EFFECTS OF SILVICULTURAL MANAGEMENT ON LOW GRADIENT STREAM WATER QUALITY IN LOUISIANA

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Oxygen depletion in rivers and streams is among the top 5 impairment types most frequently cited in state water quality reports in the U.S., especially in the South. Such impairments require the development of Total Maximum Daily Loads (TMDLs) or other strategies to ameliorate low dissolved oxygen (DO) levels or high biochemical oxygen demand (BOD). TMDLs allocated to forested waterways in some states have called for reductions in BOD through appropriate harvesting and site preparation techniques. Specific silvicultural prescriptions for riparian areas following best management practice (BMP) guidelines can help mitigate elevated BOD levels in streams. However, recent surveys and research on streams in the South, including unimpaired waterbodies, have encountered naturally-occurring low DO concentrations that are already below state water quality standards (Ice and Sugden 2003).

As part of a larger study conducted by Louisiana State University (Xu and others 2008, Mason and others 2007), this body of research examined changes in DO for a low gradient stream in north-central Louisiana, the role of common silvicultural practices, and the effectiveness of BMPs in maintaining water quality. The DO component of this study employed a before-after-control-impact (BACI) design following Smith (2002), and monitoring water quality parameters at locations above and below a planned forest harvest unit. Water quality was monitored using instrumentation that collected data on DO, temperature, conductivity, and turbidity at 15-minute intervals. This allowed daily DO fluctuations over extended periods of time to be assessed. The clearcut harvest was conducted during the summer of 2007 following current forestry BMP guidelines, and more than 1 year of data was collected before harvest to serve as a baseline.

Water quality measurements taken upstream and downstream of the timber harvest both showed a similar annual pattern, with lower DO in summer months and higher DO in winter months. Measured concentrations of DO at a site located upstream of the harvest unit were below the state standard (3 milligrams per liter) 47 percent of the time, while DO concentrations downstream of the harvest unit were below the state standard 39 percent of the time. During the pre-harvest period DO levels at the upstream site were slightly lower than those at the downstream site. In the post-harvest period the difference increased significantly ($\rho<0.001$) with higher DO measured at the site downstream of the harvest unit. Despite there being no tributaries and only minor differences between upstream and downstream flow conditions, as documented herein by DaSilva and others (2011), these post-harvest observations were evident at various times, covering a range of seasons, in subsequent years. However, the difference in DO was most noticeable during winter when high surface runoff often occurred.

Daily monitoring data from the upstream and downstream locations also included water level measurements for estimating discharge and estimated mass loadings of BOD, inorganic carbon, dissolved organic carbon, and total organic carbon. The study of this low-gradient forested stream in Louisiana demonstrated pre-harvest DO concentrations are naturally low, but are still able to maintain stream conditions for supporting aquatic life (Klimesh and others 2011). In light of this, standards set by state agencies should reflect site-specific and/or seasonal conditions. Post-harvest results from this study, as well as those by researchers in other Southern states, also suggest silvicultural management practices have little or no impact on water quality when BMP guidelines are followed. Impairment determinations and TMDL allocations for existing impairments, therefore, should not only consider the demonstrated effectiveness of forest BMPs, but also the need to account for the natural conditions exhibited in many low gradient streams and other waterbodies in the South.

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