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Late-Quaternary records of vegetation and fire in southeastern North Carolina from Jones Lake and Singletary Lake

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ABSTRACT

We conducted fossil pollen, charcoal, and geochemical analyses of sediment cores from Jones Lake and Singletary Lake spanning the last ~50,000 cal yr B.P. to examine the linkages between climate, vegetation, and fire activity on the Atlantic Coastal Plain, and particularly emphasize changes since the Last Glacial Maximum. Application of the modern analog technique (MAT) to fossil pollen data allowed for quantitative estimates of Holocene climate, but Pleistocene assemblages had no modern analogues preempting their use for quantitative reconstructions. The MAT data indicate markedly lower mean annual precipitation and temperatures during the late Pleistocene relative to the Holocene. Increased charcoal accumulation during interstadials indicates increased fire activity during these warm intervals. Geochemical data ($\delta^{13}C$, $\delta^{15}N$, C:N) and pollen concentrations indicate a sparsely-vegetated Pleistocene landscape that produced few fires followed by an increase in biomass and fire activity around the lakes during the Holocene transition. A *Quercus* spp. maximum in the early Holocene is associated with low charcoal abundances, while increased dominance of *Pinus* spp. during the middle Holocene is associated with dramatic increases in charcoal. It is unclear if the *Quercus-Pinus* transition was the result of changing fire regimes or if the fire regime changed in response to vegetation. The regional asynchronicity of the *Quercus-Pinus* transition may indicate another forcing mechanism besides climate change, such as prehistoric human activity, is responsible for the ecological change. Macroscopic charcoal and C:N ratios reach unprecedented values during the late Holocene, possibly as a result of deforestation by both prehistoric Native Americans and later immigrant populations.

1. Introduction

Numerous fossil pollen records from the southeastern United States broadly describe late-Quaternary vegetation and climate change on the Atlantic Coastal Plain (ACP; Lewis and Cocke, 1929; Delcourt, 1979, 1980; Watts, 1969, 1971, 1975, 1980a, 1980b). However, questions still remain regarding the intra-regional patterns of these changes and the responsible forcing mechanisms (Grimm et al., 1993, 2006; Goman and Leigh, 2004; LaMoreaux et al., 2009; Taylor et al., 2011; Donders, 2014). These lingering questions are a result of poor chronologies, hiatuses in sediment deposition during the late-glacial to early-Holocene transition, and a general lack of suitable late-Quaternary archives, particularly those that extend beyond 25,000 cal yr B.P. and that are located outside of Florida (Fig. 1A; Delcourt and Delcourt, 1985). Recently developed records of environmental change in the southeastern U.S. (Southeast) further highlight the importance of developing new proxy records for the region. For example, temporally-coarse pollen analyses and preconceptions once led many researchers to describe Holocene climate as largely stable in the Southeast (Frey, 1951, 1953, 1955; Watts, 1980a, b; Whitehead, 1981). More recent studies have indicated the Southeast was impacted by significant shifts in climate during the Holocene (Gaiser et al., 2001; Leigh et al., 2004; Goman and Leigh, 2004; Otvos, 2005; Leigh, 2006, 2008; Driese et al., 2008; LaMoreaux et al., 2009; Wang and Leigh, 2011; Rodriguez et al., 2012). Climate interpretations amongst sites are also variable throughout the Southeast. For example, some studies indicate the early-middle Holocene was wetter than today in the Southeast (Goman and Leigh, 2004; Leigh, 2008; LaMoreaux et al., 2009; Kocis, 2011), while others interpret this to be a period of increased regional aridity (Delcourt, 1979;

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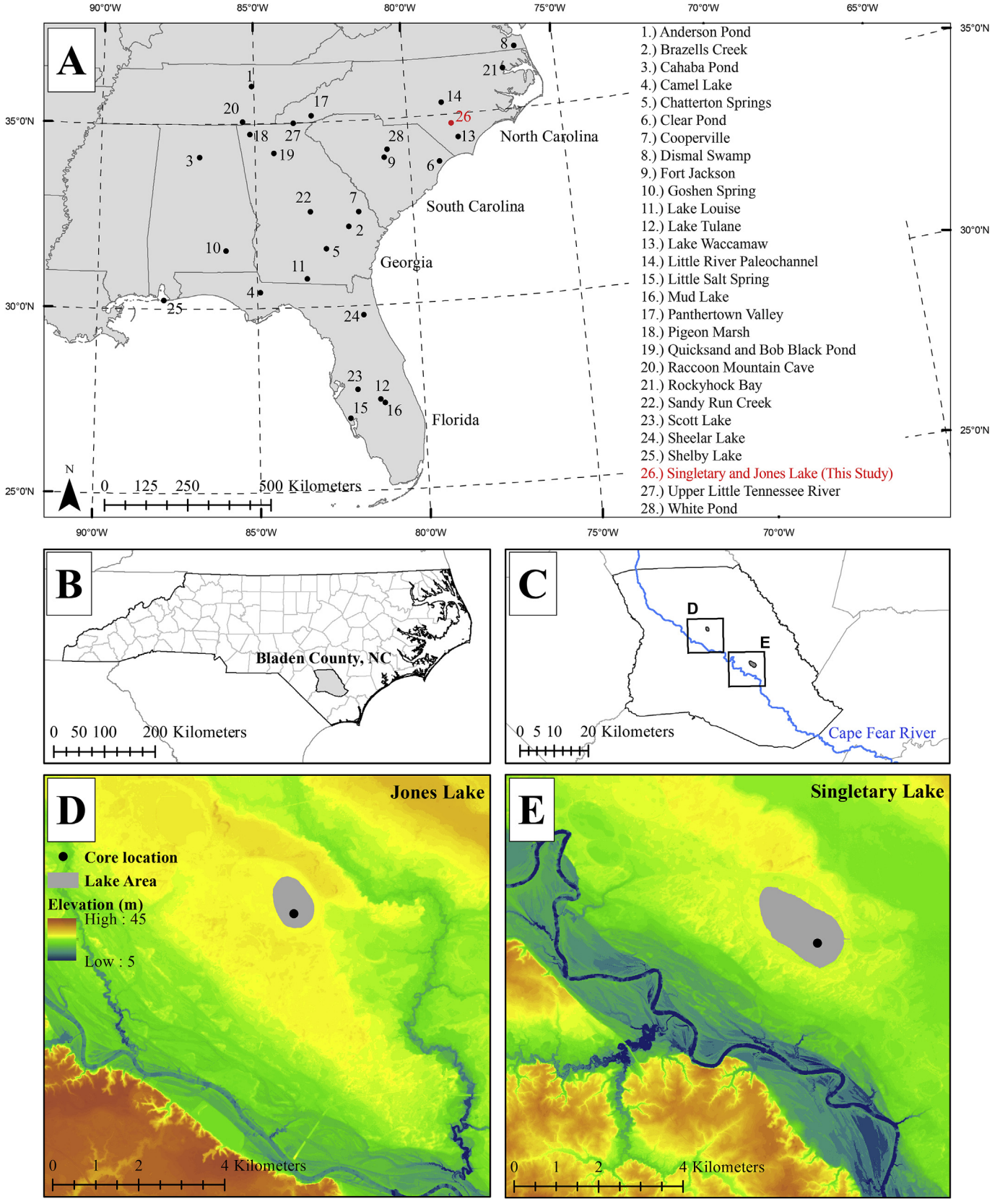

Fig. 1. Regional map and location of other paleoenvironmental study sites in the Southeastern United States (A); location of Bladen County within North Carolina (B); location of Jones Lake and Singletary Lake within Bladen County, NC (C); elevation maps (NC One Map Geospatial Portal, 2016) of Jones Lake (D) and Singletary Lake (E) with corresponding core locations. Other southeastern U.S. paleoenvironmental studies on the map include: 1: Delcourt, 1979; Liu et al., 2013; 2: LaMoreaux, 1999; 3: Delcourt et al., 1983; 4: Watts et al., 1992; 5: Seielstad, 1994; LaMoreaux, 1999; 6: Hussey, 1993; 7: Brook, 1996; 8: Lewis and Cocke, 1929; Whitehead, 1973; 9: Taylor et al., 2011; 10: Delcourt, 1980; 11: Watts, 1971; Tepper and Hyatt, 2011; 12: Grimm et al., 1993, 2006; Donders et al., 2011; Donders, 2014; 13: Stager and Cahoon, 1987; 14: Goman and Leigh, 2004; 15: Clausen et al., 1979; Zarikian et al., 2005; 16: Watts, 1969; Filley et al., 2001; 17: Tanner et al., 2015; 18: Watts, 1975; 19: Watts, 1970; 20: Driese et al., 2012; Li et al., 2012; 21: Whitehead, 1981; 22: LaMoreaux, 1999; LaMoreaux et al., 2009; 23: Watts, 1971; 24: Watts, 1980b; 25: Fearn and Liu, 1995; Liu et al., 2008; 26: Frey, 1951, 1953; 27: Wang and Leigh, 2012; 28: Watts, 1980a.