Title: Understanding the role of denitrification as a mechanism for nitrogen (N) removal along a river continuum in central Alabama

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Water Problem and Need for Research

Alabama's Mobile River basin is home to over 3.5 million people (U.S. Bureau of the Census, 2001), many of whom value the state's rural landscape for its high aquatic biodiversity and relatively pristine countryside. Intensified agricultural activity and sprawling urbanization is slowly modifying Alabama's current river geomorphology and water chemistry, with potentially irrevocable changes to the services these ecosystems provide (Bonzongo and Lyons 2004, Warner et al. 2005, Mettee et al. 1989, Ward et al. 2005). Approximately 17-45 percent of the North American species of crayfish, mussels, snails, turtles, and fishes are found in the Mobile River basin, 9 percent of which are currently protected under the Endangered Species Act (Ward et al. 2005). This threat of species loss follows documented increases in suspended sediment and nutrient concentrations across the Mobile River basin, which are known to alter the biomass and productivity of periphyton and phytoplankton communities and at the same time modify critical habitat for macroinvertebrate and fish species (Howard et al 2002). These increases in sediment and nutrient loading to the Mobile River basin are linked to mining, urban and suburban development, point source pollution such as wastewater discharge, and nonpoint source nutrient additions from agricultural activity (Howard et al 2002, Ward et al. 2005). **Indeed, the extent of water quality impairment across the state is dramatic, and highlights the need for research aimed at understanding the controls on nutrient retention in Alabama waterways.** As an example, from 1997-2001, the USGS national water quality sampling effort (NAWQA) found median nitrate concentrations exceeded the USEPA ecoregion criteria at all Alabama sites in the Mobile River basin except Pintlalla Creek, Alabama River, and Tombigbee River (Atkins et al 2004).

In addition to widespread nutrient enrichment, geomorphic modification to the Mobile River drainage through construction of impoundments, channelization, and dredging has the potential to reduce the ability of the river network to retain nutrients, thereby increasing transport of nitrogen (N) and phosphorus (P) to coastal ecosystems (Gergel et al. 2005). This notion is supported by research showing that variation phytoplankton abundance in several Mobile Bay estuaries is directly linked to differences in N delivery from the upstream catchment (Lehrter 2008), and is presaged by well-documented eutrophication in the northern Gulf of Mexico associated with nutrient delivery from the Mississippi River (Rabalais et al. 2002, Dodds 2006). The extent to which nutrient enrichment and associated anoxic conditions persist in the Mobile Bay is largely undocumented (Park et al 2007); however, reducing N transport to Alabama's coastal waterways will likely ameliorate possible loss of commercial and recreational value due to hypoxic events similar to the Dead Zones widely observed in the Gulf of Mexico (Turner et al. 2008). Given accelerating rates of anthropogenic N use and deposition in the Mobile River basin, one current research priority is to better understand what controls the delivery of bioavailable forms of N from terrestrial environments, through stream and river networks, ultimately to the Mobile Bay. Denitrification is a microbial metabolic process that converts dissolved nitrate (NO_3^-) to inert nitrogen gas (N_2), and is thought to be one mechanism by which N can be removed from both terrestrial and aquatic environments. **Here we propose using state-of-the-art analytical and molecular techniques to quantify patterns of sediment and whole-system denitrification along a river continuum within a representative subbasin in the Mobile River drainage (Cahaba River; Figure 1) in central Alabama.**

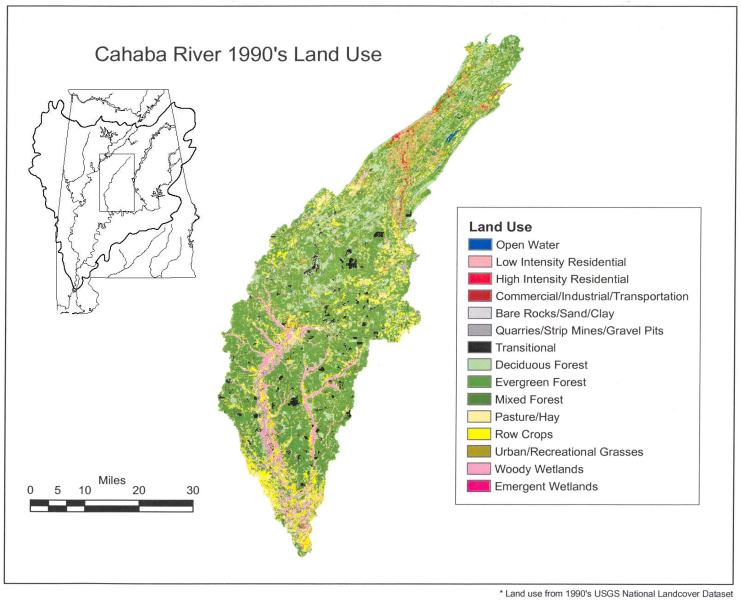

Figure 1. Alabama state map showing the Cahaba River (boxed) and its relationship to the Mobile River watershed, and 1990's land cover patterns in the Cahaba River catchment.