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Reach-scale characterization of large woody debris in a low-gradient, Midwestern U.S.A. river system

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ABSTRACT

Addition of large woody debris (LWD) to rivers has increasingly become a popular stream restoration strategy, particularly in river systems of the Midwestern United States. However, our knowledge of LWD dynamics is mostly limited to high gradient montane river systems, or coastal river systems. The LWD-related management of low-gradient, Midwestern river systems is thus largely based on higher gradient analogs of LWD dynamics. This research characterizes fluvial wood loads and investigates the relationships between fluvial wood, channel morphology, and sediment deposition in a relatively low-gradient, semiconfined, alluvial river. The LWD and channel morphology were surveyed at nine reaches along the Big River in southeastern Missouri to investigate those relationships in comparison to other regions. Wood loads in the Big River are low (3–114 m^3/100 m) relative to those of higher gradient river systems of the Pacific Northwest, but high relative to lower-gradient river systems of the Eastern United States. Wood characteristics such as size and orientation suggest that the dominant LWD recruitment mechanism in the Big River is bank erosion. Also, ratios of wood geometry to channel geometry show that the Big River maintains a relatively high wood transport capacity for most of its length. Although LWD creates sites for sediment storage, the overall impact on reach-scale sediment storage in the Big River is low (<4.2% of total in-channel storage). However, wood loads, and thus opportunities for sediment storage, have the potential to grow in the future as Midwestern riparian forests mature. This study represents the first of its kind within this particular type of river system and within this region and thus serves as a basis for understanding fluvial wood dynamics in low-gradient river systems of the Midwestern United States.

1. Introduction

Large woody debris (LWD) is universally recognized as an important ecological and geomorphological component of river systems. However, the role of LWD in river systems differs depending on region, climate, and land use history (Gregory et al., 2003). Motivations for understanding the dynamics of fluvial wood have traditionally been rooted in fish ecology (Murphy et al., 1984; Bisson et al., 1988; Beechie and Sibley, 1997; Naiman et al., 2000; Lepori et al., 2005); however, it is now understood that the role of LWD extends well beyond fish habitat: LWD contributes to bank stabilization and island development (Mott, 1994; Abbe et al., 1997; Derrick, 1997; Brooks et al., 2001; Shields et al., 2004; Gurnell et al., 2005), biogeochemical cycling (Bilby and Likens, 1980; Benke et al., 1985; Bilby, 2003), and sediment regulation (Potts and Anderson, 1990; Diehl, 1997; Wallerstein et al., 1997; Downs and Simon, 2001; Montgomery et al., 2003). While rivers in the Pacific Northwest of the United States and numerous other coastal and montane regions of the world have been the focus of a majority of these studies, LWD in streams of the Midwestern United States and other physiographically similar regions have been given far less attention.

Stream restoration projects involving the use of LWD are becoming increasingly common in the Midwest region of the United States (Alexander and Allan, 2006). Alexander and Allan (2006) conducted a comprehensive study of stream restoration projects that had taken place in the Upper Midwest between 1970 and 2004 and found that, of 1345 stream restoration projects, in-stream habitat improvement and bank stabilization were the two most common restoration goals. Of the 20 most popular procedures implemented to accomplish those goals, the addition of LWD to the river channel was the third most used. Besides the discrete addition of LWD as a restoration tool, five of the remaining 19 procedures involved wood in some way. Alexander and Allan (2006) did not specifically address the success rates of the restoration projects or the LWD application. However, their results support the common sentiment that stream restoration projects lack adequate pre- and post-project monitoring, particularly those involving LWD (Reich et al., 2003). Furthermore, Abbe et al. (2003) found that the majority of restoration projects involving the reintroduction of LWD to the

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river have been heavily based on subjective decisions and that guidelines for such projects do not include natural analogs for wood placement. A basic understanding of contemporary wood loads is thus necessary for successful application of LWD as a restoration tool. This knowledge has been relatively well established for many coastal and montane river systems of the world but is lacking for lower-gradient river systems such as those in the Midwestern United States.

This research characterizes the fluvial wood load in the Big River, located in southeast Missouri; a mid- to low-gradient Midwestern river system. We conducted comprehensive LWD surveys at nine locations along the main stem of the Big River, from its relatively high-gradient, upper portion to its low-gradient confluence with the Meramec River 210 km downstream (Fig. 1). Surveys were intended to capture LWD-related metrics and relationships that could help inform LWD-related management activities in similarly sized rivers draining physiographically similar landscapes. Thus, surveys recorded channel morphology metrics along with LWD location, geometry, and orientation. We used these data to address the following specific

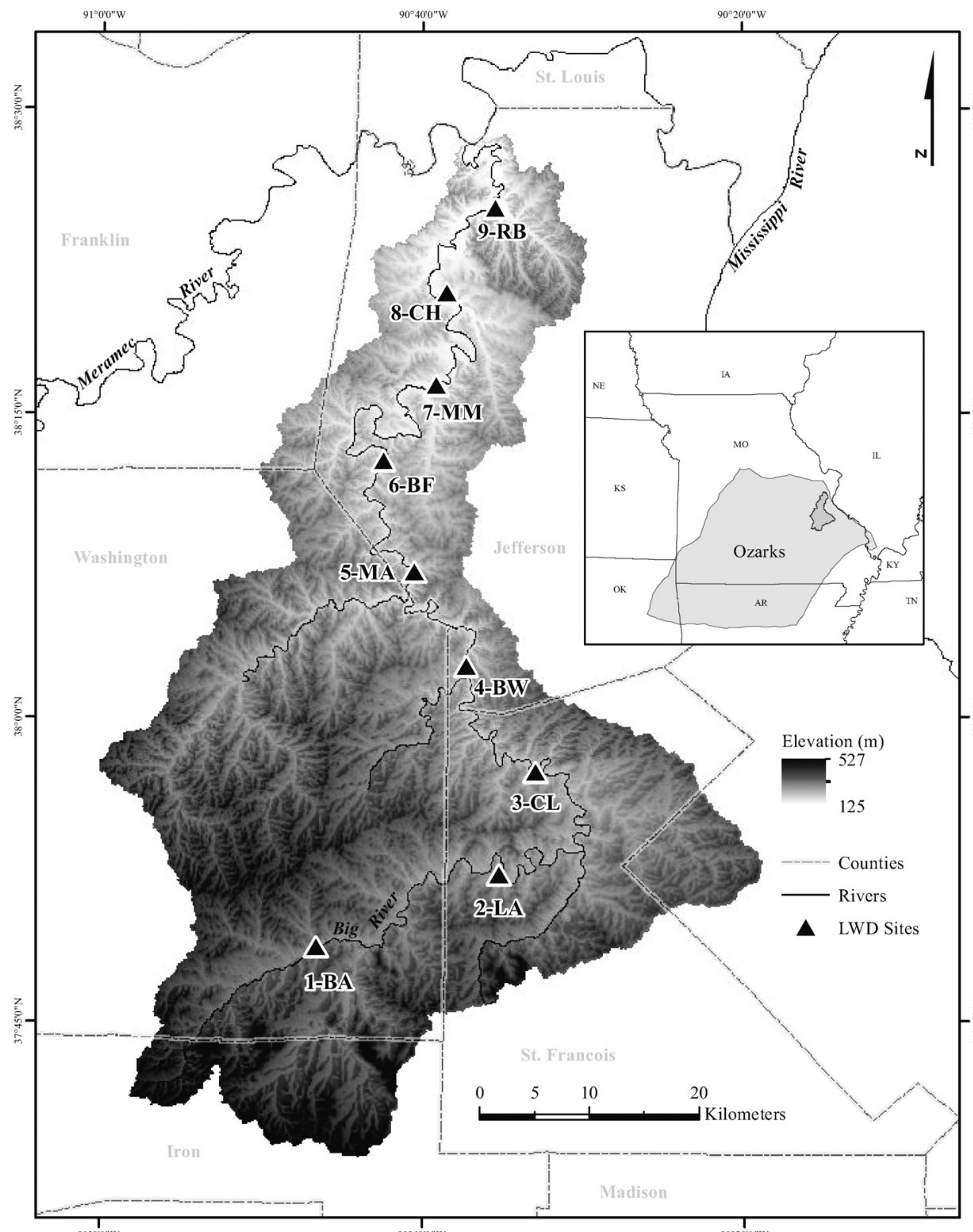

Fig. 1. Map of the Big River, tributaries, associated watershed, and locations of the nine study reaches. Sites are numbered from upstream (1-BA) to downstream (9-RB).