THESIS

A COMPARISON OF FLOODPLAIN HYDROLOGY AND COTTONWOOD WATER RELATIONS ON A REGULATED AND AN UNREGULATED RIVER IN NORTHWESTERN COLORADO

Submitted by

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ABSTRACT

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Cottonwood gallery forests are abundant along riparian zones in the southwestern U.S., but are currently in a state of decline. Recent studies attribute the decline of cottonwood forests to water stress caused by river regulation from large dams and stream diversions. This study compared the floodplain hydrology and water relations of cottonwoods in Browns Park on the regulated Green River and in Deerlodge Park on the unregulated Yampa River. An experimental flood treatment was performed on the floodplain of the regulated river to simulate the unregulated soil water regime. The overall goal was to understand whether hydrologic changes due to Flaming Gorge Dam cause water stress in mature cottonwoods.

Floodplain water levels and available soil water were measured from early June to early September in 1998 and 1999. Predawn and midday water potentials and leaf-level stomatal conductance of mature cottonwoods were compared during the 1998 and 1999 growing seasons. Finally, I characterized the tree and stand leaf area and canopy dieback of mature cottonwoods, and quantified cottonwood root density and distribution along the regulated and unregulated rivers.

Floodplain water tables and soil water content varied with river stage on the unregulated river Typical dam operations on the regulated river lowered peak flows, resulting in lower soil water availability in the upper soils on the former floodplain, and increased baseflows. A flood-flow release from the dam similar to pre-dam high flows substantially increased floodplain soil water. Predawn xylem potentials were moderate

along both rivers (-0.2 to -0.6 MPa) between early June and late August 1998 and 1999, but cottonwoods along the regulated river had the lowest values. Midday xylem potentials (-1.2 to -2.0 MPa) were well below the reported threshold for substantial cavitation (-1.05 MPa) (Blake et al. 1996) along both rivers during the 1998 and 1999 growing seasons.

Cottonwoods at both sites exhibited strong leaf-level stomatal regulation from 30 to 50% of the daily maximum in the early afternoon, with greater sensitivity to evapotranspirative demand later in the growing season. The differences in the leaf-level daily stomatal conductance between regulated and unregulated river cottonwoods in 1998 and 1999 were small, with Browns Park cottonwoods exhibiting a slightly higher total daily and maximum daily stomatal conductance in July and August. However, the Browns Park cottonwoods on the regulated river had up to a 19% lower leaf area, 13% more dead branches in the canopy, and 70% fewer roots from 50 to 175 cm below the ground surface than the Deerlodge Park cottonwoods. This reduction in leaf and root biomass appears to explain the lack of observed differences in the water status of mature cottonwoods along the regulated and unregulated rivers.

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