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STREAM NOTES

To Aid in Securing Favorable Conditions of Water Flows

Rocky Mountain Research Station October 2008

A Simple Alphanumeric Classification of Wood Debris Size and Shape

by David R. Montgomery

A simple alphanumeric classification of wood debris size and shape is proposed for use in river and stream channel surveys and restoration projects. Dividing wood debris length and diameter into seven categories, respectively distinguished by an alphanumeric code, results in a total of forty-nine distinct size and shape categories. Intended to be analogous to the phi class intervals used to characterize channel bed substrate, this classification allows for rapid visual characterization of the size and potential function of wood debris in wood budgets and channel assessments.

Recognition of the role of wood debris in the ecology and geomorphology of forest rivers and streams over the past several decades established the importance of understanding the wood regime for stream channel assessments. Characterizing the size of wood debris is important because large pieces of wood can deflect flow to form pools and catalyze formation of logjams that trap otherwise mobile sediment and smaller pieces of wood (e.g., Montgomery and others 1995; Abbe and Montgomery 1996; Collins and Montgomery 2002). Although the size of in-channel wood debris large enough to prove stable is a function of channel width and depth, as well as wood size and shape (Abbe and Montgomery 2003), definitions of large woody debris typically rely on a minimum piece length and/or diameter. Surveys of in-channel wood and semi-quantitative wood budgets (e.g., Benda and others 2003) generally involve accounting for wood larger than a certain size, but the size of wood debris large enough to prove functional depends on channel size. It would be useful therefore to have a standardized nomenclature for classifying wood size and shape. Moreover, adoption of a standard framework for classifying wood debris size and shape could help streamline wood debris inventories in channel assessments to establish (and track changes in) the distribution of wood debris size classes and potential functions of in-channel wood debris.

Classification

The proposed wood debris classification relies on a simple

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alphanumeric coding like that proposed by Rosgen (1994, 1996) for classifying stream channels. Whereas many geomorphologists criticize Rosgen's approach as overly simplistic for classifying channel morphology and predicting channel response (e.g., Kondolf and others 2003), the application of a similar coding scheme to characterize the size and diameter of wood debris provides a simple two-dimensional framework that accounts for variations in both dimensions (table 1). A simple alphanumeric code is particularly well suited for characterizing variations in the two primary dimensions of wood debris size and shape—length and diameter.

The proposed classification simply divides both wood debris length and diameter into seven discrete categories, the smallest of which corresponds to a typical minimum size definition for large woody debris in many stream survey protocols (wood less than 1 m in length and less than 0.1 m in diameter). Size classes for both wood debris length and diameter increase in progressively doubled size bins yielding categories of <1 m, 1-2 m, 2-4 m, 4-8 m, 8-16 m, 16-32 m, and >32 m for wood debris length and 0-0.1 m, 0.1-0.2 m, 0.2-0.4 m, 0.4-0.8 m, 0.8-1.6 m, 1.6-3.2 m, and >3.2 m for wood debris diameter. Pieces at the high end of each range would be included in the larger category, as in methods used to characterize sediment size. Hence, a wood debris piece with a length of 3 m and diameter of 1 m would be classified as C5, whereas a piece of wood debris with a length of 6 m and diameter of 0.5 m would be classified as D4. The simple pairing of a letter code for piece length with a numeric code for piece diameter conveys directly the respective differences (i.e., a log classified as D3 is longer and thinner than a C4 log). The proposed size categories result in a total of 49 discrete, visually estimable classes of wood debris.

Table 1. Proposed size classes and codes for the length and diameter of wood debris.

Wood length letter code and classes (m)	Wood diameter numeric code and classes (m)
(A) 0 to 1	(1) 0 to 0.1
(B) 1 to 2	(2) 0.1 to 0.2
(C) 2 to 4	(3) 0.2 to 0.4
(D) 4 to 8	(4) 0.4 to 0.8
(E) 8 to 16	(5) 0.8 to 1.6
(F) 16 to 32	(6) 1.6 to 3.2
(G) > 32	(7) > 3.2

Wood debris with an attached rootwad functions differently than the same size piece without a rootwad, and consequently the presence and size of a rootwad is an important aspect of wood debris characterization. The simple alphanumeric coding can be readily modified to include both the diameter of the bole and rootwad, with the appropriate numbers separated by a slash. For example, a 6 m-long, 1 m-diameter log with a 4 m-diameter rootwad would classify as D5/7, with the first number indicating the log diameter and the number after the slash indicating the rootwad diameter.

Discussion

Standardization of wood debris bin sizes would be useful and allow comparisons between surveys and regions, but this proposed classification is not intended to provide a comprehensive classification of organic matter for use in stream ecology. Neither is it intended to convey directly geomorphological implications regarding wood function. For example, different classes of fine organic matter, such as branches, twigs, and leaves, may share an A1 designation. Similarly, a C4 log may be a stable obstruction to flow in a small headwater stream and mobile flotsam in a large river. Nonetheless, this simple system provides a general framework for classifying wood debris in a manner useful—when coupled with information on channel size—for understanding the potential to influence channel morphology or provide structural components of log jams. With practice, the simple alphanumeric shorthand should prove relatively easy to learn and allow rapid visual classification of wood debris into the appropriate category.

Wood in different bins of the classification would be expected to function differently in different channels. Small mobile debris would have low alphanumeric combinations (e.g., the smallest

material classified as A1), whereas larger stable pieces would tend toward higher combinations (e.g., an old-growth log classified as G7). In addition, the classification would relate to potential functions. For example, stumps classified as A5 would float upright. Additional criteria could be coupled to the classification to determine which categories of wood debris would be expected to provide structural elements to particular stream channels. For example, the simple approximation of functional wood debris as being longer than half the channel width and with a diameter greater than half the channel depth (Montgomery and others 2003) could be used in conjunction with the channel size to predict which wood debris categories could provide "key pieces" large enough to influence channel morphology. Classifying wood debris by this system would also provide a simple framework for tracking changes in the size distribution and/or shape of wood debris in monitoring projects. Additional information such as the relation of the wood debris to its location in the channel, and whether the wood is associated with other wood debris could be combined with the proposed classification for projects in which such information is desired.

Much like how the phi scale for characterizing particle size (Wentworth 1922; Krumbein 1934) allows rapid characterization of channel bed substrate using pebble counts (Wolman 1954) to determine grain size distributions, the use of the proposed alphanumeric framework for classifying wood debris size and shape may provide a parallel tool for use by fluvial geomorphologists and stream ecologists. In particular, the system provides a convenient standardized shorthand to facilitate communication and comparison of results among studies conducted by different investigators for different purposes in different settings.

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Watershed Assessment of River Stability and Sediment Supply (WARSSS)

Sedimentation is a natural process that occurs in most aquatic ecosystems. Human activities such as urbanization, agriculture, grazing, silviculture, channelizaiton, etc. and alteration of riparian habitat and flow regimes have increased the concentrations and rates at which sediments enters streams and rivers. As a result, water quality, aquatic habitat, and ecological integrity in many streams and water bodies are impaired. The challenges confronting land managers, regulators, and scientists are twofold: 1) Identify and distinguish the sediment impacts of current land-use practices on water quality and aquatic ecosystems from those occurring from natural sedimentation processes, and 2) Develop mitigation plans to improve water quality and aquatic ecosystems by reducing the adverse effects of sedimentation from land-use practices.

Within that context, the Watershed Assessment of River Stability and Sediment Supply (WARSSS) methodology was developed by Dave Rosgen, in partnership with the U.S. Environmental Protection Agency, for detecting sediment problems and source areas, estimating excessive sediment loads, and developing mitigation treatments to reduce excessive sedimentation to streams. The book, ***Watershed Assessment of River Stability and Sediment Supply (WARSSS)***, provides a detailed discussion and description of the WARSSS methodology (fig. 1). Also included in this publication is an introduction to hillslope, hydrologic, and channel processes, a discussion of validation and effectiveness monitoring techniques for assessing mitigation treatments, and a case study that demonstrates the application of the WARSSS methodology.

WARSSS was developed for practitioners and resource specialist involved in land management with the goal of providing them with a geomorphology-based assessment methodology for quantifying, interpreting, and understanding hillslope and channel processes so that recurring channel instability and sediment problems in a watershed are reduced or eliminated. Chapter 1

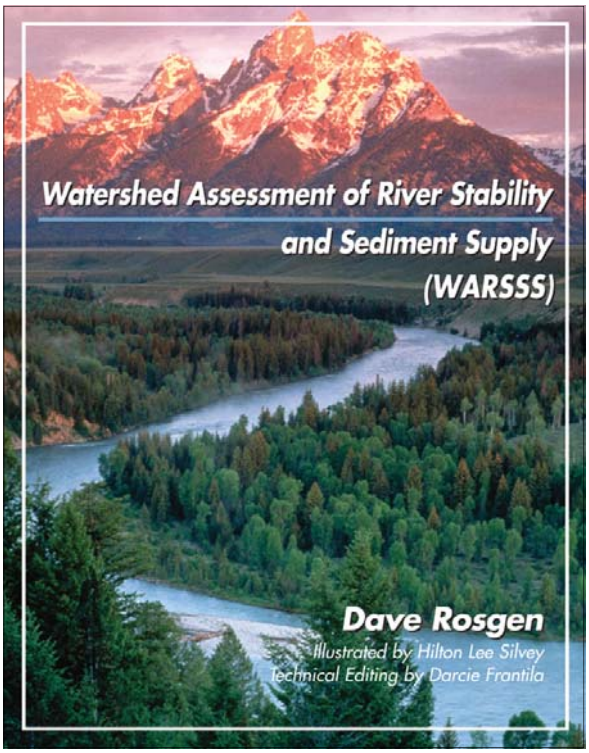


Figure 1. Cover page of publication, ***Watershed Assessment of River Stability and Sediment Supply (WARSSS).***

presents a brief overview of the WARSSS methodology and a brief discussion of the potential impacts of various land-use practices on hillslope, channel, and hydrologic processes. The general WARSSS framework and flowchart is illustrated figure 2.

Chapter 2 presents general principles related to hillslope and channel processes. This chapter also discusses currently available models for calculating hillslope erosion and sediment delivery, sediment entrainment and transport, streambank erosion, channel stability and adjustments, and flow hydrology. Numerous examples from various locations are provided to reinforce the hillslope- and channel-process concepts presented and demonstrate the application of the models discussed.

Chapter 3 presents the Reconnaissance Level

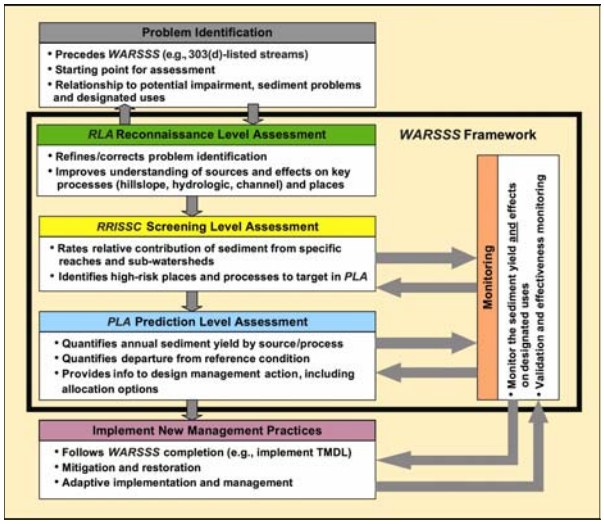


Figure 2. A flowchart describing the WARSSS methodology.

Assessment (RLA), the first of the three WARSSS assessment phases (fig 1.). This is the broadest screening level of the watershed in which existing hydrological, geological, and biological data are compiled, past and current land-use practices are reviewed, and geomorphic processes and potential sediment supply sources are identified. The RLA is designed to identify those subwatersheds and stream reaches that are potentially contributing to sediment impairment in the watershed and require additional evaluation and analyses.

Chapter 4 describes the second assessment phase, the Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC). The RRISSC phase builds on the methods and results from the RLA phase by conducting a more detailed, intermediate analysis of those subwatersheds and channel reaches identified as potential significant sediment sources. The risk rating system of RRISSC assigns slopes, subwatersheds, and stream reaches as having low-, moderate-, or high-sediment risks using comparative analyses to establish relationships between geomorphic processes, erosional and depositional patterns, and land-use activities. Those areas identified as having a low-sediment risk do not require mitigation, whereas areas identified as having moderate-sediment risk may initiate recommendations to change management activities and/or require site-specific mitigation to reduce sediment and channel stability problems. Areas identified as having high-sediment risk in RRISSC require additional and more detailed analyses.

Chapter 5 describes the most detailed assessment phase of the WARSSS methodology, the Prediction Level Assessment (PLA). The PLA is conducted on subwatersheds and channel reaches previously identified in the RRISSC as being at high risk for sediment and channel stability problems. The basic premise of the PLA methodology is to quantitatively compare sediment and channel stability conditions from a stable, reference reach to those in the high-sediment risk area to determine the nature and extent of the sediment and channel stability problems and develop appropriate mitigation treatments to reduce or eliminate the sediment and channel stability problems.

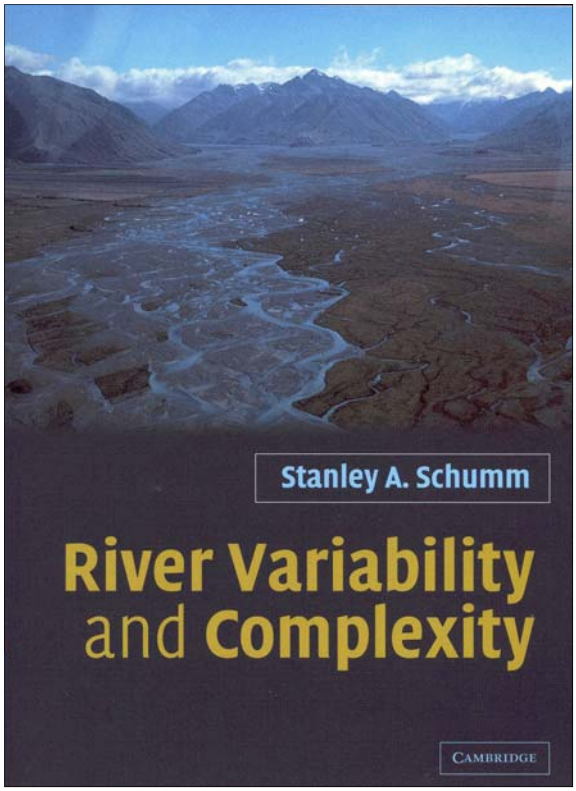
Chapter 6 describes the importance of monitoring in all three phases of the WARSSS methodology to improve the prediction capabilities (i.e., reduce predictions uncertainty) of the RLA, RRISSC, and PLA phases (fig. 2). Monitoring also provides direct feedback on the effectiveness of specific mitigation practices recommended in RRISSC and PLA to reduce sediment and channel instability problems. Included in this chapter are guidelines for developing monitoring design study plans and methods for conducting field monitoring.

Chapter 7 presents a step-by-step application and discussion of the WARSSS methodology for detecting sediment problems and key source areas, estimating excessive sediment loads and stream instability, and recommending mitigation treatments to reduce sedimentation and stream instability on the Wolf Creek watershed in southwestern Colorado.

This publication will be an excellent resource for practitioners and resource specialists needing to identify excessive sedimentation problems and sediment source areas in a watershed, estimate excessive sediment loads, and develop mitigation treatments to reduce or eliminate sediment impairment in streams and channel instability. ***Watershed Assessment of River Stability and Sediment Supply (WARSSS)*** is published by Wildland Hydrology. The book can be purchased online at http://www.wildlandhydrology.com/ and costs $120.

River Variability and Complexity

Based on numerous and diverse studies of fluvial processes, channel morphology, and channel responses on the lower Mississippi River and streams in Colorado, Stan Schumm has observed that channel morphology can vary greatly along the course of the river even though hydrologic conditions do not vary greatly. The variation of channel dimensions over short distances in many rivers indicate that other factors or controls, in addition to hydrology and hydraulics, are influencing channel morphology and fluvial processes. Thus, the primary focus and motivation of the book, ***River Variability and Complexity***, by Stanley A. Schumm is to discuss these "other controls" that influence channel dimensions, as they are often not considered and/or poorly understood in river studies, channel restoration, and land-management decisions. These "other controls" are grouped as upstream controls (history, tectonics and relief, lithology, climate:hydrology, humans), fixed local controls (bedrock:alluvium, tributaries, active tectonics, valley morphology), variable local controls (floods, vegetation, accidents), and downstream controls (base-level, length).



The book is organized into six parts and 20 chapters. Part I (background) consists of three chapters describing basic geomorphic processes operating in the fluvial system, the variability of hydraulic geometry relations, the types and characteristics of rivers in equilibrium, and the response and characteristics of rivers not in equilibrium. Part II (upstream controls) consists of five chapters discussing how upstream controls such as history, tectonics and relief, lithology, climate and hydrology, and humans influence downstream river morphology and dynamics. History refers to how tectonics and relief, climate and hydrology, and human activities change with time, which in turn influence fluvial processes and channel form. Part III (fixed local controls) consists of four chapters discussing how spatially fixed local controls such as resistant bedrock and alluvium, tributaries, tectonic features, and valley morphology influence downstream channel dynamics and morphology. Part IV (variable local controls) consists of three chapters describing the variability of local controls with time because natural disturbances such as floods, fires, landslides, etc. and vegetation changes locally alter and influence channel dynamics and morphology. Part V (downstream controls) consists of two chapters discussing how base level changes and lengthening or shortening of the channel (channelization) influence fluvial processes and channel form. Part VI (rivers and humans) consists of three chapters that build on the previous discussions on river variability by demonstrating through different examples how the variability of rivers has caused significant problems for humans attempting to modify or control rivers.

The information in this book provides a useful perspective for those conducting studies on channel dynamics and morphology, designing and stabilizing channels for infrastructure purposes, or developing plans to restore natural channel dynamics and form. ***River Variability and Complexity*** is published by Cambridge University Press. The book can be purchased online at http://www.cambridge.org/us/ and costs $43.

StreamStats Update: The Map-based Web Application to Obtain Flow Data from Ungaged Streams

StreamStats is a map-based, web application that allows users to obtain streamflow statistics, basin characteristics, and other information from U.S. Geological Survey data-collection stations and ungaged sites of interest with relative ease. For ungaged sites, the StreamStats application interfaces with multiple Geographic Information System (GIS) programs and databases to generate relevant drainage basin data and the National Flood Frequency program (Reis and Crouse 2002) to predict stream discharge for different recurrence intervals. Because StreamStats is a web application it does not require any special software other than a web-browser commonly found on most computers.

The StreamStats application developed by U.S. Geological Survey is currently available for 14 States (Connecticut, Colorado, Delaware, Idaho, Illinois, Indiana, Maryland, Massachusetts, Ohio, Oregon, Pennsylvania, Tennessee, Vermont, Washington) with four other states (California, Kentucky, New Jersey, Utah) soon to be available after internal testing is completed (fig. 1). As shown in figure 1, the U.S. Geological Survey is currently developing the StreamStats application in 13 other states.

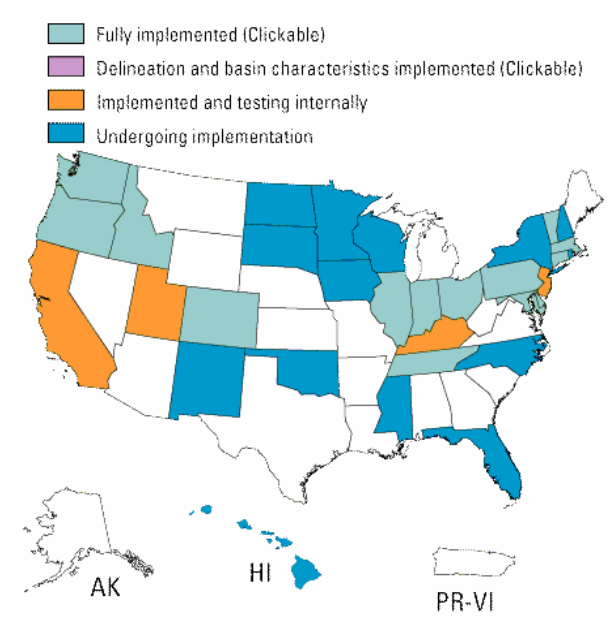


Figure 1. Map of states and territories where StreamStats is fully operational, soon to be released after internal testing, or being developed.

Information about StreamStats is available from the U.S. Geological Survey Web site at http://water.usgs.gov/osw/streamstats/index.html. This web site provides links to documents describing the applications and limitations of StreamStats, documents describing the software and databases used to develop the StreamStats application, instructions for using StreamStats, presentations given by the developers of StreamStats, and those States where StreamStats is currently available. At the web page for individual States with the StreamStats application, there are links to the U.S. Geological Survey Water-Resources Investigation Reports that describe the techniques and analyses used to develop the predictive discharge equations for ungaged streams and the reliability and limitations of the equations. The U.S. Geological Survey StreamStats Fact Sheet (Reis and others 2004) provides an excellent overview and description of the StreamStats application.

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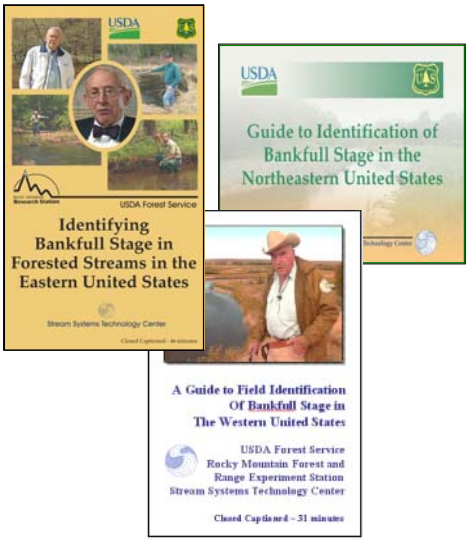

Training Products and Videos for Identifying Bankfull Stage are Now Available Online

The USDA Forest Service, Stream Systems Technology Center video presentations and technical training guides for identifying bankfull stage are now available for viewing online at the Stream Systems Technology Center website: http://www.stream.fs.fed.us/publications/videos.html.

Hardcopies of these video presentations and technical training guides for identifying bankfull stage are still available and can be obtained by placing an order by e-mail (rmrs_stream@fs.fed.us).

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