RIPARIAN ECOSYSTEMS

IN THE HUMID U.S.

Functions, Values and Management

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LARGE WOODY DEBRIS LOADING PATTERNS IN SOUTHERN APPALACHIAN STREAMS

Craig W. Hedman* and David H. Van Lear

ABSTRACT

Riparian zones are important ecotones serving both aquatic and terrestrial ecosystems. Riparian zone vegetation is a source of large woody debris (LWD) which affects the ecology and morphology of streams. Research in the northwest and northeast has established that LWD controls routing of sediment and water through channel systems, dissipates stream energy, increases stream habitat diversity, and provides food for stream organisms. Base-line information on LWD dynamics and function in the Southern Appalachians is lacking.

In this study, 12 riparian/stream systems approximately 500 m in length were examined. Stream sections were subdivided into 15-m segments to facilitate sampling. LWD was defined as any portion of a tree, i.e., bole, limb, root wad, or whole tree, that was > 10-cm diameter and > 1.5 m in length. All LWD was scaled within an area defined by a streams' bankfull channel width plus a 1-m lateral buffer. LWD loadings per 15-m sample unit were characterized as low, medium, or high after a thorough analysis of volume and weight measurements per stream station. Low loaded stations contained < 100 ft^3 (2.8 m^3), medium 100-200 ft^3 (2.8 - 5.7 m^3), and high > 200 ft^3 (> 5.7 m^3) per station.

An understanding of existing stream conditions in the Southern Appalachians requires an appreciation of how pieces of differing dimensional attributes influence loading status. It is also important to recognize that LWD loading levels in this region are highly variable, in part due to a diverse land-use history. This study has identified baseline LWD loadings in small Southern Appalachian streams. Additional research in watershed management that further explores riparian zone functions and identifies specific LWD requirements for streams is needed.

INTRODUCTION

Large woody debris (LWD) is an important ecological and morphological component of mountain streams. The importance of in-stream LWD has been recognized in recent years, particularly in the Pacific Northwest. In the northwest, amounts of LWD can be high early in succession, low in mature forests, and somewhat greater in older forests.

In the Southern Appalachians, studies of LWD loadings and dynamics as a function of forest succession are uncommon. As a consequence, the amount of LWD present in mountain streams and the role of riparian zones in contributing LWD to streams are poorly understood. In this study, 12 riparian zone/stream systems representing a 300-yr sere were sampled to obtain quantitative and qualitative baseline descriptions of in-stream LWD.

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LWD is considered to be any part of a tree such as a bole, limb, root wad, or whole tree which is > 10-cm diameter and > 1.5-m long. Riparian vegetation is a source of LWD which: (1) controls routing of sediment and water through channel systems; (2) dissipates stream energy; (3) defines habitat opportunities; and (4) serves as a substrate for in-stream biological activity (Swanson et al. 1982, Miller 1987). LWD is very important to aquatic food webs in low-order streams because of its capacity to trap fine particulate organic matter. Without debris, streams function like a pipe (Bilby and Ward 1989).

This paper addresses certain aspects of a doctoral dissertation which characterized and quantified functional attributes of Southern Appalachian riparian zones (Hedman 1992). The objective of this paper was to analyze LWD loadings in various streams and determine if specific spatial and temporal loading patterns existed.

STUDY LOCATION

This study was conducted in the Blue Ridge Mountain Physiographic province of the southeastern United States. The Coweeta Hydrologic Laboratory located near Franklin, North Carolina served as the central location of the study. Additional sites were located throughout the Wayah and Cheoah Ranger Districts of the Nantahala National Forest in North Carolina, the Andrew Pickens Ranger District of the Sumter National Forest in South Carolina, the Tallulah Ranger District of the Chattahoochee National Forest in Georgia, and the City of Greenville Municipal Watershed in northwestern South Carolina.

METHODS

Site Selection

The goal of site selection was for stage of succession or time since stand-replacing disturbances to be the primary variant. This was accomplished by standardizing several watershed features including stream width, bankslope, and stream gradient, all of which guided the selection of study sites. Channel width was of particular importance for several reasons. Bilby and Ward (1989) used channel width as opposed to watershed area as an index of relative stream size. Since variation in precipitation patterns between study sites may exist, channel width is the best indicator of the magnitude of high flows (Sternes 1969). Additionally, high discharges greatly influence patterns of debris distribution and debris-associated channel characteristics (Bilby and Ward 1989). We ran several multivariate statistical tests on geomorphological features and found that all study sites were similar.

Sixty (60) riparian zone/stream systems were field inspected during the reconnaissance phase of this study and 12 were selected. The 12 stream systems drained riparian zones that represented conditions and ages ranging from 28 yr through 334 yr post stand-level disturbances. Riparian stands were representative of the mixed mesophytic deciduous forest or cove hardwood type, eastern hemlock forest, and transitions between types. Riparian zone ecological conditions were replicated and representative of different points in time or seral stages, that is: early-successional, mid-successional, late-successional, and old-growth.

Stream Sampling

Stream corridors approximately 500 m in length were established in each study stream. Similar studies in the PNW typically covered 100-200 m. We expected high variability in loading and felt that longer stream sections would be appropriate. Streams were further subdivided into 15-m stations to facilitate data acquisition and mapping.

All LWD found within an area 1 m beyond the bankfull channel divide and within the 500-m corridor was inventoried and scaled. A total of 2827 pieces were scaled across 12 study sites and 12 pieces of information were collected on each piece of debris. This level of detail was quite comprehensive and combined parameters investigated in several PNW studies (Swanson and Lienkaemper 1978, Keller and Swanson 1979, Triska et al. 1982, Swanson et al. 1984, Bisson et al. 1987, Lienkaemper and Swanson 1987, McDade et al. 1990, Van Sickle and Gregory 1990).

LWD which met the minimum size requirement of > 10 cm diameter and > 1.5 m length, was measured and classified as **in-stream** if it was in contact with the active channel, **potential** if suspended over the stream channel and able to influence streamflow during periods of high flow, or **effective** if on the bank and able to influence flow when bankfull stages were exceeded.

Maps/Sketches

LWD was tagged and stream stations were sketched for the purpose of assigning an "address" to each piece. Stream sketches were instrumental in identifying distribution patterns of LWD. Sketches may also be helpful in subsequent studies on LWD dynamics related to piece movement and delivery.

RESULTS

The overall shape of LWD loading curves through plant community succession are determined by the amount of debris present before disturbance, that created by disturbance, that added by the regenerated stand, and decay patterns of species comprising each debris input category. Relative contributions of these input categories to total LWD loading differ with stand age (Harmon et al. 1986). In the current study, LWD loading levels were highly variable and lower than anticipated, especially in older riparian systems. High variability is attributable, in part, to the diverse land-use history of this region.

LWD loading levels are typically expressed per unit area of stream. Quantifying in this way allows for a comparison of loadings across streams and time. However, a single summary statistic in some cases fails to accurately portray ambient field conditions. For most streams under study, field observations indicated that loading was not uniform but clumpy and high variability in loading within a stream reach was apparent. Therefore, a different view of loading that would better address spatial loading patterns was evaluated.

We decided to examine loadings per stream station based on a loading level category since 15-m stations (sample units) are relatively easy to observe, gauge, and visually digest. An examination of loading data per station revealed three distinct strata: low loaded stations (< 100 ft^3 or 2.8 m^3 of debris); medium loaded stations (between 100 and 200 ft^3 or 2.8 to 5.7 m^3); and high loaded stations (> 200 ft^3 or 5.7 m^3). We felt that by analyzing loadings this way, we would better understand how loadings were actually distributed within streams.

With the exception of two stream systems, low loaded stations were very high early in succession and decreased linearly over time. Medium and high loaded stations increased linearly over time through old-growth conditions. We also examined stations sequentially given this method of stratification. For some streams especially late-successional and old-growth, a general pattern existed where relatively long stretches of medium and high loaded stations were followed and preceded by long stretches of low loaded stations. These observations suggested that loadings tend to be clumped within some streams rather than uniformly or randomly distributed. It would appear that to accurately depict stream loadings, it is important to support loading per unit area data with descriptions of distribution patterns.

SUMMARY AND CONCLUSIONS

Stratification of LWD loadings by stream station identifies the variability and spatial pattern of LWD distributions and illustrates the importance of studying long sections of streams. Especially in older riparian/stream systems, the chance of sampling high loaded clumps or low loaded reaches would increase and possibly lead to over/under estimates of loading levels if relatively short stream reaches are studied.

It is difficult to synthesize 500 m of stream in one's mind and characterize stream conditions. Stream stations comprising 15- m reaches are much easier to identify and assess. Classifying per station loading patterns will help resource managers involved in stream restoration projects where LWD inputs by man are planned to enhance a creek's functionality. If a goal is to closely mimic natural conditions, then this information will help in assessing how much debris should be introduced and which areas are in need of inputs.

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