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ESEX Commentary

Large in-stream wood studies: a call for common metrics

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ABSTRACT: During the past decade, research on large in-stream wood has expanded beyond North America's Pacific Northwest to diverse environments and has shifted toward increasingly holistic perspectives that incorporate processes of wood recruitment, retention, and loss at scales from channel segments to entire watersheds. Syntheses of this rapidly expanding literature can be facilitated by agreement on primary variables and methods of measurement. In this paper we address these issues by listing the variables that we consider fundamental to studies of in-stream wood, discussing the sources of variability in their measurement, and suggesting more consistency in future studies. We recommend 23 variables for all studies of in-stream wood, as well as another 12 variables that we suggest for studies with more specific objectives. Each of these variables relates either to the size and characteristics of in-stream wood, to the geomorphic features of the channel and valley, or to the ecological characteristics of the riparian zone adjacent to the study reach. The variables were derived from an overview of those cited in the literature and from our collective field experiences. Copyright © 2010 John Wiley & Sons, Ltd.

KEYWORDS: in-stream wood; field measurements; common metrics

Introduction

The role of downed wood in terrestrial and aquatic ecosystems has been investigated for decades (Swanson and Lienkaemper, 1978; Brown and See, 1981), and research on the physical and ecological effects of in-stream wood has increased substantially during the past decade (e.g. Gregory *et al.*, 2003a; Montgomery and Piégay, 2003). This research has led to syntheses of in-stream wood characteristics and dynamics (Harmon *et al.*, 1986; Maser *et al.*, 1988; Wohl and Goode, 2008). These syntheses have been useful in identifying regional patterns and gaps in knowledge (Hassan *et al.*, 2005), but stronger inferences have been hampered by the inherently high spatial and temporal variation in in-stream wood and by measurement error (Roper and Scarnecchia, 1995; Roper *et al.*, 2002; Archer *et al.*, 2004; Whitacre *et al.*, 2007). Our review of many studies of in-stream wood also revealed inconsistencies in the type of variables measured and methods of measurement. Agreement on the measurement and reporting of variables could resolve some of the uncertainties associated with understanding in-stream wood patterns (Barker *et al.*, 2002). Thus, our objectives in this commentary are to list the variables that we consider fundamental to studies of in-stream wood and to suggest additions to study design and reporting that would enhance the value of individual studies.

What is In-stream Large Wood?

The most fundamental questions involving large wood are (1) what are the minimum dimensions of a piece and (2) what portion of a piece should be measured. The decision about piece inclusion can be scaled to the stream dimensions, such as channel width, which govern storage and transport (Gurnell, 2003). In many studies, however, selection of the minimum dimensions of pieces that constitute large wood – minimum diameters of 5 to 20 cm and minimum lengths of 1 to 3 m – is somewhat arbitrary (Ralph *et al.*, 1994). Although some have argued that retaining these dimensions facilitates comparisons with studies of terrestrial large-diameter fuels or large wood in other aquatic systems (Harmon and Sexton, 1996; Gregory *et al.*, 2003a), a more fluvially relevant standard may be to derive the minimum dimensions from the prevalence of piece sizes in channels and riparian zones (Young *et al.*, 2006).

Other sources of variation between studies involve piece measurements *vis-à-vis* the bankfull channel and treatment of that portion of a piece below the minimum diameter. Pieces of wood that lean over or bridge a channel are variously included or excluded. It seems reasonable to measure the portion of wood that falls within the bankfull channel dimensions, but characterize the remainder of the piece as being within the riparian zone. This is especially relevant if the in-stream wood piece is part of a living tree (Opperman and Merenlender, 2007; Opperman *et al.*, 2008). Similarly, sometimes only the part of a piece above a minimum diameter is measured. This has minimal influence on volume estimates, but can positively bias the mean diameter, negatively bias the mean length, and obscure relations with riparian large wood.

The important point is to clearly state the minimum size criteria and inclusion rules and, ideally, to provide data of wood measurements in an appendix or electronic data repository so that other investigators can sort the data to meet different criteria (e.g., remove all wood pieces with diameters <10 cm where 5 cm was the minimum diameter used).

Suggested Metrics for In-stream Wood Studies

We identified core variables based on their importance in previous studies and based on our collective experience, and subdivided them into three categories: wood, geomorphic, and riparian (Table I). Variables listed in parentheses are those we describe as Level II, or suggested for studies with more specific objectives. Wood variables include the size, orientation, and characteristics of wood in the bankfull channel, as well as functional parameters directly associated with wood. Geomorphic variables include the physical characteristics of the stream channel, valley, and drainage basin for a reach, defined as the length of channel within which wood is measured. If channel morphology varies substantially within a reach, then the reach should be subdivided into geomorphic channel units and geomorphic variables measured for each unit. Riparian variables include the ecological characteristics of the valley reach beyond the channel; i.e., on the floodplain or in the riparian zone. In the discussion that follows, the potential delivery distance of wood falling directly into the channel defines the riparian zone.

Wood variables

Length

The entire length of a piece of wood that is contained within the bankfull channel can be measured. Alternatively, the length measurement may only include the portion within the bankfull channel or along the portion of the piece that meets the minimum diameter criterion. We suggest measuring both the entire length and the length within the bankfull channel, and clearly distinguishing these when reporting data. The former is likely to prove useful in studies of relative mobility, and the latter is necessary to calculate volume of wood per unit length or area of channel. We also recommend using the vertical and lateral zones described by Robison and Beschta (1990) because wood in these zones functions differently with regard to fluvial processes and aquatic habitat.

Diameter

As noted earlier, at a minimum we suggest measurements of diameter at both ends of each piece. We prefer this standard, in part, because estimating piece volume is one of the primary variables of interest in studies of large wood in streams. Nonetheless, we believe that estimates of volume should be regarded with some caution. Young *et al.* (2006) found that estimates of piece volume and reach-based volume were imprecise, which they attributed in part to differences in taper characteristics between species (Husch *et al.*, 2002) and between intact and broken pieces (Williams and Gove, 2003). Piece volume is typically calculated using the equation for the volume of a cylinder, but addressing the effects of piece shape on volume would require a third measurement near the midpoint of each piece, which is rarely done.

Orientation

Measuring the angle of the wood with respect to the overall flow direction at bankfull (Cherry and Beschta, 1989; Robison and Beschta, 1990; Braudrick and Grant, 2000; Magilligan *et al.*, 2008) provides a readily obtained, quantitative, highly comparable metric for assessing stability and transport processes between pieces at a site and between sites. Alternative measures proposed in the literature include orientation with respect to the local flow vector (Buffington *et al.*, 2002), fall direction or where the piece originated (Sobota *et al.*, 2006) and zones of orientation within a 360° range (Magilligan *et al.*, 2008). Azimuth and plunge of the wood can also be measured to facilitate three-dimensional statistical analyses (e.g., eigenvalue method) and to include the vertical orientation, which is relevant to channel hydraulics and pool scour (Beschta, 1983; Cherry and Beschta, 1989; Buffington *et al.*, 2002).

Rootwad

The presence or absence of a rootwad can provide important information on relative stability and function of the piece (Abbe *et al.*, 1997; Braudrick and Grant, 2000). The measurement of a rootwad, however, is rarely addressed. Investigators measuring piece diameters typically ignore the rootwad and the buttswell immediately preceding it, although these portions of the wood piece can influence wood volume and piece mobility. In some instances a piece of wood is composed solely of the rootwad. We suggest measuring the rootwad length from the base of the root ball to the furthest extent of the bole, and measuring the diameter at the base of the bole where it meets the roots.

Jams

Previous studies range from those that simply mention the presence of jams to those that inventory jam size and spacing (Gregory *et al.*, 1985; Gurnell and Sweet, 1998; Kaczka, 2003; Comiti *et al.*, 2008) or characterize the effect of jams on hydraulics (Linstead, 2001; Manners *et al.*, 2007) or sediment storage (Jeffries *et al.*, 2003; Douglas and Guyot, 2005). Jams can exert more substantial geomorphic and ecological influences than individual pieces of wood (Bilby and Likens, 1980; Montgomery *et al.*, 1995; Montgomery *et al.*, 2003a; Montgomery *et al.*, 2003b; Abbe and Montgomery, 2003; O'Connor *et al.*, 2003), and can have different spatial distributions (Richmond and Fausch, 1995; Kraft and Warren, 2003; Warren *et al.*, 2007; Wohl and Jaeger, 2009) and greater stability (Wohl and Goode, 2008) than individual pieces of wood. For these reasons, it is important to at least note the spatial distribution and size (either number of pieces of wood or total dimensions) of jams and the criteria for designating a jam. Abbe and Montgomery (2003) proposed three categories for jams (transport, in situ, or combination).

Accumulation

More than one of the 11 categories suggested here can be chosen to characterize the mechanism that retains wood within the stream. This is useful for interpreting geomorphic function and relative stability of wood. One of the categories is debris dams, also known as logjams or jams. This is sufficiently important that we suggest that the presence and characteristics of jams deserve separate entries.

Table I. Suggested metrics for research-oriented in-stream wood studies

Levels	Notes
Wood – measured for each piece	
Level I	*Notes*
1. Length	Whole piece and length in bankfull channel
2. Diameter	≥1 measurement
3. Orientation	Angle with respect to downstream bank
4. Root wad	Note if present, including orientation with respect to flow
5. Jams	Spatial distribution and size (no. pieces per jam, or total dimensions of jam)
6. Accumulation[a]	11 categories
7. Status[b,c]	Decay class (six categories), burn status (three categories)
8. Stability[d]	Six categories
Level II	
9. Species	Note species or general category (e.g., deciduous/coniferous)
10. Submergence	Measure in relation to stage
11. Age	Tree-ring counting or radiocarbon dates
12. Biomass/density	Based on volume and wood density
13. Function	Characteristics of wood function include sediment storage (note if present; ideally, measure dimensions and grain size), pool scour (note if present; ideally, measure dimensions), backwater pools (note if present; ideally, measure dimensions), flow deflection, energy dissipation, and bank stabilization
Geomorphic (channel and valley) – measured for each reach	
Level I	
1. Channel gradient	Average streambed or water-surface gradient at study reach
2. Channel width	Average bankfull channel width at study reach
3. Flow depth	Either bankfull or at time of measurement
4. Grain size	Bed-material size distribution; D_{50} and sorting at minimum
5. Discharge	Bankfull, mean annual, peak annual, or at time of measurement
6. Reach length	Length of channel along which wood is measured
7. Channel morphology	Cascade, step-pool, plane-bed, pool-riffle, dune-ripple, braided
8. Drainage area	Area drained by study reach
9. Elevation	At study reach, and range for catchment
10. Valley side slope	Average or maximum side slope values
11. Confinement	Ratio of channel width/valley-bottom width
12. Connectedness	Ratio of channel width/distance to valley wall
13. Disturbance history	Wildfire, blowdown, insect infestation, hillslope mass movements, avalanches
14. Management history	Timber harvest, percent roaded, tie-driven, dams, diversions, etc.
Level II	
15. Bank scour	Visual estimate of percentage of total stream bank length
Riparian – measured for each reach	
Level I	
1. Forested	Yes/no, deciduous/conifer, note cover type if not forested (e.g., willow or herbaceous dominated meadow, bedrock)
Level II	
2. Dominant species	Where forested, note forest type(s)/species of trees
3. Source[e]	Six categories
4. Seral stage	Young, mid-successional, or mature
5. Floodplain survey	Dimensions and spatial density of wood on forest floor
6. Basal area	Measure of the cross-sectional area of standing trees at breast height (may be measured by species)
7. Site potential	Rate of tree growth, time to reach maturity, longevity of trees

Note: Level I lists metrics that we propose should be included in all studies; Level II lists those metrics that are more study-specific.

[a] Accumulation classes: debris jam (part of a jam of three or more pieces), tree/rootwad (associated with a living tree or rootwad), boulder (associated with a boulder in the stream), meander (caught on the outside of a bend), bar (sitting on a point, alternate, or mid-stream bar), bedrock (caught on bedrock), beaver dam (incorporated in a beaver dam), bank (embedded in the bank, buried by soil or other bank materials), log step (forms a step in the stream, can be partially buried in streambed or not buried), buried in bed (portion of log buried in streambed, but not functioning as a step), none/other (specify if something else). A piece can have more than one class.

[b] Decay classes: rotten (very soft wood that can be pulled apart easily by hand), decayed (moderately soft wood that cannot be pulled apart easily), bare (no bark or most bark is gone), limbs (limbs still attached, may have most or all bark intact), bark (all bark intact, a relatively new piece of wood), needles/leaves (green or brown needles/leaves still attached, very fresh piece of wood, tree may appear to be living).

[c] Burn classes: unburned, partially burned, completely burned.

[d] Stability classes: unattached/drift (entire piece is contained within bankfull channel and no portion is buried or pinned), bridge (both ends above bankfull channel, center suspended above channel), collapsed bridge (two ends above bankfull channel, broken in middle), ramp (one end in channel, the other end above bankfull channel), pinned (all or a portion is lodged beneath other pieces of wood in the stream), buried (all or a portion is buried in the streambed).

[e] Source classes: unknown (source of wood cannot be determined), riparian (sources of wood appears to be valley bottom adjacent to the channel), hillslope (wood originates from a steeper landform adjacent to the valley bottom; either a depositional feature such as a moraine, or the valley wall), floated (fluvial transport from upstream), hillslope mass movement/debris flow, avalanche (recruitment via moving snow), bank undercutting, other (other clearly defined source such as debris flow; explained in comments section).

Status
Decay and burn categories are visual assessments of each piece that provide information on relative age and stability. Burn categories are specific to instances where wood input is associated with a wildfire. Robison and Beschta (1990) and Schuett-Hames *et al.* (1999) proposed decay categories based on bark conditions, surface texture, presence of branches, wood shape and wood color.

Stability
This category helps to characterize the relative stability/mobility of the wood based on its position within and above the channel, degree of burial, and association with other wood. This category may also imply something about the geomorphic function of the wood, such as the promotion of scour or retention of sediment, as well as the method of recruitment (Richmond and Fausch, 1995).

Species
Where it is possible to identify the species of wood, this information is useful in studying recruitment, decay rates, and retention of wood. In the Colorado Front Range, for example, wood from deciduous trees has a much shorter residence time in streams than coniferous wood (Wohl and Goode, 2008). This contrasts with patterns observed in the southern Appalachians, where American chestnut (*Castanea dentata*) constituted a large proportion of the wood in streams flowing through mid- and late-successional forests despite its absence from the canopy for decades (Hedman *et al.*, 1996).

Submergence
Noting the dimensions of the wood submerged in relation to stage is needed to calculate the drag coefficient and hydraulic resistance associated with individual pieces (Manga and Kirchner, 2000; Curran and Wohl, 2003; Daniels and Rhoads, 2004), thus improving our understanding of the physical influences of wood on hydraulics, stream morphology, and habitat.

Age
Measures of age are not readily obtainable, but are very informative when feasible. Tree-ring counting or radiocarbon dating can provide a maximum time that wood has been in the channel (Keller and Tally, 1979; Hyatt and Naiman, 2001), because in some environments dead trees may remain standing for many years before entering a stream.

Biomass/density
This variable can be particularly important when quantifying carbon storage in a stream (Seo *et al.*, 2008). Biomass estimation, however, rests on accurate estimates of volume and may be even more problematic because wood density varies with species, age, and stage of decomposition (Brown and See, 1981; Hardy, 1996), which are rarely assessed.

Function
In order to understand the geomorphic function and habitat alteration associated with wood, it is useful to at least note whether sediment is stored in association with individual pieces or jams (Keller and Swanson, 1979). If possible, this should be expanded to a measurement of the volume and grain-size distribution of stored sediment. As with sediment storage, noting the presence of streambed scour and, preferably, measuring basic dimensions and type of scour (Bisson *et al.*, 1982; Buffington *et al.*, 2002), provides information relevant to geomorphic function and fish habitat (Carlson *et al.*, 1990; Fausch and Northcote, 1992; Richmond and Fausch, 1995). Other characteristics of wood function include backwater pools, flow deflection, energy dissipation, and bank stabilization.

Geomorphic variables

Each of the variables mentioned provides insight into the dynamics of wood recruitment and retention within a reach and facilitates comparisons among sites. Methods for acquiring these data should be fully explained in each case.

Channel gradient
Report either the bed gradient or water-surface gradient over the study reach length. This facilitates calculation of hydraulic parameters useful to understanding wood mobility and aquatic habitat.

Channel width
An average value of bankfull channel width should be provided, along with a measure of variability and planform irregularity. Because wood mobility (Gurnell, 2003) and load (Bilby and Ward, 1989; Hassan *et al.*, 2005; Wohl and Jaeger, 2009) vary with channel width (Wohl and Jaeger, 2009), reporting width facilitates understanding of loads and mobility and comparison among sites. Although many studies measure wood within the bankfull channel, different investigators estimate the bankfull dimensions using varying criteria such as flow recurrence interval, breaks in slope along the channel banks, or high-flow indicators (Radecki-Pawlik, 2002; Navratil *et al.*, 2006). Consequently, it is important to state the criteria used to estimate bankfull dimensions.

Flow depth
Report either bankfull (preferred) or some measure of flow depth (mean, maximum) at time of measurement; this is particularly relevant to estimating in-stream transport, which depends partly on the ratio of log diameter to flow depth (Bocchiola *et al.*, 2008). For studies involving fish, residual pool depth (Lisle, 1987) is commonly an important measure that indicates pool depth independent of flow (Richmond and Fausch, 1995).

Grain size
Some estimate of surface bed-material size distribution should be provided, as well as a commonly used metric such as D_{50} or sorting. It is important to explain the method by which grain-size distribution was measured or estimated, given the potential for substantial variation among different methods (Wohl *et al.*, 1996; Faustini and Kaufmann, 2007; Whitacre *et al.*, 2007). The grain size of the channel bed and banks both reflects and influences hydraulics and sediment transport, as well as influencing aquatic habitat and community structure (Haschenburger and Rice, 2004); thus, more detail about bed grain-size distribution is desirable. Useful information includes grain-size distributions upstream and downstream from wood (Faustini and Jones, 2003); associations between channel depositional features such as point or transverse bars and wood (Montgomery *et al.*, 2003a); grain-size distributions for the bed surface and subsurface (Haschenburger and Rice, 2004); and the patchiness or size and spatial distribution of grain-size categories on the streambed (e.g. boulders, cobbles, gravels, sand, silt and clay) (Buffington and Montgomery, 1999).

Discharge
Some measure of discharge is useful when assessing transport capacity and wood retention (Bocchiola *et al.*, 2008). Bankfull

discharge, as estimated from channel morphology or a recurrence interval for gaged sites, is the most widely used and thus easiest to compare between sites.

Reach length
This value should be provided, as well as the rationale for measuring wood within the specified length. This facilitates calculation of wood load per area of channel.

Channel morphology
Describing the channel morphologic type(s) as per the Montgomery and Buffington (1997) classification characterizes channel stability and sources of flow-energy expenditure.

Drainage area
Provide the area drained by the stream at the study reach. Because wood characteristics can vary between sites within the same watershed in relation to drainage area (Martin and Benda, 2001; Marcus *et al.*, 2002; Wohl and Jaeger, 2009), this facilitates comparison of wood characteristics within and between watersheds.

Elevation
Elevation of the study reach and the range of elevations for the watershed facilitate cross-site comparisons.

Valley side slope, confinement, and connectedness
These variables can be measured in the field or obtained from topographic maps or digital elevation maps. Each provides information on potential recruitment processes and sources.

Disturbance history
This variable incorporates natural disturbances that can influence both wood recruitment to streams over years to centuries (Young, 1994; Kraft *et al.*, 2002; Zelt and Wohl, 2004) and current distribution of pieces within a stream network. The type, presence, spatial extent, and relative age of the disturbance should be noted.

Management history
Like disturbance, management activities in the vicinity, upstream from the study site, or even upstream within the watershed can influence wood recruitment and retention (Murphy and Hall, 1981; Carlson *et al.*, 1990; Nowakowski and Wohl, 2008). Note the type, presence, spatial extent, and relative age of management activities.

Bank scour
A visual estimate of the total percentage of stream bank length that is actively eroding or unstable provides insight into recruitment processes (i.e., bank failure) or channel instability related to wood storage and movement.

Riparian variables

Forested
Land cover adjacent to the channel can provide important insight into mechanisms and volumes of local wood recruitment. Stream segments within meadows, bedrock gorges, or talus slopes, for example, will have minimal or no riparian recruitment, and this may help to explain variations in wood load among different study reaches (Wohl and Jaeger, 2009).

Dominant species
At a minimum, noting the type (e.g., deciduous versus coniferous) of trees that form the dominant species in forested riparian zones provides information on potential for wood recruitment (Bragg *et al.*, 2000; Welty *et al.*, 2002). Reference to the dominant forest type (e.g. Mesic – Douglas-fir series), which is available for most federal and state forest lands in the United States, can provide insights into the most likely species to be recruited to specific streams.

Source
A visual assessment of the probable source of wood recruitment can be used in developing wood budgets that partition recruitment among various sources (Benda *et al.*, 2003; May and Gresswell, 2003; Webb and Erskine, 2003).

Seral stage
The categorical stage of forest development (young, mid-successional, or mature) and noting whether stands appear even- or uneven-aged provides information on potential recruitment and past forest disturbance (Bragg *et al.*, 2000; Welty *et al.*, 2002).

Floodplain survey
Studies of in-stream wood typically ignore downed wood outside the channel, yet wood on the ground within the floodplain creates pieces available for recruitment. Rates and patterns of recruitment and retention of wood on the floodplain can be related to in-stream wood loading (Jeffries *et al.*, 2003; Pettit and Naiman, 2006; Young *et al.*, 2006).

Basal area
The cross-sectional area of tree cover (in m^2/ha) provides insights into stem density and tree size, and this metric allows comparisons across forest types, especially if basal areas are reported by species (Fausch and Northcote, 1992; Nowakowski and Wohl, 2008).

Site potential
Information on the rate of tree growth, time to attain old-growth conditions, and longevity of trees in a region is useful in understanding wood recruitment (Bragg *et al.*, 2000; Welty *et al.*, 2002).

Additional Information

An explanation of the overall study design deployed in the survey and classification of large wood should be included in publications on in-stream large wood. This would include the following:

(1) *Rationale for reach selection*. It is important to explain whether the study reach was chosen to represent particular characteristics of the area, to avoid certain types of management history, to facilitate repeated access, or based on other criteria. It is often not clear in published papers how or why a particular study reach was chosen, yet this information is useful for determining whether a particular dataset should be included in a synthesis.
(2) *In-stream wood loads*. If all of the variables described earlier are listed in a paper, readers can compute the volume of in-stream wood using one of the typical metrics (m^3/100 m, m^3/ha, pieces/100 m). Providing at least one of these calculated values in the paper, however, greatly facilitates comparison between sites and regions.
(3) *Large wood monitoring*. There are relatively few short-term (<10 year) published datasets (Lienkaemper and Swanson, 1987; Benke and Wallace, 1990; Young, 1994; Berg *et al.*, 1998) on wood dynamics and extremely few long-term

(≥10 year) published datasets (Gurnell *et al.*, 2002; Faustini and Jones, 2003; Wohl and Goode, 2008). Datasets based on monitoring of wood dynamics through time are extremely valuable in understanding temporal variations in wood recruitment, retention, and function, and there is a great need for more of them. For tracking individual pieces of large wood over time, we suggest that numbered metal tags be nailed into wood pieces during the initial and follow-up stream surveys (Acker *et al.*, 2003). This facilitates repeat surveys conducted to record movement through time, and changes in status, size, stability, and function between visits. If wood moves out of a study reach, tagged pieces can sometimes be relocated to quantify total distance traveled laterally or downstream. New wood entering the study reach during the monitoring period can be readily identified and tagged. Repeat photography of a reach can also be used to document movement and recruitment of new large wood (Hall, 2001a, 2001b).

Conclusions

Although the 23 (or 35) variables listed in Table I may appear unmanageable, many of these variables rely on quick visual assessments or measurements derived from maps. Inclusion of these data in all studies of in-stream wood would substantially facilitate the insights and models (e.g. Gregory *et al.*, 2003b) that can result from inter-study compilations.

The great majority of in-stream wood studies to date have been conducted in the US Pacific Northwest, although within the past five years investigators have described different environments in Europe (Piégay and Gurnell, 1997; Gurnell *et al.*, 2000; Kail, 2003; Comiti *et al.*, 2006), Asia (Seo *et al.*, 2008), South Africa (Gomi *et al.*, 2006; Pettit and Naiman, 2006), Australia (Webb and Erskine, 2003), New Zealand (Baillie and Davies, 2002; Meleason *et al.*, 2005), South America (Andreoli *et al.*, 2007; Comiti *et al.*, 2008), and other parts of North America (Thompson, 1995; Downs and Simon, 2001; Hart, 2002; Marcus *et al.*, 2002; Fausch and Young, 2004; Morris *et al.*, 2007; Magilligan *et al.*, 2008). The rapidly growing literature from diverse environments makes it particularly timely to propose standard techniques for measuring and reporting the variables that will allow us to examine regional differences in wood recruitment and retention within different portions of a drainage network.

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