constructed along 1500 m of eroding bank using woody debris or harvested trees (Shields et al. 2004). Within-channel LW loading was increased by a factor of 20. During the first winter following construction, about 4,000 black willow (*Salix nigra*) cuttings were planted on point bars and in sediment deposits. Effects of modification on physical habitat quality and fish were quantified by semiannual sampling at base flow during 1999-2003 inclusive.

Results

During the first year following construction, only 4 of the 72 structures failed. However, after three years, 36% of the structures were destroyed, and 35% were damaged (table 1). Initially, local scour adjacent to the structures and backwater from small beaver dams resulted in greater baseflow depths and higher levels of habitat heterogeneity based on the variances of water width and depth. Mean water depth in the treated reach was 2-4x that in the untreated downstream reach. However, as LW structures failed, conditions in the treated and untreated reaches converged.

Fish numbers (catch per unit of effort) and species richness increased following LW addition in both treated and untreated reaches, but differences between the two reaches were not significant ($p > 0.1$) (figure 2). These responses were consistent with previous observations and a conceptual model of response to

	As built (2000)	After one year (2001)	After two years (2002)	After three years (2003)
No. of remaining structures	72	68	50	46
No. of remaining structures located in bends	39	38	30	27
No. of remaining structures located in straight reaches	33	30	20	19

Table 1. Number of large wood structures remaining 1, 2, and 3 years after installation.

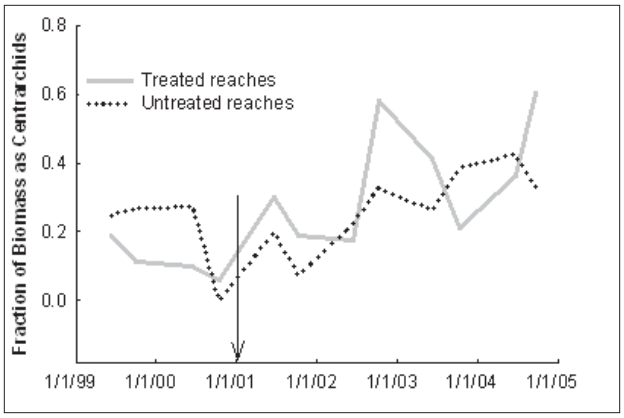

Figure 2. Relative abundance (biomass) of centrarchids in treated and untreated reaches of Little Topashaw Creek before and after LW addition. Approximate date for LW addition is shown by the vertical arrow.

addition of pool habitats in incising warmwater streams—patterns of relative abundance shifted toward those typical of less-degraded streams (Shields et al. 1998).

Conclusions

Since lightly degraded sand bed streams typically contain high levels of LW, rehabilitation of damaged streams should often feature LW addition. However, effects of LW addition are likely to be short-lived unless compatibility with the overall geomorphic and ecological context is insured. Since LW tends to be mobile and to decay rapidly in small, warmwater streams, LW projects must be planned and designed so that perennial woody plants colonize sediment deposits within the LW structures, and new LW is recruited to maintain loading levels within treated reaches as added LW breaks up and decays. Evidently cover and velocity shelter associated with LW formations are extremely important for recovery of species assemblages in incised channels, since organisms cannot retreat to the floodplain for velocity refuge except during rare events (Crook and Robertson 1999). LW structures hold potential for rehabilitating reaches of small (drainage area < 200 km^2) sand-bed streams in post-degradational stages of incised channel evolution. Application of this approach on a regional basis could trigger unprecedented recovery of stream corridor ecosystems at much lower cost than other practices (Shields et al. 2004).

Additional information about this study and Topashaw Creek is available from our Web page at: http://msa.ars.usda.gov/ms/oxford/nsl/wqe_unit/topashaw.html.

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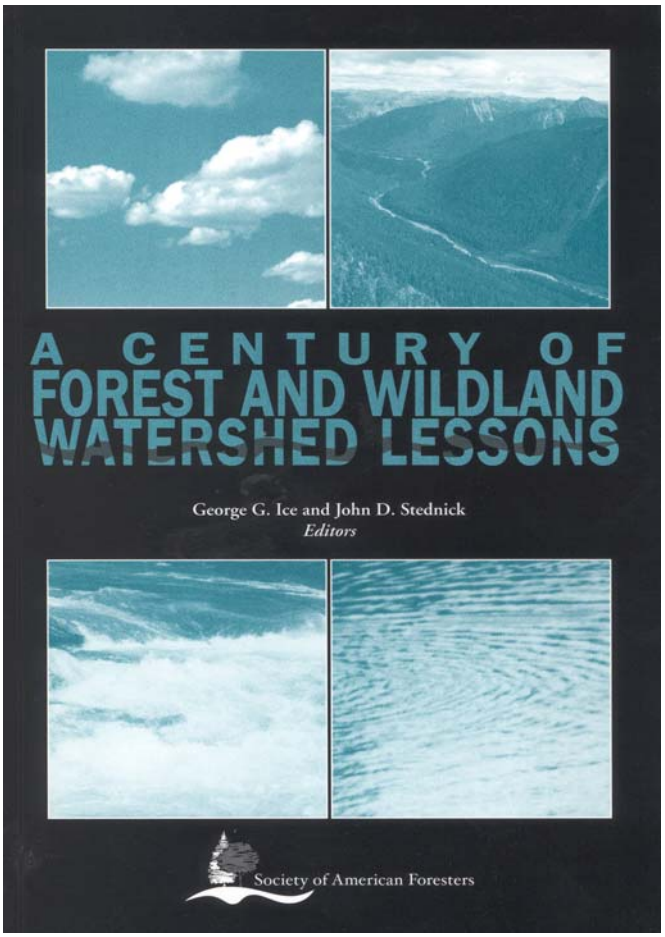
A Century of Forest and Wildland Watershed Lessons



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A Century of Forest and Wildland Watershed Lessons, edited by George Ice and John Stednick, summarizes the findings and lessons learned from key forest and wildland watershed studies of the past century by the grandmasters who were involved in those research efforts. The compilation is organized by geographical regions of the United Sates and summarizes key watershed research findings from the Northeast, Southeast, Mid-South, Central and Upper Midwest, Southwest, Central Rocky Mountains, Northern Rocky Mountains, Pacific Southwest, and Pacific Northwest.

Chapters typically begin with a brief history of watershed research studies in a particular geographic region that describes the origin of experimental watershed studies and the issues that needed to be addressed at the time. Each chapter then progresses to a fairly succinct description of what was learned about watershed and hydrologic processes over time and then transitions into discussing wildland hydrology issues that are pertinent today. A particularly nice feature of the book is that each chapter ends with a short bulleted summary section that highlights key lessons learned from the research conducted within each region. One could simply read these sections and come away with a fairly good understanding of differences in hydrologic processes and issues across the United States.

This book can be a valuable reference for anyone who works in a variety of hydrologic regions of the United States or who may change hydrology-related jobs and transfer from one region of the country to another. Sure, water flows downhill everywhere, but it behaves differently from region to region and needs to be understand in different contexts. For example, ***A Century of Forest and Wildland Watershed Lessons*** has a chapter on regional differences in forest snow hydrology that would allow a hydrologist from the Rocky Mountains who might have analyzed snow in the subalpine forests of Colorado to quickly understand how snow processes differ in the transient snow zones of California. Similarly, land fragmentation issues and the hydrology of the Upper Midwest are different from forest management issues in the Pacific Northwest that focus more heavily on water quality and fisheries issues. Should you transfer to one of the National Forests in Idaho or Montana, you might want to quickly get a refresher on erosion, sedimentation, and cumulative effects issues common to the Northern Rocky Mountains and arrive at that new job with instantly impressing everyone with your broad grasp of local hydrologic science and watershed issues.

The 300 page soft cover book is published by the Society of American Foresters and can be purchased from the SAF Online Store for the non-member price of $49 ($39 for SAF members). The easiest way to find the site for purchasing the book is to do a search on the full title of the book using Google.

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Editorial Policy

For a successful newsletter, we need voluntary contributions of relevant articles or items of general interest. YOU can help by taking the time to share innovative ideas or approaches to problem solving that you may have developed.

Feel free to contact John Potyondy to discuss ideas for contributions (970-295-5986). Or submit typed, single-spaced contributions limited to 2 pages to John Potyondy at jpotyondy@fs.fed.us in electronic format. If possible, include graphics and photos that help explain ideas.

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