Goodman MP 4

By: Elizabeth Goodman

As of: Tue Apr 23, 2013 11:12pm EDT
21,236 words - 201 matches - 158 sources

Document Viewer BETA

Similarity Index

11%

Mode: Similarity Report

paper text:

STAKEHOLDER PERCEPTIONS OF WETLAND RESTORATION ON TIMBER LANDS WITHIN THE WACCAMAW RIVER WATERSHED by Ms. Elizabeth B. Goodman Dr. Elizabeth Shapiro, Advisor May 2013

Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University 2013 **Table of Contents I. INTRODUCTION 1 II.** 9

 I. INTRODUCTION The Nature Conservancy considers

the southeastern coastal plain of the United States 136

“a place unlike any other” (2013d, p. 1).

The North Carolina Department of Environment and Natural Resources calls **the** 93

Waccamaw River Drainage Basin and its vast wetland habitats “a showcase of biological richness” (NCDWQ, 1999, as cited in Riggs et al. 2000, Section 3.1.2.). The Waccamaw River, its adjacent hardwood swamps, and wetland tributaries provide habitat for numerous rare aquatic plant and animal species (Lumber River Basin Restoration Priorities [RBRP] 2008). Below its origin at Lake Waccamaw, the river meanders through the “largest remaining cypress/tupelo-gum blackwater swamp in North Carolina” (Lumber RBRP 2008, p. 4). Despite the beauty and ecology of the Waccamaw River, water quality and habitat impairments exist. Land use practices associated with agriculture and residential and commercial development has altered the river, its headwaters, and the floodplain. My research focuses on decades of silviculture, or timber production, which have diminished the water retention of the Waccamaw River’s swamps and wetlands through ditching and draining techniques (Riggs et. al. 2000, Waccamaw Riverkeeper, 2012a). Instead of gradually releasing runoff, the expedited flows cause spikes in river flow, altering natural flood intervals, and increasing riverine sediment loads (Riggs et. al. 2000). A 2000 watershed drainage study prepared by East Carolina University personnel (Riggs et al.) highlights the past hydrologic modifications of the watershed and recommends restorative actions and best management practices within the drainage network to restore wetland hydrology. Within the past 25 years, greater emphasis has been placed on restoring wetlands (Davenport et al 2010; Dale and Gerlack 2007) as well as their numerous ecosystem services. Wetlands provide filtration of nutrients, erosion and sediment control, food and fiber sources, flood attenuation, aesthetics, and outdoor recreation (Millennium Ecosystem Assessment 2005). The

Society for Ecological Restoration (SER) describes its namesake **as** “the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” **(SER** 143

2013, Paragraph 1). Even though ecological restoration is a relatively recent practice, the “movement has captured the imagination of conservationists globally and the serious attention of professional resource managers, ecologists, and the environmentally informed public” (Clewell & Aronson 2006, p. 421). My research focuses specifically on wetland restoration, which is defined by Federal Geographic Data Committee as “the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to former or degraded wetland” (EPA, 2013, Paragraph 2). Within the past 30 years, a large portion of wetland restoration has been conducted to satisfy Clean Water Act permitting, which requires that compensatory mitigation to offset impacts to wetlands (Clewell & Aronson, 2006). Clewell and Aronson (2006) conducted a detailed review of the motivations for ecological restoration, settling on five general rationales: technocratic, biotic, heuristic, idealistic, and pragmatic. Table 1 provides a summary of each rationale, as derived from Clewell and Aronson (2006), which provide a basis for comparison for my research of perceptions and motivations within the Waccamaw River watershed. Table 1. Summary of Rationales for Restoration (Clewell and Aronson, 2006). Rationale Summary Technocratic Large organization and government agency approach “to recover the social values that were once provided by ecosystems prior to suffering environmental impacts” (p. 421) Restoration on publically-owned lands by internal personnel or consulting firms Usually mitigation for compliance with the Clean Water Act Essential at managing large and complex endeavors Authoritative, Top-Down Approach Practitioner acts in technical role instead of identifying creative solutions Limited bonds between nature and culture; public exlusion Projects under-appreciated by stakeholders; public benefits poorly understood Biotic “Scientifically informed by ecological principles and knowledge” p. 422 Increasing biodiversity is a value supported by scientific community and public Mostly used for threatened and endangered species or coral reefs Heuristic “Elucidate ecological principles from ecosystems undergoing restoration and to serve as a pedagogic aid in ecological science” p. 422 Reassembling ecological systems provides answers to biological questions Monitoring and research challenges “The expansion of ecological science is rarely sufficient motivation to initiate a restoration project” (p. 422) Idealistic Supported by human attachment to nature; place attachment Restoration has a strong link to culture: used for “atonement for environmental damage, reentry into nature, renewal of the nexus between nature and culture, and spiritual renewal” (p. 423). Ecosystems treated as inseparable aspects of culture Largely supported by volunteer efforts Slower-pace, and small-scale projects Simply constructed projects that do not use large, costly equipment Lacks structure of data collection and monitoring Has gained success and public support Pragmatic Not currently recognized regime; proposed by authors “Restoration of natural capital” and “restitution of anthropogenic climate change” p. 424 Focus on restoration of ecosystem services to provide natural capital Focus on fostering ecological complexity to attenuate climate change Requires large government or national programs and public unrest with current biological conditions Past restoration research has primarily focused on technical principles; for wetlands restoration, this may include vegetation densities, groundwater levels, or soil profiles. Limited “understanding of the human dimensions of wetlands management means policy makers, natural resource agencies and local project managers have little guidance in how to increase compliance or promote voluntary wetlands stewardship in local communities” (Davenport et al 2010, p. 711; Johnson and Pflugh 2008). Restoration research has only recently included social science principles, such as stakeholder perceptions and participation (Bradshaw and Chadwick, 1980;

Handel et al., 1994; Higgs, 1997; **Montalvo et al., 1997;** 110

Burger 2002). According to Burger (2002, p. 631), management of natural resources, such as the Waccamaw River watershed, must consider “how people with different backgrounds and levels of knowledge conceptualize the central issues in restoration and stewardship". Watershed planning efforts in the Kingston Lake watershed, a tributary to the Waccamaw River, recognized stakeholder identification and partnerships "as critical to the successful development and implementation of a watershed plan" (Libes and Fuss, 2010, p. 3). Recent research is being used to guide natural resource managers and policy makers with a need to understand what influences stakeholder support and consensus on the conservation and restoration of natural resources (Burger 2002, Davenport et al 2010, Alam 2011). Davenport et al. (2010) conducted a study to partially address the deficiency of social research in wetland restoration projects. Their study explores the "social construction of wetlands" (p. 712) by evaluating partnerships and perceptions between the community, as well as public and private agencies, to conduct

wetland restoration in the Cache River Watershed of southern Illinois. 94

Davenport et al. found that "understanding what an ecosystem means to the local community is critical to effective engagement of residents in ecosystem restoration planning and implementation" (p. 719). They make several recommendations for implementing wetland restoration projects, stressing the need to: identify and mitigate project burdens, emphasis local cultural benefits, and acknowledge and reduce uncertainty in restoration outcomes. Another study, conducted by Alam (2011), evaluates community perceptions and attitudes to the Buriganga River in Dhaka City, Bangladesh. The study focuses on the place attachment that may influence residents' engagement with conservation and restoration of the river. Community perceptions of ecosystem restoration relate to the length of time a resident has lived

in the area, their **proximity to the** resource, **and the** extent **of** 4

their involvement with the place (Alam 2011). When the human element is considered in ecological restoration, public and stakeholder support is positively related to restoration progress (Clewell & Aronson 2006; Petursdottir et al. 2013). Integration of social and ecological factors is vital to planning restoration projects and sustaining restoration programs (Petursdottir et al. 2013). As the 2006 Southern Forest Resource Assessment Final Report states "information about values and attitudes equips managers to deal with potential conflicts among stakeholders, to establish policies and goals, and to define broad strategies" (Ch. 7, Introduction). Watershed-based organizations are beginning to understand and incorporate stakeholder collaboration into restoration projects. When evaluating the lessons learned from the Kingston Lake Watershed Plan, a community-based plan in a tributary to the Waccamaw River, Libes and Fuss (2010) emphasized community engagement through outreach talks at existing organizations. They found that "carefully listening to your stakeholders" (p. 4) was essential to clear communication with stakeholders and for tailoring the watershed plan to their priorities. Similarly, in a programmatic case study, the Ecosystem Workforce Program identifies techniques used by watershed councils in Oregon to manage and implement watershed restoration projects (MacDonald et al. 2010). According to MacDonald et al. (2010), "watershed councils have brought together communities, landowners, and state and federal agencies to reach agreement and then develop and implement restoration activities across the state" (p. 13). Watershed councils strategized to engage non-governmental organizations and "build social agreement" (p. 14) to implement their watershed health and salmon management programs (MacDonald et al. 2010). My research focuses on pine plantations, which are typically managed for timber production, and have been associated with extensive hydrologic alterations in the Waccamaw River watershed. The southeastern United States generates about 15

percent of the world's timber harvest **and** more than **60 percent of the** 31

timber harvest in the United States (Wear 2007). Acres of planted pine were practically absent 50 years ago; during this time, timber production has doubled and planted pine increased to 39 million acres (Wear and Greis, 2011). According to David Wear (2007), the

Project Leader for **Forest Economics and Policy** with the **Southern Research Station** of the USDA **Forest Service,** 80

planted pine stands used for timber production are not optimal wildlife habitat and are less diverse than naturally regenerated stands. Although planted pine supports habitat values that are generally greater than for agricultural and developed land uses (Wear 2007), pine plantations are also associated with ditching and draining wetlands, vegetation monoculture, and sedimentation after harvests (Riggs et al. 2000). Public and private timber land owners are beginning to recognize the ecological and financial benefits of restoring natural hydrology and vegetation. "After decades of conflict over timber and other resources, people are bridging the divide and finding common ground" (Bosworth and Brown, 2007; Tidwell and Brown, 2011, p. 386). On a national scale, the US Forest Service plans to "restore the functions and processes characteristic of healthy ecosystems" and provides funding

for restoration solely **on National Forest System lands** through **the** 122

Collaborative Forest Landscape Restoration Program (Tidwell and Brown, 2011, p. 387). Pregernig (2002) conducted a study of forest owners and managers to determine perceptions that effect restorative action in degraded forest stands. Pregernig's study concluded that "the more a person feels (subjectively) affected by the phenomena of forest decline, the more he or she will be prepared to accept innovative restoration measures" (p. 35). Prior to conducting potentially complex restoration measures, the author recommends ensuring the decision -maker is fully aware of the degradation, is convinced that the restorative action will remedy the damage, knows the technological solutions, and is "positive" (p. 35) toward the application of these technologies (Pregernig 2002). As discussed above, past initiatives within the Waccamaw River watershed recommend restoration practices to minimize the impacts associated with silviculture (Riggs et. al., 2000). Despite recommendations for restorative action, minimal restoration efforts have been achieved in the 12 years since the Riggs et al. watershed evaluation. Land conservation, including protection of wetlands, appears to be the primary action by stakeholders within the watershed. Many try to answer the fundamental question: Why do we restore ecosystems? (Aronson & Van Andel 2005; Clewell & Aronson 2006). Yet my research asks: Why not? Why has so little restoration been completed in the Waccamaw River watershed since it was ardently recommended 12 years ago by Riggs et. al.? My research is intended to better understand the stakeholders working within the Waccamaw River watershed and the conservation and restoration efforts that have occurred since Riggs et. al. recommended hydrologic improvements. This research

will be used to understand **the** perceptions **of** restoration practices within **the** 55

watershed, particularly on silviculture lands that have been ditched and drained. Based on my review of Geographic Information Systems (GIS) in counties surrounding the Waccamaw River, forests and pine plantations are a dominant land cover adjacent to and within the floodplain. My scoping conversations and review of agency and non-profit programs reveal an emphasis on conservation; however, there is little understanding of the past and current restoration initiatives within the watershed, particularly on timber lands (Waccamaw Riverkeeper 2012b). My research will be used to answer the following research questions about the Waccamaw River watershed: ? Who are the stakeholders involved in restoration efforts? ? What is the extent of conservation and restoration efforts? ? What are the perceptions of restoration within the watershed? ? What are the constraints in implementing restoration projects? This research will be used by the Waccamaw Riverkeeper, among other organizations, to facilitate conservation and restoration in the watershed. II. RESEARCH SITE There is no special classification or organized sentiment to protect the Waccamaw. It isn't wild or scenic in ways that we have learned to recognize. People have always lived along it, here and there, wherever high land came down to waters, and they have done with their land very much as they wished. The River was taken for granted, a mundane fact with a long, unpunctuated, unheeded history of casual use and abuse. Its swamps has been cut and recut, logs had floated down it, steamboats had churned up it; much of its watershed and many of its tributaries had been drained. Franklin Burroughs, The River Home, page 74 The Waccamaw River drainage basin begins in southeastern North Carolina and flows generally southwest into South Carolina, parallel to the Atlantic Ocean coastline and separated from the ocean by approximately 15 miles (NRCS 2010). The Waccamaw River is distinctive because of its origin from a Carolina bay in Lake Waccamaw in Columbus and Brunswick Counties, North Carolina (SCDNR Website 2012). Overall, the river drains 1,110 square miles and travels about 150

miles from the **headwaters in North Carolina,** through South Carolina, **to the Atlantic Ocean** 88

(see Figure 1). The Waccamaw River has a gentle, or low-gradient, slope common of rivers within the coastal plain. In the 149 river miles

between the headwaters **of the** basin to **the** mouth **of the** Waccamaw River, **the** elevation **of the** 91

water surface changes only 50 feet (a slope of 0.0006 percent) (USACE 1977). The upper extent of the Waccamaw River is only 35 feet wide near Lake Waccamaw, the river width increasing to between 90 and 190 feet from Red Bluff to Conway, and up to 4,000 feet wide as the now-tidal river approaches the Atlantic Ocean (USACE 2009). The upper and middle Waccamaw River is a slow-moving blackwater river surrounded by vast wetlands. As a blackwater river, the Waccamaw's dark, tea-colored, tannin soaked waters meander through expansive bottomland wetlands. Blackwater rivers have naturally low pH, or acidic waters, and low dissolved oxygen levels (SCDHEC 2013). While most aquatic life needs a dissolved oxygen concentrations of 5 milligrams per liter (mg/l) or greater, species have adapted to the Waccamaw River's naturally low dissolved oxygen

levels of less than 5 mg/l, particularly **during warmer** 100 temperatures in the Summer months (SCDHEC 2013). Dissolved oxygen allows bacteria to attenuate anthropogenic materials, such as fertilizer, sewage, or wastewater; low dissolved oxygen levels prevent this attenuation from occurring and can increase river pollution (Waccamaw Riverkeeper website 2012a). Figure 1. Location Map of Waccamaw River Watershed (Waccamaw Riverkeeper website 2012a) The following section describes the characteristics of the research site as it pertains to my research. Most drainage networks and hydrologic modifications are located in the upper and middle Waccamaw River watershed; therefore, the following section focuses on these portions of the watershed and provides

a summary of the features **in the** lower, coastal section **of the** 55

Waccamaw River watershed. A. The Upper Waccamaw River For the purposes of my research, the upper Waccamaw River watershed is considered to be primarily located within southeastern North Carolina, includes Brunswick and Columbus Counties, and extends to the boundary with South Carolina. The uppermost portion of the Waccamaw River watershed, part of the White Marsh subwatershed, extends into Bladen County, North Carolina. Limestone bluffs in this region “act as a natural antacid to the otherwise acidic waters”, allowing unique flora and fauna to flourish (Blythe 2012, Paragraph 6). The Nature Conservancy (2000) identifies the headwaters of the Waccamaw River as a hotspot for biodiversity

based on the combination **of** threats **and** high **presence of** 139

endemic species. Several extensive wetlands, including White Marsh, Juniper Swamp, and the Green Swamp, are a source of water for streams flowing into the Waccamaw River. The Nature Conservancy considers Green Swamp as a “botanical wonderland” (Paragraph 4), containing 14 species of insectivorous plants and several protected animals,

including the red-cockaded woodpecker, the eastern diamondback rattlesnake, and **Bachman's sparrow** 71

(NC Sea Grant 2002). The Green Swamp is approximately 175,000 acres in the north-central part of the Brunswick County (Brunswick County 2007). The eastern portion of Green Swamp drains toward the Cape Fear River, while the western portion flows toward the Waccamaw River. Figure 2. Upper Waccamaw River

Watershed Schematic (Riggs et al 2001). Note: Figure designates the river south of Old Dock as the Lower Waccamaw River watershed.

For the purposes of my research, **this portion of the** 107

river is still considered part of the Upper Waccamaw River watershed. This difference is attributed to Riggs et al.'s focus on the river in North Carolina, and my research site extends into South Carolina. B. The Middle Waccamaw River The middle Waccamaw River

extends from the boundary between **North** and **South Carolina to the** 13

City of Conway, South Carolina, and is entirely located within Horry County. The main distinction between the upper and middle Waccamaw River watershed is the occurrence of drainage canals dug in the 1950s

by the United States Army Corps of Engineers (Section 103

II.D.1). Major tributaries to the river in this area include Buck Creek, Simpson Creek, Todd Creek, Crabtree Swamp, and Tilly Swamp. This portion of the Waccamaw River watershed is the target of watershed planning efforts because increased development related to the City of Conway and

City of Myrtle Beach, both **located in Horry County, South Carolina** (Libes **and** 77

Fuss 2010). Horry County's population increased by 36.5 percent between 1990 and 2000 with another 71 percent increase projected for 2000-2025 (Horry County 2008, as cited in Libes and Fuss 2010). Kingston Lake, which includes the Crabtree Swamp and Canal, is the focus of several watershed planning efforts (Libes and Fuss 2010, Coastal Carolina University 2006). C. The Lower Waccamaw River and Winyah Bay Below the City of Conway, South Carolina, the river transitions into a wider, tidally- influenced river (USACE 1977, Burroughs 1992). As the river approaches Georgetown County and the City of Georgetown, muddy waters from the Great

Pee Dee River merge into **the Waccamaw River'** s blackwater. **The** 140

Waccamaw River, along with other rivers, flows into the Winyah Bay near Georgetown, South Carolina. The Winyah Bay contains 525,000 total acres (The Nature Conservancy 2013b) and the “largest contiguous block of tidal freshwater wetlands in South Carolina” (Lowcountry Open Land Trust 2013, Paragraph 2). The Winyah Bay is the third largest estuarine basin on the East Coast (Lowcountry Open Land Trust 2013), supporting

habitat for a variety of avian **wildlife, including** bald eagles **and** 116

peregrine falcons. Threatened and endangered species, including red-cockaded woodpeckers,

short-nosed sturgeon, loggerhead sea turtles, least terns, piping plovers, and wood storks, 64

can also

be found in the habitats **of** Winyah Bay. **The** 155

Nature Conservancy states that Winyah Bay is of national significance (2013b). D. Land Use in the Waccamaw River Watershed The Waccamaw River was historically used for commerce to transport products from rice fields and turpentine and logging industries (Blythe 2012, Burroughs 1992). The Waccamaw River was first used by Englishmen for trade in the early 1700s; the river became increasingly important for commerce and exportation of goods as settlers began to clear the land (USACE 1977). In the mid-1800s, timber could be rafted all the way down from Lake Waccamaw, and transferred to larger vessels in Conway (USACE 1977, Burroughs 1992). After dredging projects were completed on the Waccamaw River in 1880s (see below), the volume of commerce extended to Lake Waccamaw (USACE 1977). The present day limit of interstate commerce navigation is Red Bluff, South Carolina (USACE 1977). Extensive wetland systems surrounding the Waccamaw and Pee Dee Rivers isolated much of southeastern North Carolina and northeastern South Carolina (Burroughs 1992, Riggs et al. 2000). “Impenetrable” Carolina bays and swamps prevented coastal tourism-related development until the mid-1900s (Burroughs 1992); instead, land use was confined to agriculture and forestry (Riggs et al. 2000).

According to the Horry **County** 2008 Envision **Comprehensive Plan,** 150 “although the commercial function of the Waccamaw has waned, the river is a critical component to Horry County’s ecological health and provides many recreational opportunities for residents and visitors alike” (p. 33). Currently, the river is used for recreation, water sports, and fishing. According to the Waccamaw Watershed Academy website, water quality is good in the Waccamaw River since the watershed is fairly undeveloped. It also is a drinking-water supply (Waccamaw Watershed Academy 2013) and source of power-plant cooling water (Blythe 2012). Outside of the municipal areas of Conway,

Myrtle Beach, North Myrtle Beach, and Longs, **South Carolina,** 19

and Whiteville, North Carolina, land use within the watershed remains primarily agricultural, timberland, and residential. Timber production, as well as agriculture, contributes to the regional economy (Lowcountry Open Land Trust 2013). 1. Navigational and Flood Control Projects Numerous flood control and navigation projects have been completed on the Waccamaw River and its tributaries. In 1776, the General Assembly of South Carolina passed a state act to "oblige all male inhabitants residing on or near Waccamaw River, to work on and lay open the navigation of the said river” (as quoted in USACE 1977, p. 07-12). The River and Harbor Acts of June 14, 1880 and July 3, 1930 authorized dredging the Waccamaw River channel between Conway and Red Bluff, South Carolina, and clearing trees and debris within the river up to Lake Waccamaw (USACE 1977, USACE 2009). According to a 2009 US Army Corps of Engineers report, the last maintenance work conducted on the Waccamaw River was clearing and snagging the channel in November 1976. Several tributaries to the Waccamaw River remain within Watershed Conservation Districts, in which swamps and streams were channelized by the US

Army Corps of Engineers under **Section** 205 **and** 208 **of the** Flood Control **Act of** 90

1954. Most of the channels are now maintained by county or municipal authorities tough regular dredging and mowing vegetation on the banks. One of the flood control projects include 5.1 miles of channel improvements and 1 mile of clearing and snagging on Crabtree Swamp completed in 1966 (USACE 2009). 2. Watershed Threats A primary threat to the Waccamaw River watershed is past and current impacts to wetlands and riparian corridors, and the subsequent loss of associated functions, such as natural filtration of pollutants. The Waccamaw Riverkeeper also identifies non-point source pollution as an existing threats to the watershed, stating that the loss of wetlands, “and their natural ability to remove pollutants, exacerbate these problems” (2012a, Paragraph 12). Increased urbanization has also resulted in fragmented natural resources, reducing wildlife diversity and degrading water resources. In some cases, coastal development occurs on former wetlands that were drained by ditches for agriculture or silviculture use (Riggs et al. 2000). Uncontrolled development can cause loss of wetlands, pollution from stormwater runoff, and soil erosion, as well as a decreased ability to manage forestland with prescribed fire (The Nature Conservancy 2011). Urbanization also increases the risk that invasive plants harmful to native ecosystems, such as water hyacinth, Chinese privet, and kudzu, will intrude on and displace native plant communities (The Nature Conservancy 2011). Soil erosion, and the resultant sedimentation, is also identified as a threat to the watershed. According to the

South Carolina Department of Health and Environmental Control (SCDHEC) 34

(2013),

there is a significant increasing trend **in** turbidity on **the** 13

Waccamaw River at the monitoring station on Highway 9, just south of the North Carolina-South Carolina border. Riggs et. al. (2000) attribute increased riverine sediments to silviculture practices, because the removal of vegetation and hydrology through ditch networks exposes the soils to erosive sheet flows during rain events. Networks of ditches, used to drain wetlands and prepare land for pine production, have impacted the wetland function of retaining and slowly-releasing groundwater (Waccamaw Riverkeeper 2012a). Significant fluctuations in river flow have been documented

by the U.S. Geological Survey (USGS); while fluctuations **are** 132

natural, alterations such as the ditch networks have intensified changes in river flows (Waccamaw Riverkeeper 2012a). Pollution from upriver hog farms also threatens the watershed. In July 2012, a North Carolina hog farm owner was prosecuted for intentionally discharging hog waste into a tributary of the Waccamaw River. While most of the waste was ultimately pumped out of the river into treatment ponds, a citizen within the watershed reported “creepy” blue-toned pollution could still be seen within the tributary (Blythe 2012, Paragraph 14). 3. Water Quality Impairments According to the Waccamaw Watershed Academy website (2013), water quality is good in the Waccamaw River since the watershed is fairly undeveloped. However, the SCDHEC identified high levels of mercury in fish species, low dissolved oxygen levels, and fecal coliform contamination (SCDHEC 2013). SCDHEC issued a fish-consumption advisory in 1994 after the high levels of mercury were found. While the source of the mercury is uncertain, it is known to occur in nature and originate in the atmosphere (Waccamaw Riverkeeper website 2012a). According to Riggs et. al. (2000), sedimentation in riverine systems can carry and store toxic metals, including mercury. SCDHEC, in their 2010 Mercury Assessment and Reduction Initiative, suggests that surface waters in the Pee Dee drainage basin, including the Waccamaw River, “naturally speed up the availability of methylmercury for bioaccumulation in fish” (p. 55). SCDHEC attributes the rapid conversion of mercury to methylmercury to biogeochemical characteristics of blackwater rivers, including low pH, high organic matter, and sulfur and iron content. III. SOUTHEASTERN UNITED STATES TIMBER INDUSTRY Timber lands and production are an integral

part of the history, culture, and economy **in the** Southeastern **United States.**	135

During the past two centuries, market conditions have shifted between agriculture and silviculture, influencing Southeastern land use and the condition of the region’s forests (Wear 2007). The southeastern United States generates about 15

percent of the world’s timber harvest **and** more than **60 percent of the**	31

nation’s timber harvest (Wear 2007). Since 1986, “if the South were compared with any other country, none would produce more timber than this one region of the United States” (Wear and Greis 2011, p. 17). Since the 1970s, timber production in the Southeast has shifted from harvesting volunteer growth to pine plantation forestry (Wear and Greis 2011). Acres of planted pine were practically absent 50 years ago; during this time, timber production has doubled and planted pine increased to 39 million acres (Wear and Greis, 2011). The wood-related sectors of the South’s economy contributed more than 1 million jobs and more than 51 billion dollars of employee compensation in 2009 (Wear and Greis 2011, ch. 12). Silviculture was South Carolina’s leading manufacturing industry in 2006, generating $4.1 billion in labor income (South Carolina Forestry Commission 2006). Timber forecasts suggest continued growth of planted pine in the Southeast because of genetic and silvicultural improvements (Wear and Greis 2011). Although planted pine is widespread throughout the Southeast, the vast majority of pine plantations are located in the Coastal Plains, such as the Waccamaw River watershed. According to the 2011 Southern Forest Futures Report, 27 percent of forests are in pine plantation (Wear and Greis 2011). A. Change in Timber Land Ownership In the late 1990s, the forest products industry held about 20

percent of the forest land in the South (Wear **and** 124

Greis 2011). The 2011 Southern Forest Futures Report defines the forest products industry as vertically integrated timber products companies, or publicly-traded and privately-held organizations that produce paper and/or wood products from forest resources and own or lease more than 100,000 forest acres in the United States. According to the 2011 Southern Forest Futures Report, “the largest ownership transition in the last century” occurred between 1998 and 2008 when the forest products industry divested about three fourths of its timberland holdings in the southeastern United States (Wear and Greis 2011, Ch. 6, p. 1). During this period, the forest products industry ownership declined from 23.4 to 7.5 million acres (Wear and Greis 2011). The divestiture was caused by several factors, including debts incurred during corporate mergers in the 1990s, undervalued timber land in stock prices, the tax burden in holding timber land, and easing timber-scarcity concerns (Wear 2007, Wear and Greis 2011). International Paper divested much of their land within the Waccamaw River watershed, including large parcels in the upper watershed near Green Swamp (Interviews Jan 18th, 2013). Timber investment organizations (TIMOs) acquired most of the land divested by the forest products industry. TIMOs are management companies that aid institutional investors in buying, selling, and managing their timberland investments (Wear and Greis 2011). During the divestiture of forest product industry lands, TIMOs land holdings in the southeast increased from 2.2 to 13.4 million acres. Wear (2007) estimates that about 25 different large TIMOs operate

in the United States. Unlike **the forest products industry,** 129

the investors and pensions funds that have purchased timber lands through TIMOs are not subject to the corporate income tax. TIMOs and their clients include investors with long run and short run investment horizons, focus on recreational as well as timber values, and, in some cases, partnerships with large conservation groups (Wear 2007). The primary result of this change in timber land ownership is increased liquidity in land holdings (Wear 2007, Wear and Greis 2011). TIMOs focus on maximizing profits from forest management and land sales, instead of timber production. TIMOs generally focus on 10 to 15-year returns, a shorter return period than the forest products industry (Wear 2007). Land assets may be sold for alternative uses as the TIMOs reassess the highest and best use of forestland holdings. According to Wear (2007), “this structure of ownership, with frequent transactions, is more likely to encourage continuing fragmentation of forests" (p. 9). As noted above, the change in land ownership has presented a unique opportunity for conservation groups within the southeastern United States (Weinberg and Larson 2008). The sale of land by the forest products industry and fragmentation of large timber parcels has allowed conservation groups, such as The Nature Conservancy, to purchase land or partner with TIMOs to acquire conservation easements on land with environmental value (Wear 2007, Wear and Greis 2011). B. Regulations and Best Management Practices

The Clean Water Act of 1972 (33 U.S.C. 1344) 79

uses regulatory policy to prevent the discharge of fill material into wetlands and provides the basis for

compensatory mitigation programs **to offset impacts to** 54

wetlands. Permits are required for actions that fill wetlands

under Section 404 of the Clean Water Act. Sections **404(** f **)(1)(A** 81

– F)

of the Clean Water Act exempt certain practices **from the** 144

permitting regulations. Normal agriculture and silviculture practices do not require permits for plowing, seeding, cultivating, or minor drainage if these practices are part of an established, on-going operation. Minor drainage in wetlands or waters under the jurisdiction of the United States should not convert a wetland to upland or drain aquatic resources, such as wetlands, bogs, or streams. Permanent or temporary roads used for farming or forestry activities are also exempt from the Section 404 permitting requirements; yet these roads and all farming and timber practices must occur in accordance with the state's Best Management Practices (BMPs) manual. New farming or forestry practices that require hydrologic modification are not exempt

from Section 404 of the Clean Water Act. 112

Best Management Practices (BMPs) that limit soil disturbance and hydrologic alterations must be used during site preparation and establishment of pine plantations. Per the Clean Water Act, silviculture must avoid immediate or gradual loss of wetland habitat and maintain the flow, circulation, or reach of federal waters. Though there is generally good adherence to the BMP by the professional forestry community, the BMPs recommend narrow riparian buffers usually less than 50 feet wide. Riparian buffers filter and trap sediment from runoff and erosion from timbered forest lands. Davies and Nelson (1994), as cited in Wenger 1999, found that vegetative buffers lessen sedimentation from logged forests to streams and rivers. The authors found that approximately 100 feet of buffer prevented impacts of erosion and instability associated with timber harvests. According to the Waccamaw Riverkeeper, silviculture practices impact the riparian corridor along the river, particularly in upper extent of the watershed in North Carolina. C. Perceptions of Forestry According to the

South Carolina Statewide Forest Resource Assessment and Strategy 7

(2010), population growth within South Carolina has resulted in new residents that have different views on forestry than people who have lived in the State all of their lives. Anecdotal information indicates that newcomers may be less familiar with timber harvesting operations, so they may advocate for regulations against logging. Many of these newcomers are more accustomed to older, natural hardwood forests versus the young pine plantations that are actively managed and commonplace in South Carolina

(South Carolina Statewide Forest Resource Assessment and Strategy 7

2010). The

Southern Forest Resource Assessment Final Report **(Wear and Greis 2002)** found **that** 104

public values have “shifted away from a commodity-oriented, anthropocentric approach to forest management and toward inclusion of natural biological factors in a biocentric approach” (Ch. 7, Section 5.4). A survey conducted as part of the 2002 Southern Forest Resource Assessment identified a moderate pro-environment attitude among respondents (Wear and Greis 2002). The survey found that 62.5 percent of respondents felt that “too little” resources were expended to protect forests in the Southeast, over six times the percentage (9.2 percent) that reported “too much” resources were used (Wear and Greis 2002, Ch. 7, Section 5.4). Bengston (1994) argues that the timber industry needs to adapt to evolving change in environmental and social values. D. Forest Stewardship Certifications The Sustainable Forestry Initiative is a globally-recognized certification that is used by forest owners and managers to demonstrate their use of sustainable forestry practices. Sustainable forestry practices are intended “to meet the needs of the present without compromising the ability of future generations to meet their own needs” (SFI, 2010, p. 3/14). Participants in the Sustainable Forestry Initiative, including TIMOs, are third-party certified for their compliance with the following principles with relevance to my research (SFI, 2010): ? “Managing forests for ecosystem services, including conservation of soil, air and water quality” (p. 3/14), in addition to aquatic habitats and biological diversity. ? “Protect water bodies and riparian zones, and to conform with best management practices to protect water quality” (p. 3/14). ? “Manage forests in ways that protect and promote biological diversity” (p. 3/14), and ecological or natural community types. ? Protection of ecological Special Sites. E. Silviculture in the Waccamaw River Watershed A primary land use within the Waccamaw River watershed is agriculture and silviculture (Brunswick County CAMO 2006, SCDHEC 2010). In the 1850’s, timber was harvested from swamps using steam skidders and railroad trams (Riggs et. al., 2000). Timber harvests occurred during dry seasons and logs were “rafted” down the Waccamaw River to the City of Conway, South Carolina (Burroughs 1992, p. 53). The transport of timber down the Waccamaw River initiated the industrialization of the river near the City of Conway (Horry County 2008). Timber harvests were dependent on weather and water-levels in the Waccamaw River floodplain, instead of the more recent practice to ditch and drain wetlands to increase productive timber lands (Riggs et. al., 2000). Franklin Burroughs, in his travels down the Waccamaw River, describes how the logging industry dug canals and built causeways

in the twentieth century, resulting **in the** degradation **of the** 126

Waccamaw watershed (1992). During the 1920s, Riggs et. al. (2000) and Burroughs (1992) reported that lumber companies ditched portions of the upper Waccamaw watershed, known as the Penholoway wetlands, toward the Cape Fear River, causing lower water levels in the Waccamaw River and contributing to sand deposition. The Socastee wetlands, located in North Carolina near Old Dock and Crusoe Island were the next focus of ditching and draining efforts (Riggs et al. 2000). Some of the most extensive hydrologic alterations have occurred within the Green Swamp, located

in the eastern portion of the watershed. The 119

Green Swamp used to sheet flow across the vast floodplain prior to extensive ditching and draining in the 1930s (Riggs et al. 2000). The Green Swamp was once approximately 200,000 acres, but was drastically reduced in 1955 by drainage systems associated with silviculture (Riggs et al 2000). During this time, the “window-pane” (p. 119) drainage pattern emerged within the watershed, meaning that wetlands were drained through a lattice of primary and secondary ditches and converted into “agricultural-style” (p. 116) pine plantations (Riggs et al). Window-pane drainage is rarely practiced today; however, Riggs et al. argue that such drainage networks are no longer necessary since most of the land was converted by the mid-1980s (2001). The window-pane drainage pattern can be seen within Green Swamp

as shown in Figures **3 and 4.** 152

Figure 3. Development History of Drainage Ditches and Roads (Riggs et al. 2001). Figure 4. Infrared Aerial Photograph of “Window Pane” Ditching and Draining in Green Swamp (Upper Waccamaw Watershed) (Riggs et al. 2001). The White Marsh wetlands,

located in the western portion of the watershed, 120

have remained relatively undisturbed and continue to sheet flow across the floodplain. The silviculture modifications spared Juniper Creek and the Waccamaw River near the North Carolina boundary. F. Effects of Ditching and Draining According to Wear (2007), while planted pine is not optimal wildlife habitat, it supports habitat values that are generally greater than for agricultural and developed land uses. Planted forests are less diverse than naturally regenerated stands, although young stands can provide scarce open, early successional habitats in certain places (Wear 2007). Drainage ditches, whether used for agriculture or silviculture, are designed to quickly transport surface water off the land (Riggs et. al. 2000). Drainage ditches transform slow-moving sheet flow across the wetlands into a channel that lowers the surficial water table and bypasses the wetlands (Riggs et al 2000). The Nature Conservancy states that sheet flow causes slow stormwater infiltration, allows sediment to deposit instead of flowing into the river, and maintains water levels (NC Sea Grant 2002). Brinson (1991) has attributed several changes within the Waccamaw River to the development of drainage networks and conversion of vegetation to pine monoculture, including changes in water runoff and river flow, increased sedimentation, and decreased downstream productivity. These past timber management techniques have decreased the wetland function of retaining and slowly-releasing groundwater to the surrounding streams and Waccamaw River (Waccamaw Riverkeeper 2012a). The extensive drainage networks within the upper

Waccamaw River watershed have lowered the groundwater table, disrupting wetland habitats and altering runoff and river flows (Riggs et al 2001, Brinson 1991). Significant fluctuations in river flow have been documented by the USGS; while fluctuations are natural, alterations such as the ditch networks have intensified changes in river flows (Waccamaw Riverkeeper 2012a). An evaluation of a river gauge at Longs, South Carolina by Coastal Carolina University shows an increasing trend in river fluctuation in the past 60 years (see Figure 5). A study conducted by Bales and Pope (1996) compared the Waccamaw and Lumber River's peak flows. The Lumber River is a similar blackwater river with less hydrologic modification. Differences in peak flows were attributed to "vast amount of drainage ditching" (Riggs et al. 2000, p. 136) within the Waccamaw River basin (Bales and Pope 1996). Riggs et al. (2000) also attribute sand deposition within the Waccamaw River to erosional events that are mobilized by tributaries and ditches. Clear-cutting along stream and river banks causes bank erosion and sediment production, which is evident in "fan deltas of sand deposited at the mouth of the ditch or tributary stream" (Riggs et. al., 2000, p. 145). Another potentially irreversible effect of the drainage ditches has been the drying out of organic peat in the upper Waccamaw River watershed, which oxidizes and causes regional land subsidence (Riggs et al 2000). Heavy logging equipment and associated soil disturbance exacerbates oxidation processes. Unique "ridge and swale" (p. 145) features formed by the Waccamaw River are also impacted by the networks of drainage ditches and logging equipment (Riggs et. al. 2000). The conversion of diverse habitats, such as those found in the upper Waccamaw River watershed, to pine plantations, are creating monocultures and impacting endemic habitats within the watershed (Riggs et. al., 2000). In addition to drainage ditches, the construction of logging roads influenced the hydrology of the upper Waccamaw River watershed. In most cases, fill material from the digging the drainage ditches was side cast and used to elevate logging roads from the floodplain. According to Riggs et al. (2000), "drainage ditches and roads are intimately paired" (p. 131). During heavy rainfalls, logging roads can impound flood waters or cause waters to sheet flow across the wetlands, potentially offsetting the effect of the drainage ditches (Riggs et al. 2000). Figure 5. Discharge at Longs, SC Monitoring Station between 1951 and 2012 (Libes 2013). IV. THE CALL FOR RESTORATION "The environmental problems within the Waccamaw drainage system did not happen overnight. Therefore, restoring this precious resource will not only take time, but must be citizen driven, involve all user groups, and be based upon good science and a complete understanding of the entire plumbing system of the Waccamaw drainage system. To accomplish this, it is imperative that a program be undertaken to educate both the public, private, and political sectors about the importance for making changes and necessity for getting involved in the River. The action or inaction that begins today will determine the character and quality of the Waccamaw drainage system for our children and grandchildren". Stan Riggs et. al. 2000.

The Waccamaw River **system is in**	158

"serious jeopardy due to centuries of extreme land-use modifications resulting from growth and development pressures" (Riggs et al., 2000, p. 13). Causes of instability include draining vast wetlands with ditch networks and conversion of native, diverse ecosystems to monoculture pine plantations. In their study of the Waccamaw River watershed, Riggs et al. (2000) identify the ditch network and drainage modifications as the "greatest importance to the problem of sediment pollution" (p. 33). Riggs et al. provide several recommendations to improve the Waccamaw River watershed and drainage system. Among the recommendations is the development of a

Regional Water Management Council and **a Watershed Management Plan.** 125

To date, a Regional Water Management Council has been created as a Waccamaw River Taskforce and the development of a Waccamaw Riverkeeper position within the Winyah Riverkeeper foundation. A Watershed Management Plan has not been developed for the entire watershed, although watershed management planning is occurring on tributaries to the Waccamaw River, such as Kingston Lake (Coastal Carolina University, 2006). The authors also recommend a maintenance plan to temporarily re-establish sheet flow conditions across wetlands by closing and opening drainage ditches and logging roads (Riggs et. al. 2000). Recommended restorative practices include plugging ditches, encouraging beaver communities to construct dams construction within drainage ditches, and breaching logging roads to expose wetlands to sheet flow. In addition to these hydrologic improvements, the authors also recommend improvements of land management adjacent to waterways, ditch networks, and steep slopes (which, in the coastal plain, usually only occur on roadway side slopes). Recommended Best Management Practices (BMPs) include buffering drainage ditches and tributaries and constructing risers and weirs to support wetlands adjacent to streams. The intentions of these recommendations are to retain hydrology within the soils and reduce erosion on exposed soils, thereby reducing sediment pollution within the Waccamaw River. Programs and initiatives to restoration of aquatic resources on public and private timber lands have existed for over 20 years. Federal programs are available to provide an incentive for landowners to protect, enhance, or restore wetlands. For example, in 1992, the USDA Natural Resources Conservation Service (NRCS) established the Wetlands Reserve Program (WRP) for this purpose. Landowners voluntarily remove portions of their agricultural or silvicultural land to enroll in the cost-share program, while the USDA-NRCS provides technical and financial support. Recent initiatives also encourage restoration as a component of timber management. "After decades of conflict over timber and other resources, people are bridging the divide and finding common ground" (Bosworth and Brown, 2007; Tidwell and Brown, 2011, p. 386). On a national scale, the US Forest Service plans to "restore the functions and processes characteristic of healthy ecosystems" (Tidwell and Brown, 2011, p. 387).

The Omnibus Public Land Management Act of 2009 created the Collaborative Forest Landscape Restoration 82

Program for long-term restoration projects that engage federal partners in long-term collaborative restoration on a landscape scale (Tidwell and Brown, 2011). However, funding from the Collaborative Forest Landscape Restoration Program can only be used on National Forest System lands. V. OBJECTIVES In 2000, Riggs et al. recommended restorative action to attenuate the detrimental effects of drainage networks in the upper Waccamaw River watershed. Yet, based on my experience within the Waccamaw River watershed, minimal restoration efforts have been achieved in the 12 years since the Riggs et al. watershed evaluation. Land conservation, including protection of wetlands, appears to be the primary action by stakeholders within the watershed. My research asks: Why has so little restoration been completed in the Waccamaw River watershed since the Riggs et al. recommendations? The intention of my research is to document the conservation and restoration efforts that have occurred within the Waccamaw River watershed since Riggs et. al. recommended hydrologic improvements. My research

will be used to perceive the effectiveness and impacts of 113

restoration practices within the watershed, particularly on silviculture lands that have been ditched and drained. Secondary research questions therefore include: ? What past, current, and proposed restoration efforts are occurring in the Waccamaw River watershed? ? Who are the stakeholders involved in implementing the restoration and what are their motivations (i.e. financial, social) in restoration efforts? ? What programs are currently used within the Waccamaw River watershed to encourage restoration on timber lands? ? What are the stakeholders' perceptions of restoration and how do these perceptions influence land management within the watershed? Over the next two years, the Riverkeeper plans to coordinate a community planning group comprised of representatives from timber companies, local communities, municipalities, and conservation organizations. This research correlates with the objectives of community planning group, which is to evaluate timber management and the effect of ditching and draining on sedimentation and other water quality issues within the community. My research compliments these initiatives by providing a better understanding of stakeholders, restoration efforts, and perceptions of restoration. VI.

METHODS Data were collected for my study through key informant interviews with 2

10 public, private, and non-governmental organizations involved in conservation efforts within the watershed, but representing diverse purposes. My sampling strategy for selecting stakeholders within the watershed was purposive, but designed for heterogeneity (Davenport 2010). A list of stakeholders from public, private, and non-governmental organizations was generated early in my research through discussions with the Waccamaw Riverkeeper. I used a snowball sampling method to expand my list of stakeholders. This technique, also known as chain referral recruitment technique, involved asking the key informants for referrals of other stakeholders in the watershed (Davenport 2010). I limited the sample pool to organizations actively working in the Waccamaw River watershed, meaning the organization was currently conducting research, funding projects, or owned conservation lands within the watershed. Participants have been or currently are involved with conservation or restoration projects within the Waccamaw River watershed. During project scoping, the timber industry was identified as a stakeholder within the watershed because of extensive land holdings within the watershed and adjacent to the Waccamaw River. Geographic Information System (GIS) data obtained from public sources, including North Carolina data portal, South Carolina Data Clearinghouse, and individual Counties, was used to identify timber companies with large land holdings (>1000 acres) within the watershed. Based on a review of GIS parcels within the Waccamaw River watershed, properties greater than 1,000 acres are typically owned by a land conservancy, government agency, or timber companies. I also used the semi-structured interviews conducted with public, private, and non-profit organizations to identify timber companies active in the watershed. Semi-structured interviews with 2 key informants from the timber industry were conducted will

be used to determine what programs, if any, **are** used **to** 117

promote restoration on timber lands. Interviews were conducted via telephone with representatives of public, private, and non-governmental organizations. Information shared in interviews was recorded through detailed note taking. Where possible,

interviews were conducted in-person **with representatives** from **the** timber **industry,** typically at **the** 131

participant's office during normal work hours. In- person interviews were recorded with the participant's consent. In-person interviews were conducted with representatives from the timber industry, rather than representatives of public, private, and non-governmental organizations, in an effort to establish trust during the interview process. All participants were informed of the

purpose of my **study and** requested **to sign a consent form prior to** participating in **the** interview. I conducted **semi-structured** interviews using **an interview script** 2

for public agencies, universities, and non-governmental organizations (Appendix A) and representatives from the timber industry, primarily TIMOs (Appendix B). Separate scripts were created for these stakeholder groups because the questions were structured to answer my research questions, which required tailoring the questions to the type of stakeholder. The interview script directed my open-ended questions, but I maintained the ability to request additional information and clarify or expound upon responses (Davenport 2010; Babbie 2010). The script for public agencies, universities, and non-governmental organizations (Appendix A) included 11 primary questions, while the script for the timber industry (Appendix B) contained 20 primary

questions. Interviews with participants ranged from 30 min to 1 hour. **The** 2

Duke

University Institutional Review Board approved the research design, data collection methods, **and** scripts **for** 67

compliance with their human subjects research protocol. The study participants were asked about their participation in wetland conservation and restoration, their perception of the need for restoration within the watershed, their relationships with agencies and non-profit organizations, and factors that influence their participation wetland restoration. My goal was to determine if stakeholders felt that restoration was needed within the watershed, to understand which programs are effective in developing restoration projects, and to identify obstacles of conducting restoration within the watershed. Interviews were conducted until I obtained theoretical saturation, “meaning that the driving research questions were sufficiently answered and little theoretical insight would be gained by conducting additional interviews” (Davenport 2010, p. 715; Babbie 2010). Interviews with agencies, non-profit organizations, and timber companies were used to identify key themes in planning and implementing restoration projects in the Waccamaw River watershed. The key themes were also identified in a content analysis of each stakeholder's organizational or management plans and conservation and/or restoration plans. Similar in- depth, open-ended interviews were conducted by the Ecosystem Workforce Program with the coordinators of watershed councils in Oregon to determine how the councils managed, developed and implemented restoration projects (MacDonald et al. 2010). VII. RESULTS A. Restoration since Riggs et al. In the twelve years since Riggs et al. completed their evaluation of the Waccamaw River watershed, several restoration projects have been implemented. At the onset of stakeholder interviews, the stakeholders were asked to describe past and current wetland-based initiatives in which their organization or agency participated. These questions were used to provide an understanding of wetland initiatives within the Waccamaw River watershed beyond publically- available sources. Identified restoration projects are shown on Figure 6. The primary example is the Crabtree Canal Restoration, although the restoration focused on a drainage ditch dug

by the US Army Corps of Engineers and is unrelated **to** 42

silviculture impacts. However, it provides an example of partnerships and funding mechanisms used to implement restoration, as well as constraints of doing restoration in an urbanizing environment. The remainder of restoration projects have yet to be implemented, but are planned as part of several mitigation banks proposed within the Waccamaw watershed. Figure 6. Restoration Projects Conducted or Proposed in the Waccamaw River watershed since 2000. 1. Crabtree Canal Restoration The Crabtree Canal Restoration project is located in the Kingston Lake sub-watershed, which flows around the City of Conway in Horry County, South Carolina and discharges into the Waccamaw River. After a major flooding event in the early 1960s, the US Army Corps of Engineers dredged an eight-mile canal through Crabtree Swamp to prevent and control flooding (Thepaut et al. 2012). For the past fifty years, Horry County has maintained the canal by dredging deposited sediments and mowing the canal banks (Interview Jan 23, 2013). According to Thepault et al. (2012), "the dredge materials were piled onto the adjacent banks, creating a very steep, unstable levee system that isolated the remaining floodplain, increased water velocities, and eliminated habitat and fish spawning grounds" (p. 1). As the City of Conway's population grew, residential and commercial development encroached upon the Crabtree Swamp, as residents increasingly relied on the Crabtree Canal for drainage. Horry County and the City of Conway, with assistance from federal agencies, Coastal Carolina University, and Clemson University, are restoring portions of Crabtree Swamp as part of a 2010 Kingston Lake Watershed Management Plan (Libes and Fuss 2010). A restoration plan was developed to reconnect the canal with its floodplain, while stabilizing the canal banks and improving water quality (Thepault et al. 2012). In April 2009, a half-mile stretch along one streambank was restored by removing dredge materials, re-grading the bank slopes and re- vegetating with native trees, shrubs and wetland plants (Thepault et al. 2012, Interview Jan 23, 2013). Restoring the floodplain in this half-mile segment has allowed floodwater to dissipate and improving water quality through sediment deposition on naturalizing point bars (Thepault et al. 2012, Interview Jan 23, 2013). Motivations for the Crabtree Canal Restoration Project appear to be based on a combination of the biotic and idealistic rationales, as presented by Clewell and Aronson (2006). The project was scientifically informed by knowledge of sedimentation within Kingston Lake and restoration approaches that could be used to alleviate this impairment. However, the project garnered support from the community and was largely supported by volunteer or student efforts. The project was small scale, only half mile, despite plans to extend the project in the future. One aspect of the idealistic rationale that does not align with the Crabtree Canal Restoration Project is the extent of baseline data collection and monitoring; support from Coastal Carolina University and Clemson University have ensured through monitoring of the project. 2. Mitigation Banks Mitigation banking provides another incentive for timberland owners to protect or restore wetlands and streams within their property. Mitigation banks are permanently protected lands that contain natural resources, such as wetlands, streams, and riparian corridors (NMBA 2012). Since the 1980s, mitigation banks have been used to offset unavoidable impacts to these resources permitted

by the US Army Corps of Engineers; all of **the** 118

banks are located on lands managed for pine production. Currently, four mitigation banks are proposed within the Waccamaw River watershed. At this time of this report, all of these mitigation bank proposals are pending; none of the mitigation banks have received approval from the US Army Corps of Engineers. 1. The Carter Stilley Wetland and Stream Mitigation Bank is located in Horry County, South Carolina encompasses approximately 1,300 acres located

adjacent to the SCDNR **Waccamaw** River **Heritage Preserve. The land** 19

is owned by American Timberlands Company and was managed for timber production and recreation prior to the mitigation bank proposal. The project will restore or enhance about 470 acres of wetlands, 7,510 linear feet of coastal plain streams, and enhance or preserve 377 acres of riparian buffer. 2. The Waccamaw Mitigation Bank

is located in Horry **County, South Carolina** on **the** drainage divide between **the** Waccamaw **River** 102 and coastal Horry County. The proposed mitigation bank is a 775.1 acre-parcel entirely surrounded by the SCDNR Lewis Ocean Bay Heritage Preserve and will ultimately be transferred to the SCDNR. The proposed Waccamaw Mitigation Bank will enhance 143.3 acres of relic wet pine savanna through prescribed burning and will preserve 365.8 acres of Carolina Bays. 3. The Cowpen Swamp Mitigation Bank is a 733.75-acre property in the headwaters of Buck Creek and Simpson Creek, which drain to the Waccamaw River. The proposed mitigation bank is a portion of a 1,678.55-acre parent tract that is subject to a development agreement with Horry County. The proposed Cowpen Swamp Mitigation Bank includes approximately 144.14 acres of wetlands, 562.79 acres of upland pine plantation, 17.26 acres of maintained roads, and 9.42 acres of maintained powerline right-of-way. The proposed mitigation bank will enhance the existing 144.14 acres of wetlands on the project site and will restore both vegetation and hydrology within 415.26 acres of palustrine forested wetlands that were converted to upland pine plantation by past management activities. The mitigation work plan consists of removing planted loblolly pine, planting native hardwood species, and plugging the existing ditches to restore natural flows within the project site. 4. The Burroughs and Chapin Mitigation Bank is located near the City of Conway, South Carolina and Kingston Lake, a tributary to the Waccamaw River. The 239-acre project site is located immediately adjacent to another 148.44-acre mitigation site. The proposed mitigation bank is expected to preserve 27 acres of fully functional wetlands, enhance vegetation and hydrology within 107 acres of existing wetlands, and restore 40 acres of drained wetlands that are currently identified as uplands. The mitigation work plan consists of removing planted loblolly pine and plugging the existing ditches on the project site to restore the natural water table. Once hydrology has been restored, the bank sponsor plans to allow wetland vegetation to naturally re-establish on the project site. Clewell and Aronson (2006) describe restoration associated with compensatory mitigation to be motivated by the technocratic rationale. The proposed mitigation banks, described below, align with the technocratic regime in that “the public is sometimes effectively excluded from technocratic restoration planning and is seldom offered the opportunity to become engaged in restoration work because of liability issues and the exigencies of quality control, timeliness, and budget” (Clewell and Aronson, 2006, p. 422). The extent of public involvement includes a public notice issued

by the US Army Corps of Engineers and notices sent **to** 42

surrounding landowners. According to Clewell and Aronson (2006), exclusion of the public can result in less stakeholder awareness and appreciation of restoration projects and their associated benefits. B. Stakeholder Analysis Identification of stakeholders is essential to the success of my research. Stakeholders include federal and state agencies, local or municipal agencies, universities, and non- governmental organizations active within the watershed. Stakeholders also include land development organizations and timber investment management organizations (TIMOs) with land holdings in the watershed. Early in my research, a literature review and internet -based search was used to identify stakeholders within the watershed. The research involved reviewing publically-available information, such as county Geographic Information Systems to determine large timber landowners along the Waccamaw River, or review of the SCDNR Heritage Preserve Database. Stakeholders were further identified through a chain referral recruitment technique (see Section VI). Stakeholder identification started in June 2012 in discussions with Christine Ellis, the Waccamaw Riverkeeper. Stakeholders were limited to organizations actively working in the Waccamaw River watershed, meaning the organization was currently conducting research, funding projects, or owned conservation lands within the watershed. My goal was to achieve a heterogeneous representation of the agencies, organizations, and timber management groups that influence wetland conservation and restoration within the Waccamaw River watershed. I organized stakeholders into six groups:

(1) Federal Agencies, (2) State Agencies, (3) Local and Municipal **Agencies, (4)** Academia, **(5)** 27

Non-governmental Organizations (NGOs), and (6) Timber Investment Management Organizations (TIMOs) and Land Development Organizations. Federal, state, and local/municipal stakeholders were separated into three different groups because of differences in their jurisdiction over natural resources and land use within the watershed. For example, federal agencies generally have a broad-based, multi-state jurisdiction, while state and local agencies are more limited in the geographic reach of their policies and programs. The stakeholder groups were also classified based on the funding sources that may influence their perceptions of wetland restoration within the watershed. For example, state agencies generally rely on state budgets, while NGOs generally rely on donations, memberships, or grant funding. TIMOs rely on a pool of private investors and have fiduciary responsibility to make land management decisions in their investors' best interest. The following describes each stakeholder, their mission and purpose, and their current actions within the Waccamaw River watershed. Figure 7. Stakeholder Analysis State Agencies: SC Forestry Commission SCDNR NCDENR Federal Agencies:

US Fish & Wildlife Service US Dept. of **the** 74

Interior

US Army Corps of Engineers Local/Municipal: City **of** 74

Conway Horry County Academia: Brunswick County Coastal Carolina University Columbus County & East Carolina University City of Whiteville Restoration Efforts in the Waccamaw River Watershed NGOs: Dogwood Alliance TNC: North Carolina TNC: Winyah Bay NC Coastal Land Trust Waccamaw Riverkeeper American Rivers TIMOs/Land Developers: RMS The Campbell Group Plum Creek Riverstone Properties LLC Burroughs & Chapin Company American Timberland Company 43 1. Federal Agencies a) US Army Corps of Engineers The Waccamaw River watershed is located within the South Atlantic Division of the US

Army Corps of Engineers, specifically their **Charleston District and** Wilmington **District.** 56

In addition to their missions to provide navigation safety, hurricane and storm risk management, hydropower, and beach re-nourishment, the US Army Corps of Engineers support environmental conservation and ecosystem restoration. According to their website, the agency focuses on restoring, enhancing and maintaining ecosystems while meeting their other missions. The US Army Corps of Engineers also regulates

wetlands and waters of the United States through **Section 404 of the Clean Water Act** (see **Section** III.B.). **The** 18

agency evaluates permit applications to impact wetlands, as well as reviews and approves wetland mitigation proposals, including mitigation banks

such as those proposed in **the Waccamaw River** 156

watershed. b)

US Fish & Wildlife Service: Waccamaw National Wildlife Refuge The **Waccamaw National Wildlife Refuge was** 63 created by the US Fish & Wildlife Service on December 1, 1997 (USFWS 2012) to preserve and manage coastal river ecosystems "for the benefit of endangered and threatened species, freshwater and anadromous fish, migratory birds, and forest wildlife, including a wide array of plants and animals associated with bottomland hardwood habitats" (USFWS 2012, Paragraph 1). The NWR also provides numerous recreation activities. The Waccamaw NWR, which includes over 55,000 acres, spans across the lower portions of the Waccamaw and Pee Dee River watersheds. Presently Waccamaw NWR encompasses nearly 27,000 acres. Last year, the Waccamaw NWR expanded by 245 acres, with greater expansion proposed in the near future (Anderson 2013, Interview Nov 9th, 2012, Interview Dec 19th, 2012). In recent years, the USFWS began using conservation easements on private property, in which the property owner maintains ownership instead of the USFWS purchasing the land (Anderson 2013, Interview Nov 9th, 2012). Craig Sasser with the USFWS states that the 44 conservation easements, instead of purchasing land with limited federal funding, are the USFWS effort "to find creative ways to connect the conserved lands" (Anderson 2013, Paragraph 25). Using this conservation strategy, the USFWS accomplished their goals to connect segments of the NWR and achieve their goals of contiguous corridors. c) US Department of the Interior:

America's Great Outdoors Initiative The America's Great Outdoors (AGO) Initiative 73

was launched in 2010, is primarily administered by the US Department of the Interior, and contains a goal to renew and restore rivers, among others. The AGO Fifty-State Report (2011) identifies the Waccamaw River National Blueway in Southeastern North Carolina as a project initiative. Goals of the project include preserving critical floodplain, protecting a wildlife-migration corridor, providing recreational opportunities, and supporting ecotourism (Department of the Interior, 2011). The initiative would also connect with the existing Waccamaw River Blue Trail, located in South Carolina. Actions would include acquisition of conservation easements and restoration of wildlife habitat as part of the designation as a National Blueway. The

North Carolina Natural Heritage Program and **North Carolina Wildlife Resources Commission** have prioritized **the** 78

blueway corridor along the Waccamaw River for 20 years (Department of the Interior, 2011). Because of the possibility of new businesses and recreation opportunities, Brunswick and Columbus Counties have expressed their support for the Waccamaw River Blueway (Department of the Interior, 2011). Additional partners include the US Fish & Wildlife Service, American Rivers, Winyah Rivers Foundation (Waccamaw Riverkeeper), City of

Conway, and Horry and Georgetown counties. The Department of Interior intends to partner with states and communities to implement projects, but because of fiscal constraints, projects will likely be implemented using existing resources, leveraging grants, and private funding (Department of the Interior, 2011).. 2. State Agencies a)

South Carolina Department of Natural Resources (1) Waccamaw **River**	142

Heritage Preserve The

South Carolina Department of Natural Resources (SCDNR) owns **and**	105

manages the 5,347-acre Waccamaw River Heritage Preserve, which starts at the North Carolina/South Carolina state boundary and ends just below Horry County Highway 31 at Red Bluff. The Waccamaw River Heritage Preserve primarily consists of riverine bottomland hardwood ecosystem on the both sides of the Waccamaw River. However, the 5,347-acre preserve is not contiguous and numerous private inholdings occur along the river (SCDNR 2012). The Waccamaw River Heritage Preserve contains several rare plant species and is an important travel corridor for black bear (Ursus americanus) (SCDNR 2012). The SCDNR encourages recreation, such as kayaking and camping, on the Waccamaw River within the heritage preserve. (2)

Lewis Ocean Bay Heritage Preserve The	151

SCDNR also owns and manages the 9,690-acre

Lewis Ocean Bay Heritage **Preserve,** located between **the Waccamaw River**	13

and Myrtle Beach, South Carolina. The

Lewis Ocean Bay Heritage **Preserve** encompasses tributaries **to the Waccamaw River,**	13

including Tilley Swamp, a rare example of a meandering, non-channelized stream and wetland complex in the region. The Lewis Ocean Bay Heritage Preserve supports the highest black bear population in South Carolina, as well as the federally-threatened Red Cockaded Woodpecker and rare Venus flytraps and pitcher plants (SCDNR 2012). The SCDNR has managed the bay habitat and pine flatwoods through prescribed burning. Lewis Ocean Bay Heritage Preserve also contains 23 Carolina Bays, the largest concentration of undisturbed Carolina Bays, which are elliptical or oval depressions with unknown origins primarily found in North and South Carolina (SCDNR 2012). b)

South Carolina Forestry Commission The South Carolina Forestry Commission’ s mission **is to** 76

“protect, promote, enhance, and nurture the forest lands of South Carolina in a manner consistent with achieving the greatest good for its citizens” (SCFC 2013, Paragraph 1). The Forestry Commission’s responsibilities include rural and urban forest lands and their values, including timber production, wildlife, and water quality. The agency’s primary role within the Waccamaw River watershed is to assist private landowners with forestry-related practices, provide technical assistance to the USDA- NRCS in cost-share wetland programs, and advise the forest industry, including TIMOs, on

compliance with Clean Water Act Section 404 regulations **and the** 54

Sustainable Forestry Initiative (Interview Feb 6th, 2013). c)

NC Department of Environment & Natural Resources The North Carolina Department of Environment and Natural Resources 50

has two divisions that are involved in the Waccamaw River watershed. The first is the North Carolina

Ecosystem Enhancement Program (NCEEP), whose **mission is to** 149 “restore and protect North Carolina’s natural resources for future generations while supporting responsible economic development” (NCEEP 2013, Paragraph 1). NCEEP’s primary goal is

to provide compensatory mitigation to offset **impacts to** natural **resources** elsewhere in **the**	18

watershed. The second division is the North Carolina Natural Heritage Program, whose mission is to “provide science and incentives to inform conservation decisions and support conservation of significant natural areas”

in North Carolina (NC **Natural Heritage Program**	148

2013, Paragraph 1). According to the Natural Heritage Program website (2013), the program identifies natural, endemic resources, including rare and significant plants and natural communities, that require attention in land-use planning. The Natural Heritage Program has identified Lake Waccamaw, Green Swamp, and portions of the Waccamaw River floodplain as Natural Heritage Priority sites. 3. Non-Governmental Organizations and Non-Profit Organizations a)

Waccamaw Riverkeeper The Waccamaw Riverkeeper is a member **of** the **Winyah Rivers Foundation,** whose **mission is to**	24

“protect, preserve, monitor, and revitalize the health of the lands and waters of the greater Winyah Bay watershed” (Waccamaw Riverkeeper 2012a, Paragraph 1). The Waccamaw Riverkeeper is also part of the Waterkeeper Alliance, a grassroots advocacy organization with “waterkeepers” working locally around the globe. The Waccamaw Riverkeeper program, created in 2002, advocates for the Waccamaw River watershed. Mrs. Christine Ellis, a paid advocate for the Waccamaw Riverkeeper, mobilizes the Riverkeeper membership and surrounding communities for the benefit of the river and its uses. Mrs. Ellis was my primary contact to initiate stakeholder analysis within the watershed. The Waccamaw Riverkeeper office has been located

at Coastal Carolina University's Burroughs and Chapin Center for Marine and Wetland Studies	58

since 2005 (Waccamaw Watershed Academy 2013b). The Center and Winyah Rivers Foundation have partnered to advocate for community education and outreach to support watershed education, science and management. The Waccamaw Riverkeeper and personnel from the Waccamaw Watershed Academy collaborate with communities within the watershed and Coastal Carolina University to support numerous programs, including the Waccamaw River Volunteer Monitoring Project (Waccamaw Watershed Academy 2013b). b) The Nature Conservancy The Nature Conservancy was founded in 1951 with a mission “to conserve the lands and waters on which all life depends” (The Nature Conservancy 2013a, Paragraph 1). The Nature Conservancy is a 501(c)(3) organization governed by a worldwide, volunteer Board of Directors. Chapters at the state and local level are used to achieve the Conservancy’s place-based mission. Land acquisition is a primary tool that the Nature Conservancy uses to support conservation initiatives

in the United States (The Nature Conservancy 2013a). **The** 130

Nature Conservancy uses conservation of private lands as “an innovative tactic that leverages the increasing interest of the private sector to take part in conservation” (The Nature Conservancy 2013a, Paragraph 1). Through collaborations with landowners, communities, and the business sector, the Nature Conservancy also uses land trusts, conservation easements, incentives, and private reserves to support land conservation. (1) North Carolina The Federal Paper Board, a former timber company, donated 16,427 acres of land within Green Swamp, the upper Waccamaw River watershed, to The Nature Conservancy between 1977 and the late 1980s (The Nature Conservancy 2012). The Nature Conservancy purchased 2,500 acres on the Waccamaw River and Juniper Creek, in addition to 553 acres in White Marsh. In 2006, the Nature Conservancy purchased 76,000 acres from International Paper, the largest private land conservation transaction in North Carolina history, creating the Juniper Creek Game Land (The Nature Conservancy 2010). (2) South Carolina The Nature Conservancy’s South Carolina chapter focuses on the Winyah Bay and Sandy Island, among other regions of the state. The Waccamaw River and Pee Dee Rivers and associated creeks form the waters around the 9,164-acre inland island. No bridges cross the surrounding waters to Sandy Island, which is believed to have preserved its unique landscape, habitats, and a 100-person Gullah community (The Nature Conservancy 2013c). Sandy Island contains habitat for several rare plant communities (The Nature Conservancy 2013c), including an expansive longleaf pine

habitat for the endangered red-cockaded woodpecker, and 133 priority habitats such as cypress-tupelo swamps and floodplain forests. In 2012 The Nature Conservancy entered into an agreement

with the US Fish and Wildlife Service where they help **the** 15

Conservancy manage the wetlands surrounding the Sandy Island Preserve. The Nature Conservancy has protected 20,340 acres in Winyah Bay, and collaborated with the partners to protect a total of 56,000 acres (The Nature Conservancy 2013b). This was achieved primarily through land acquisitions. In addition, significant portions of the landscape are protected through management agreements and conservation easements. The Nature Conservancy is currently using seasonal controlled burns in longleaf pine forests and isolated freshwater wetlands to restore growth of native species and habitats. c) NC

Coastal Land Trust The North Carolina Coastal Land Trust, founded in 1992, **is a non-profit organization to** 49

work with landowners on conservation initiatives with scenic, recreational, historic or ecological importance. The

North Carolina Coastal Land Trust' s **mission is to** enhance North Carolina's **coastal communities** 89

"through the acquisition of open space and natural areas, conservation education and the promotion of good land stewardship"

(North Carolina Coastal Land Trust 2013, Paragraph 1). **The North Carolina Coastal Land Trust** 75

has not focused on the Waccamaw River watershed in the past, but will be working in the watershed over the next five years, at a minimum. In July 2012, the North Carolina Coastal Land Trust received a $1 million dollar restitution, paid by a Columbus County, North Carolina hog facility that deliberately discharged greater

than 324,000 gallons of untreated hog waste into a tributary **of** 98

the Lake Waccamaw and the Waccamaw River (Blythe 2012). The North Carolina Coastal Land Trust will receive the restitution in five annual payments. According to the Raleigh News and Observer (Blythe 2012),

Camilla Herlevich, as **executive director of the North Carolina Coastal Land Trust,** has expressed plans **to** 68

purchase “many hundreds of acres to permanently protect a large swatch of land along the Waccamaw River” (Blythe 2012, Final Paragraph). The North Carolina Coastal Land Trust will use the money as leverage for “matching grants that offer the most bang for the buck” (Blythe 2012, Final Paragraph). d) Dogwood Alliance Dogwood Alliance, founded in 1996, is a non-profit organization that advocates for forests within the Southern United States. According to their website, the Dogwood Alliance collaborates with industry leaders to identify innovative business solutions that protect Southern forests (Dogwood Alliance 2013). Their primary strategy is to transform environmental practices, including packaging and paper usage, at large corporations (including Staples and McDonald’s), as a means to reduce industrial forestry in Southern forests. Dogwood Alliance has also worked with Georgia-Pacific, one of the major paper producers

in the Southern United States, and operator **of** a sawmill **in** 141

Whiteville, North Carolina in the Waccamaw River watershed (Dogwood Alliance 2013). Dogwood Alliance is making an announcement pertaining to the Waccamaw River watershed at the end of April 2013. e) American Rivers American Rivers, headquartered in Washington DC with regional offices in the Southeast, works

to protect and restore the rivers **and** streams **of the** 109

United States. According to their website, while the Waccamaw River is “one of the finest blackwater rivers in the Southeast” (Paragraph 1), development is impacting the river’s “clean drinking water, scenic landscapes, and diverse fish and wildlife” (Paragraph 1). American Rivers’ primary action in the Waccamaw River watershed is the development of the

Waccamaw River Blue Trail in 2009. The **Waccamaw River Blue Trail**	108

originates near the Waccamaw River Heritage Preserve in South Carolina and ends in Winyah Bay. American Rivers partnered with the Waccamaw Riverkeeper to develop the trail and the two organizations are working towards extending the trail into North Carolina. According to American Rivers website, blue trails “not only improve recreation and enhance local economies, they connect communities to treasured landscapes and offer a new, popular approach to conserving land and water resources” (Paragraph 2). Indirect benefits of blue trails include increased stormwater management, restoration and protection of wildlife corridors, and re-vegetating trails in the riparian buffer for improved water quality and flood attenuation. 4. Academia a)

East Carolina University East Carolina University is located in Greenville, North Carolina. As discussed previously, **a**	62

2000 watershed drainage study prepared by East Carolina University personnel (Riggs et al.) was the impetus of my research because it highlights the past hydrologic modifications of the watershed and recommends restorative actions within the watershed. b)

Coastal Carolina University Coastal Carolina University, founded in 1954,	99

is located in Conway, South Carolina. The University

includes the Coastal Science Center and the Burroughs & Chapin Center for Marine and Wetland Studies.	51

Dr. Susan Libes is an Associate Professor at the Burroughs & Chapin Center and has spearheaded research and numerous projects within the Waccamaw River watershed. She has supervised water quality monitoring on the Waccamaw River, led efforts to restore Crabtree Canal near Conway, and established the Waccamaw Watershed Academy (see below). Dr. Libes was the point of contact for Coastal Carolina University for my research. (1)

Waccamaw Watershed Academy Coastal Carolina University established the Waccamaw Watershed Academy (WWA) 70

in 2004 “to meet local needs for expertise in the areas of watershed and wetland science and management” (WWA 2013c, Paragraph 1). WWA provides research, education, and public outreach to Coastal Carolina University and communities within the Waccamaw River watershed (WWA 2013c). WWA’s research capabilities are used by the surrounding community to provide technical support for regulatory studies of environmental issues. Projects have been used to determine sources and bacteria levels in the Waccamaw River. According to the WWA website, Coastal Carolina University faculty is evaluating “the sources, transport pathways, and biological impacts of pollutants in the Waccamaw Watershed, including mercury, pathogenic bacteria, oxygen-demanding substances and nutrients” (Waccamaw Watershed Academy 2013c, Paragraph 4). The WWA hopes to use their research to develop BMPs for land conservation on a site-specific and regional scale. (2) Volunteer Water Monitoring Program The WWA’s Volunteer Water Monitoring Program, which includes the Waccamaw River, administers volunteer-based projects and trains volunteers in environmental testing equipment. The program objectives are to assist local municipalities in meeting National Pollutant Discharge Elimination System requirements, detect illicit discharges, expand geographic and temporal scope of water quality monitoring, and assist in the development of site specific water quality standards (Waccamaw Watershed Academy 2013c). 5. Municipalities a) Brunswick County, North Carolina

Brunswick County is located in the southeastern corner of North Carolina along **the Atlantic Ocean** 14

coast. The Waccamaw River drainage area, including Green Swamp and Juniper Creek, is on the west and northwest

portion of the County, as discussed **in** Section II **.A.** According **to** 15

the 2004 Brunswick Tomorrow plan, Brunswick County’s aquatic resources, including Green Swamp, make the region among the most ecologically diverse regions in North America. Goals associated within the “Brunswick Tomorrow” plan (2004) that correspond with wetland restoration include: ? Preserve and protect wetlands from development pressure. ? Protecting the water quality of rivers and streams. ? Implement ongoing educational programs on the significance of wetland conservation ? Expand public awareness of the importance of wetlands and swamps. According to Brunswick County's Land Use Plan (2007), several restoration projects have occurred on other watersheds within the County that were prioritized

by the North Carolina Department of Environment and Natural Resources. 83

The Land Use Plan (2007) also notes that many of the County's wastewater management systems are reuse systems; there is potential for use of high quality reclaimed water for wetland restoration or enhancement. b) Columbus County and Whiteville,

North Carolina Columbus County, North Carolina **is located in the** southeastern corner **of North Carolina,** on **the** western boundary **of** 65

Brunswick County. The City of Whiteville is located within Columbus County. In February 2013, Columbus County commissioners voted to make a $1,000 contribution toward an effort to preserve about a seven-acre tract of land on the Waccamaw River with a high concentration of wetlands (Cartrette 2013). With the help of a land protection grant from the Nature Conservancy, the land will provide one of the last access points needed for the Blue Trail that is under development through the American Great Outdoors Initiative (Section VII.B.1.c.). Purchase of this tract was also supported by The Waccamaw Riverkeeper (Cartrette 2013). c) Horry County, South Carolina Horry

County is located in the northeast **corner of** South **Carolina** along **the Atlantic Ocean** 14

coast. Brunswick and Columbus Counties are located along the northern border of Horry County in North Carolina. The Waccamaw River primarily flows through Horry County while in the state of South Carolina (see Section II.B.); only a small segment of the tidally-influenced river flows in Georgetown County. According to the Comprehensive Plan, Horry County needs to "restore and maintain the chemical, physical, and biological integrity of the County's waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water" (Horry County 2008, p. 86). Goals associated within the Horry

County Comprehensive Plan that correspond with wetland restoration include: ? Conserving wetland benefits, including flood attenuation, pollutant filtration, groundwater retention, and recreation; and ? Maintaining floodplains to allow for their natural function of attenuating storm events. ? Continue the County's relationship with the Waccamaw Watershed Academy and the Waccamaw Riverkeeper to educate landowners and developers about discharges into the Waccamaw River. ? Create agreements between North and South Carolina that address watershed concerns ? Continue partnerships with local universities to better understand the outcome of the County's land use planning on waterways ? Implement riparian buffer ordinances to protect natural vegetated areas around waterways ? Implement ordinances to regulate buffers on jurisdictional and isolated wetlands According to the Horry County Comprehensive Plan, two wetland restoration projects have been completed within Horry

County on the boundary **of the** Waccamaw **River** watershed **and the** 44

Pee Dee River watershed. These projects were completed in 1997, prior to the Riggs et al. study in 2000, by the

Natural Resource Conservation Services (NRCS) Wetland Reserve Program (WRP) 15

and through a mitigation project (Horry County 2008). d) City of Conway, South Carolina The City of Conway

is the County Seat of Horry **County,** South Carolina **and is** located on **the** Waccamaw River. **The** 87

City of Conway considers the Waccamaw River an amenity and highlights the resource through their riverwalk (City of Conway Shaping our Future plan). The City of Conway partners with the Waccamaw Riverkeeper to host the annual Riverfest on the Waccamaw River, a festival that celebrates the community and the Waccamaw River. The City also partnered with Horry County and Coastal Carolina University for the Crabtree Canal Restoration on a tributary to the Waccamaw River (see Section VII.A.1.). The City's goals were to improve the appearance of Crabtree Canal in an effort to restore water quality and use of the tributary as a public amenity. The City of Conway also supported the American Rivers and Waccamaw Riverkeeper's efforts to establish the Waccamaw River Blue Trail (see Section VII.B.3.e). The City recognized the blue trail as a potential means to promote ecotourism and generate business within the downtown river front. Bridgette Johnson, with the Conway

Chamber of Commerce, states that the City utilizes the river “as a tourist attraction for the guests who don't have the opportunity to go out and paddle or canoe or even see a river, especially a black river” (Moore 2009, Paragraph 7). 6. Timber Investment Management Organizations and Land Developers a) American Timberlands Company American Timberlands Company manages land investments with “diverse value attributes” (Paragraph 1), such as recreational, timber, or mitigation opportunities (American Timberlands Company 2013). In addition to land management and investment, American Timberlands Company’s services include reforestation, carbon credits, wetland and stream mitigation banking, and conservation easements (American Timberlands Company 2013). In June 2008, American Timberlands Company and a Georgia-based private equity fund acquired 14 parcels (over 20,000 acres) near Myrtle Beach in Horry County SC (American Timberlands Company 2013). The parcels range in size between 37 to 6,858 acres and include river frontage on the Waccamaw River. Their website lists that values of the parcels include extensive conservation opportunities, in addition to “timber, commercial and residential real estate development opportunities and recreational use” (American Timberlands Company 2013, Paragraph 2). The growth and development surrounding Myrtle Beach is expected to create a higher future demand for the properties. b) Resource Management Services Resource Management Services (RMS) is an employee-owned and managed timber investment firm founded in 1950. RMS has managed timberlands for private landowners from the 1950s to mid-1960s, collaborated with the forest products industry in the mid-1960s, and transitioned into timber investments in mid-1980s through 2003 (RMS 2012a). Since 2004, RMS has acted as an independent timberland investment manager. According to their website, RMS integrated forest stewardship into their founding documents and management plans. All RMS-managed properties within the

United States are third-party certified by **the Sustainable Forestry Initiative Standard** 35

(United States standard) (RMS 2012b). RMS maintains these certifications to uphold their “social license” to manage forests (RMS 2012b, Paragraph 5). The certifications also offer fiduciary value to clients and public as a statement that RMS forests “are sustainably managed for multiple forest values, including forest products, clean air and water, wildlife and fish habitat” (RMS 2012b, Paragraph 6). In 2000, Tony Doster in the RMS North Carolina office negotiated a Forest Legacy Conservation Easement by collaborating with industry, non-profit, and government stakeholders (RMS 2012c). The easement preserved the property and accounted for the development value, while allowing RMS to continue operations. RMS has numerous parcels for sale in the Waccamaw River watershed. c) Burroughs & Chapin Company Burroughs & Chapin Company is a development firms headquartered in Myrtle Beach, South Carolina. According to their website, Burroughs & Chapin is one of South Carolina’s largest private landowners that provides residential and resort development, commercial development and leasing, and property management. Burroughs & Chapin is one of the largest timber management companies in South Carolina, managing more than 20,000 acres of timber lands. They manage forests to maximize productivity and identify non-timber opportunities for asset growth. As discussed in Section VII.A.2, Burroughs and Chapin has proposed a mitigation bank near the City of Conway, South Carolina and Kingston Lake. According to their website, Burroughs and Chapin is “an industry leader in the area of environmental sustainability” (Paragraph 10) and recognizes that land stewardship correlates with long-term value. d) Riverstone Properties LLC The Riverstone Properties LLC is based in Richmond, Virginia and owns numerous operating companies and real estate assets in the Southeast, including the Kiawah Island Golf Resort, Sea Pines at Hilton Head, and the Keswick Hall and Estate. Riverstone Properties LLC owns several large timber and development tracts in North and South Carolina, including an 18,607-acre tract in the White Marsh swamp (Figure 8). White Marsh is a tributary to the Waccamaw River, located southwest of Lake Waccamaw in Columbus County, North Carolina. As discussed in Section III.E., the White Marsh wetlands have remained relatively undisturbed and continue to sheet flow across the floodplain. According to a property advertisement by Riverstone Properties LLC (Land and Timber website), the tract contains 711,896 hardwood trees merchantable for timber. The 18,607-acre tract is currently for sale by Riverstone Properties LLC and is advertised for timber, hunting, or conservation purposes. Email correspondence with personnel from The Nature Conservancy – North Carolina indicates that The Nature Conservancy, as well as other conservation organizations, have expressed interest in the property, but that the property value assigned by Riverstone Properties LLC exceeded the price that conservation organizations were able to pay. Figure 8. 18,607 White Marsh Tract owned by Riverstone Properties LLC. e) The Campbell Group, LLC (and TC&I Timber Company) The Campbell Group, LLC, founded in 1981, acquires and manages over 3.25 million acres of timber lands for investors within the United States and Australia (The Campbell Group 2013). They are also one of the only timberland managers who managers for conservation purposes, on behalf of a non-profit organization. The Campbell Group, “in order to protect and enhance its land and to foster an atmosphere of goodwill and cooperation” (Paragraph 2), allows for hunting and recreation leases (The Campbell Group 2013). The Campbell Group lists environmental enhancement and reforestation among theirs services, and participates in the Sustainable Forestry Initiative. In 2006, The Campbell Group purchased approximately 87,000 acres of timber lands in North Carolina from International Paper (The Campbell Group 2006). The purchase was made on behalf a company managed by The Campbell Group, known as TC & I. f) Plum Creek Plum Creek owns and manages approximately

6.4 million acres of timber lands throughout **the United States** 35

(Plum Creek 2012a). According to their website, the company is committed to being the “premier timberland company” (Paragraph 3) by leading the industry in environmentally responsible resource stewardship and “engaging with our communities on matters of common interest” (Paragraph 3), in addition to achieving returns and consistently providing quality products and services. Plum Creek describes themselves as a community partner through their environmental practices and support for wildlife, conservation, communities, and sustainable forestry (Plum Creek 2012a). All lands owned by Plum Creek are certified under the Sustainable Forestry Initiative Principles (Plum Creek 2012a). Plum Creek sold most of its timber lands in the Waccamaw River to The Campbell Group (Interviews Jan 18th, 2013). However, Plum Creek remains a stakeholder within the watershed because of

a Memorandum of Understanding (MOU) between Plum Creek, the North Carolina Department of Environment and Natural Resources and The Nature Conservancy (Plum Creek 22

2012b) that conserved ecologically significant areas within North Carolina. Plum Creek, in accordance with the MOU, now protects these significant ecological areas on all Plum Creek lands within North Carolina, including wetlands with habitat for bald eagles and herons. Portions of Juniper Creek, a tributary to

the Waccamaw River, and the Waccamaw **River were** 138

protected through this MOU (Plum Creek 2012b). The MOU also protects Longleaf pine savannas, an endemic ecosystem found within the Waccamaw River watershed,

the federally listed endangered Cooley's meadow rue, and several **state-listed species,** including **the Venus flytrap, Carolina Grass-of-Parnassus, pygmy sunfish and Plymouth gentian** 23

(Plum Creek 2012b). C. Interviews and Stakeholder Participation 1. Interview Topics I conducted semi-structured interviews with representatives of

public agencies, universities, **and non-profit conservation organizations working** 46 in the Waccamaw River watershed. These interviews addressed the following topics in an effort to answer my research questions: ? Current and past wetland initiatives ? Perception of emphasis on wetland conservation instead of wetland restoration ? Organization's priorities of conservation versus restoration ? Need for wetland restoration within the Waccamaw River watershed ? Relationships between TIMOs and agencies, organizations, and academia ? Use of federal or state programs as incentives to conduct restoration ? Use of wetland mitigation programs as incentives to conduct restoration ? Motivations to participate in wetland conservation or restoration programs ? Constraints or obstacles that prevent participation in wetland restoration ? Comparison of stakeholder's participation in wetland programs in other watersheds 2. Stakeholder Participation in Study As noted in earlier sections, stakeholders were organized into six groups:

(1) Federal Agencies, (2) State Agencies, (3) Local and Municipal **Agencies, (4)** Academia, **(5)** 27

Non- governmental Organizations, and (6) TIMOs and Land Development Organizations. As of April 7, 2013, 12 stakeholders (48 percent of the identified stakeholders) agreed to interviews. Several stakeholders have not responded to multiple requests to conduct an interview, while two TIMOs could not participate because of concerns that statements could infringe upon their fiduciary responsibility to their investors. Table 2 and

Figures 9 and 10 provide **an overview of the** 127

stakeholder participation in my study. Table 2. Stakeholder Participation in Study Type of Stakeholder Number Identified Number Interviewed Percent Federal Agencies 3 1 33% State Agencies 3 2 67% Local/Municipal Agencies 5 1 20% Academia 2 1 50% NGOs 6 5 83% TIMOs/Land Development 6 2 33% 25 12 48% Stakeholder Representation 7

6 5 4 Count 3 2 1 0 114

Federal Agencies State Agencies Local/Municipal Academia Agencies NGOs TIMOs/Land Development Number Identified Number Interviewed Figure 9. Stakeholder Identification and Response Percentage of Stakeholders Interviewed 33% 33% Federal Agencies State Agencies Local/Municipal Agencies Academia

NGOs 67% TIMOs/Land Development 83% 20% 50% Figure 10. Stakeholder Participation in Interviews 3. Stakeholders Excluded from Study Private land owners with timber on their property are one of the largest landowner groups within the watershed (Interview Feb 6th, 2013). However, this group is not represented in this stakeholder analysis because most private landowners manage their timber on a small- scale, instead of industrial pine plantations. In many cases, private land owners manage their timber for recreation or aesthetics, instead of timber production and harvest (Forest Futures Report). While private landowners collectively comprise a large portion of the watershed, their individual parcels are generally disadvantageous for wetland conservation and restoration. As discussed in the Results section, coordination and agreement among multiple landowners can be a constraint in implementing wetland restoration projects. D. Analysis of Stakeholder Perceptions The study results presented in Section VII.D focus on the stakeholders' perceptions of wetland restoration on timber lands in the Waccamaw River watershed, as well as perceived constraints in conducting wetland restoration. Interview notes and audio recordings are presented to demonstrate the emergent themes. 1. Partnerships and Relationships Based on the stakeholder interviews, TIMOs and NGOs typically have a collaborative relationship. TIMOs regularly communicate with NGOs, such The Nature Conservancy and

the North Carolina Coastal Land Trust, about **property** acquisition or access. **The** 137

North Carolina Coastal Land Trust and The 147

Nature Conservancy both hold easements on lands owned by TIMOs. However, TIMO employees expressed that their forestry practices are often misunderstood by NGOs and perceived as impactful to surrounding resources. Collaborative forums, such as the Cape Fear Arch Conservation Collaboration, allow TIMOs and NGOs to share their motivations, reduce misperceptions about timber management practices, and prevent conflict between the two stakeholders. Municipalities generally do not partner or collaborate with TIMOs; a stakeholder pointed out that the timber industry is exempt from local stormwater regulations, so communication between municipalities and TIMOs is limited. The Environmental Protection Agency excludes ditches, channels, culverts, and other stormwater conveyances associated with logging roads from

permitting requirements under **the National Pollutant Discharge Elimination System (NPDES)** program established by **the Clean Water Act (CWA)** 57 because they are not associated with industrial activity. 2. Emphasis on Conservation Interviewees were also asked whether they perceived

a greater emphasis on wetland conservation in the	53

watershed instead of wetland restoration. Nearly all of the stakeholders felt there was

a greater emphasis on wetland conservation instead of **restoration.**	53

An NGO employee stated that conservation was their first priority within the watershed, with stewardship and restoration on their conserved lands as the second priority. Another NGO employee linked the increase in land acquisition for conservation with the divesture of International Paper lands in the watershed, which occurred at approximately the time period as the Riggs et al. analysis of the Waccamaw River watershed in 2000. 3. Need for Wetland Restoration A federal agency employee stated that wetland systems within the Waccamaw River watershed were less impacted compared to other watersheds within the region. However, the same federal agency employee also stated a need to restore Carolina Bays. An NGO employee identified a multitude of opportunities for restoration within the Waccamaw River watershed, particularly in the altered drainages in Horry County, South Carolina. Another NGO employee felt that most of the wetlands within the watershed are intact, but identified the timberlands in the upper Waccamaw River watershed as “delicate” and their drainage networks as suitable for restoration. A TIMO employee felt there was a need for wetland restoration

in the upper portion of the Waccamaw **River,** but that most **of**	123

the impacts in need of restoration were caused by agricultural land uses. Another TIMO employee stated that the Waccamaw River watershed was healthy overall and in little need for wetland restoration. A professor from Coastal Carolina University and several NGO employees expressed concern that areas drained by silviculture will no longer contain wetlands, which will increase the likelihood for converting pine plantations to residential or commercial development, since these lands will no longer require Clean Water Act permits or mitigation. 4. Incentives for Wetland Restoration a) Fair Market Value In many cases, the fair market value of the land proposed by the TIMO is based on the harvest and sale of all merchantable timber, among other factors. Fair market value can change as timber and real estate markets change, and land assets may be sold for alternative uses as the TIMOs reassess the highest and best use of forestland holdings. As confirmed by a TIMO stakeholder, this increased liquidity in the TIMO ownership (Wear 2007), discourages TIMOs from participating in wetland restoration projects that often require years or decades of monitoring and change the land use from productive silviculture to wetlands. As discussed in Section III.A., the sale of land by the forest products industry presented a unique opportunity for conservation groups within the southeastern United States (Weinberg and Larson 2008). The sale of land by the forest products industry and fragmentation of large timber parcels has allowed conservation groups, such as The Nature Conservancy, to purchase land or partner with TIMOs to acquire conservation easements on land with environmental value (Wear 2007, Wear and Greis 2011). This finding was confirmed by stakeholders from The Nature Conservancy and a TIMO employee. Yet, there continues to be a conflict between NGOs/Agencies and TIMOs over the fair market value of land that is suitable for conservation or restoration purposes. NGOs and agencies who hope to purchase the parcel for conservation or restoration typically do not plan to harvest the timber on the land and will therefore not recoup the costs of the land purchase. According to stakeholders from an NGO, differences in land appraisals between TIMOs and NGOs often prevent the NGO from acquiring the property or can delay the land acquisition for years. b) Mitigation Banks Mitigation banks appear to be the primary driver of restoration efforts within the watershed. A stakeholder from a municipal agency identified a need for mitigation banks within the watershed, particularly as the economy improves and associated infrastructure needs increase. The stakeholder noted that development of mitigation banks is left to private industry, instead of counties or municipalities investing in their development. TIMOs are also involved in mitigation banking. As discussed in previous sections, American Timberlands Company is sponsoring the Carter Stilley Wetland and Stream Mitigation Bank in Horry County, South Carolina, while RMS is developing a wetland mitigation bank in Brunswick County, North Carolina. Burroughs and Chapin is also developing

a wetland mitigation bank near **the City of Conway,** 19

South Carolina. 5. Constraints against Wetland Restoration The primary objective of my research was to analyze why so little wetland restoration has been conducted in the Waccamaw River watershed since the Riggs et al. report. During the interviews, I asked the stakeholders about their perception of factors that constrain wetland restoration projects. If stakeholders felt that wetland conservation was emphasized more than wetland restoration, I asked the interviewee about what constraints prevented greater emphasis on wetland restoration. The interviews revealed an array of stakeholder perceptions, revealing concerns about funding, awareness, and skepticism about the capacity to restore wetlands in general. Six factors emerged as perceived constraints to wetland restoration in the Waccamaw River watershed, as shown in Figure 11. Many stakeholders perceived wetland restoration costs to be much more than wetland conservation costs. Based on a 1994 evaluation, costs to restore a freshwater forested wetland, the dominant wetland type in the Waccamaw River headwaters and floodplain, average $77,000 per acre (King and Bohlen 1994). Stakeholders cited costs associated with employing specialized personnel, such as soil scientists, engineers, and hydrologists, purchasing monitoring equipment, hiring construction teams, and long-term monitoring. According to a municipal stakeholder, stormwater and land development fees in Horry County are currently used towards water quality improvements within the watershed, but restoration projects were not prioritized for use of this funding. Adjacent Land Use Land Acquisition Limited Qualification & Personnel Capacity Difficult for Public to Understand Limited Funding Restoration Costs More Than Conservation Restoration

Not Effective 0 1 2 3 4 5 6 101

Number of Respondents Figure 11. Perceived Constraints to Conducting Wetland Restoration Stakeholders also felt that restoration was not effective, or not the most effective use of funding. A stakeholder from a municipal agency stated that the expenditure of funds is more effective in conserving un-impacted land compared to spending greater funds to restore land. Another stakeholder from academia echoed this perception, stating that it is more cost-effective to protect lands now instead of restoring lands in the future. A stakeholder from a NGO perceived restoration projects to be ineffective in their ability to restore wetland functions and services. Stakeholders also felt that the public within the watershed are unfamiliar with wetland restoration; an NGO stated that wetland conservation was “easier to sell to the public” because of this unfamiliarity. A state agency perceived limited public awareness of their wetland restoration programs as a constraint. Stakeholders involved with the Crabtree Canal Restoration Project identified public awareness and property owner education as a primary obstacle in implementing the project. Similarly, stakeholders identified their own qualifications and personnel capacity as a constraint to conducting wetland restoration. Federal, state, and local agencies have limited personnel due to budgetary cut backs during the recent recession. In addition, many restoration projects involve specialized personnel. A state agency stated that their personnel were “less comfortable” with restoration projects because of their limited participation in such projects. A federal agency expressed similar concerns, in that their personnel did not have the technical capacity to support wetland restoration projects. Responses from NGOs indicated the same constraint. Acquiring land and adjacent land use were also identified as constraints to conducting wetland restoration. These constraints were primarily identified by stakeholders within Horry County, South Carolina, which is the most developed portion of the Waccamaw River watershed. Stakeholders felt it was difficult to acquire the large parcels usually required for wetland restoration. Similarly, stakeholders within Horry County felt that adjacent

land uses, such as residential or commercial development, 111

prohibited wetland restoration because of the risk of flooding or altering the extent of floodplains. A stakeholder from a municipal agency stated that their agency operated within confined systems in which they must acknowledge that people are dependent on the drainage of wetland system. Plugging ditches to restore wetland hydrology within a developing landscape could adversely impact adjacent communities. According to a stakeholder from a state agency, the extensive drainage networks in the upper Waccamaw River watershed could not be built under current Clean Water Act regulations. Large landowners, such as TIMOs, are dependent on these drainage networks and the roads to manage their land. The stakeholder perceived a wetland restoration that would affect land access for forestry as improbable and rare. 6. Comparison to Other Watersheds A state agency indicated their past involvement in wetland restoration on state lands in western South Carolina. This project was completed as mitigation for impacts associated with a transportation project in the area. A TIMO stated that restoration projects were more prevalent on their timber lands in Texas and Florida, primarily because of more flexible long-term agreements and less property encumbrance. Another TIMO also described restoration projects in Florida and Alabama, which for the latter was motivated by state incentives for game lands. It’s important to note that the TIMOs’ restoration projects in Texas and Florida involved restoration of long leaf pine habitats, not necessarily wetland-specific restoration. VIII. DISCUSSION AND RECOMMENDATIONS In 2000, Riggs et al. recommended restorative action to attenuate the detrimental effects of drainage networks in the upper Waccamaw River watershed. Yet, based on my experience within the Waccamaw River watershed, minimal restoration efforts have been achieved in the 12 years since the Riggs et al. watershed evaluation. My research asks: Why has so little restoration been completed in the Waccamaw River watershed since the Riggs et al. recommendations? Restoration efforts are underway in the Waccamaw River watershed, as demonstrated by the Crabtree Canal restoration and proposal of four mitigation banks. However, stakeholders confirmed my perception that a greater emphasis has been placed on conservation within the watershed as compared to restoration. This emphasis was attributed to several factors, including wetland restoration’s potential conflict with adjacent land uses, cost and personnel requirements, and concerns over restoration’s effectiveness. The focus on conservation also correlates with the NGOs missions and values identified during the content analysis, while restoration is often a secondary objective once land is already protected. Emphasis on conservation corresponds with the change in ownership of pine plantations that occurred between 1998 and 2008, when International Paper divested most of its lands and individual parcels became available for conservation by NGOs. The emphasis on conservation may be a result of stakeholder perception of riverine health. Stakeholders, in interviews and in their planning documents, tout the Waccamaw River’s diversity and undisturbed places. Yet, stakeholders also discussed the opportunities for restoration, including the drainage networks within the pine plantations. Other stakeholders had perceptions that agricultural operations presented a greater risk to the watershed than pine plantations, a perception that requires additional evaluation to determine how each land use is affecting the watershed. As Pregernig (2002) found in his study of forestry professionals and forest owners, stakeholders within the Waccamaw River watershed may not prioritize restoration efforts until they are directly affected by the impacts of the drainage networks. Collaboration between stakeholders within the watershed is beneficial to conservation and restoration efforts. When a TIMO employee felt that their timber management practices were misunderstood by NGOs, they became involved in Cape Fear Arch, a collaborative forum that has increased communication between TIMOs, NGOs, and agencies. The forum is a way for TIMOs to express their motivations behind their timber management practices, highlight ways in which they have managed timber responsibly, and determine the priorities of the NGOs and agencies. There continues to be a conflict between NGOs/Agencies and TIMOs over the fair market value of land that is suitable for conservation or restoration purposes. According to stakeholders from an NGO, differences in land appraisals between TIMOs and NGOs often prevent the NGO from acquiring the property or can delay the land acquisition for years. Based on my research, several actions could be used to promote wetland restoration within the Waccamaw River watershed. 1) Academia has a proven example of partnership and restoration, as exemplified by Coastal Carolina University's Crabtree Canal restoration project. Yet, based on my discussions with university professor, little collaboration has been conducted with TIMOs or the forest products industry. This presents a unique opportunity for future collaboration and study to determine methods of restoring wetland functions within timber management practices. 2) As recommended in the study by Pregernig (2002), complex restoration measures, such as those required in the Waccamaw River watershed, require that stakeholders are fully aware of the degradation, are convinced that the restorative action will remedy the damage, knows the technological solutions, and are "positive" toward the application of these technologies. Continued study and promotion of existing restoration projects should be used to educate NGOs and agencies about the effectiveness and costs of implementing restoration. These projects should also be shared with the public to increase awareness about the need for restoration, and to improve the public's familiarity with such methods. 3) Stakeholders should identify and prioritize potential restoration projects, particularly in regions of the watershed where impacts related to development or infrastructure is expected. Not only is restoration typically needed in these regions, but development and infrastructure usually require Clean Water Act permits and the associated mitigation. Since mitigation is currently the primary driver of restoration within the watershed, efforts should be made to ensure that mitigation funds go towards a prioritized project. 4) Stakeholders expressed concern that drained areas will be converted from pine plantations to residential/commercial development, since wetlands would no longer exist and the US Army Corps of Engineers would not require a Clean Water Permit. Counties and municipalities should consider land use planning and zoning changes that recognize former floodplains and wetlands, even if these areas have been drained by silviculture or other land use practices. While this recommendation is likely to be unpopular, it would provide an opportunity for wetland restoration to occur if pine plantations were sold and limit the impact of restoration on adjacent land uses. ‣ Counties and municipalities should evaluate the use of stormwater or land development fee that would be allocated directly towards wetland restoration projects. Fees currently go towards water quality improvements within the watershed; however, wetland restoration projects can provide similar benefits to water quality in the Waccamaw River by attenuating flows and reducing sediment deposition. IX. CITATIONS

Alam, K. 2011. Public attitudes toward restoration of impaired river ecosystems: Does residents' attachment to place matter? Urban Ecosystems, 14(4), 635-653. 21

Available from: http://dx.doi.org

/10.1007/s11252-011-0176-5 157

American Timberlands Company. 2013. Accessed February 24, 2013. Website available from: http://www.americantimberlands.com/ Anderson, T. 2013. Waccamaw Wildlife Refuge Ready to Expand. My Horry County News. Available from: http://www.myhorrynews.com/news/local/myrtle_beach/ article_ef42a660-6bef-11e2-8783-001a4bcf6878.html

Aronson, J., and J. Van Andel. 2005. Challenges for ecological theory. Pages 234–247 in J. Van Andel and J. Aronson, editors. Restoration ecology: the new frontier. Blackwell Science, Oxford, United Kingdom. 11

Babbie E. 2010. **The Practice of Social Research,** Twelfth Edition. **Wadsworth;** 115

California. 528

p. Bales, J.D., and Pope, B.F., 1996, Streamflow characteristics of the Waccamaw River at Freeland, North Carolina, 1940- 1994: **U.S. Geological Survey, Water-Resources Investigations Report 96-4093, 35 p.** 4

Bengston, D.N. 1994. Changing forest values and ecosystem management. Society and Natural Resources. 7: 515–533. Blythe, **A.**	36

2012, July 25th.

$1 Million From Hog Farm Case To Help Waccamaw River. Raleigh **News** and **Observer.**	69

Available from:

http://www.newsobserver.com/2012/07/25/ 2221356/1-million-from-hog-farm-case-to.html#	41

storylink=misearch

Bosworth D and **Brown H.** 2007. **After the Timber Wars: Community-Based Stewardship Journal of Forestry; 105, 5; 271—**	39

276

Bradshaw, A. D., and M. J. Chadwick. 1980. The restoration of land: the ecology and reclamation of derelict and degraded land. Blackwell, London. Brinson **M.**	20

1991. Landscape **properties of pocosins and associated wetlands: Wetlands, v. 11, p. 441-465.**	66

Brunswick County. 2004. Brunswick Tomorrow. Accessed April 11, 2013. Available from: http://www.brunsco.net/Departments/LandDevelopment/Planning/BrunswickTomorro w.aspx Brunswick County. 2007. CAMA Core Land Use Plan. Accessed February 25, 2013. Available from: http://www.brunsco.net/Departments/LandDevelopment/Planning/ LandUsePlan.aspx

Burger J. 2002. Restoration, Stewardship, Environmental Health, and Policy: Understanding Stakeholders' Perceptions. Environmental Management Vol. 30, No. 5, pp. 631–640 29

Burroughs F. 1992. Horry and the Waccamaw. W.W. Norton & Company. New York. 208 p. Burroughs & Chapin Company Website. Accessed April 7, 2013. Available from: http://www.burroughschapin.com/our-expertise/timber-management.aspx City of Conway. 2011. Shaping our Future 2019: 12 Elements of the Comprehensive Plan. Available from: http://www.cityofconway.com/comprehensiveplan.html Carolina University.

2006. Watershed Management Planning for the Waccamaw River Basin starting with the Kingston Lake Watershed in Horry County, 37

SC. Available from: www.coastal.edu/wwa/pdf/Poster%20July%202006.pdf Cartrette, N. 2013. County to Consider Land Protection Grant for River Tract. The News Reporter: Whiteville. Available from: http://www.whiteville.com/news/county-to- consider-land-protection-grant-for-river-tract/article_4c9b3d08-707e-11e2-92d6- 001a4bcf887a.html Conner RC. 2011. South Carolina, 2010

forest inventory and analysis factsheet. e-Science Update SRS– 041. **Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 4 p.** Clewell **A** 17

and Aronson J.

2006. Motivations for the Restoration of Ecosystems. Conservation Biology. Volume 20, No. 2, 420–428 52

Dale L, Gerlack AK. 2007. It's all in the numbers: acreage tallies and environmental program evaluation. Environ Manage 39:246–260 Davenport MA, 2

Bridges CA, Mangun JC, Carver AD, Williard KWJ, and **Jones EO.** 96

2010. Building Local Community Commitment to Wetlands Restoration: A Case Study of the Cache River Wetlands in Southern Illinois, USA. Environmental Management (2010) 45:711–722

Davies, P. E. and M. Nelson. 1994. Relationships between riparian buffer widths and the effects of logging on stream habitat, invertebrate community composition and fish abundance. Australian Journal of Marine and Freshwater Resources 45: 1289-1305. 8

Dogwood Alliance. 2013. Website accessed February 24, 2013. Available from: http://www.dogwoodalliance.org/ [EPA] Environmental Protection Agency. Website: Federal Agency Definitions for Wetland Tracking. Accessed January 20th, 2013. Available from: http://water.epa.gov/type/wetlands/restore/defs.cfm

Handel, S. N., G. R. Robinson, and A. J. Beattie. 1994. Biodiversity resources for restoration ecology. Restoration Ecology 2:230–241. 28

Higgs ES. 1997. What is Good Ecological Restoration? Conservation Biology, 92

Vol. 11, No. 2, pp. 338-348 Horry County. 2008. Envision 2025: Comprehensive Plan.

Johnson BB and **Pflugh KK. 2008. Local officials' and citizens' views on freshwater wetlands. Society and Natural Resources 21:387–403** 33

King D and Bohlen C. 1994. **Making Sense of Wetland Restoration Costs. University of Maryland.** 61

EPA Cooperative Agreement No. CR-818227-CI. Available from: http://www.epa.gov/nscep/index.html Land and Farm website. Accessed April 7, 2013. White Marsh Timber Tract. Available from: http://www.landandfarm.com/property/White_Marsh_Timber_Tract-280804/ Libes S. 2013. Presentation at the Waccamaw River Conference. Myrtle Beach, South Carolina. Libes S and Fuss D. 2010.

Community-Based Watershed Planning in the Kingston Lake 43

Watershed of Northeastern South Carolina: Activities during 2008-2010. Proceedings of the 2010 South Carolina Water Resources Conference, held October 13-14, 2010, at the Columbia Metropolitan Convention Center. Lowcountry Open Land Trust. 2013. Winyah Bay. Website accessed February 24, 2013. Available from: http://www.lolt.org/conservation-programs/protected/winyah-bay.html MacDonald F, Moseley C, Davis EJ, Nielsen-Pincus M, and Ellison A. 2010. Mobilizing Human Resources for Watershed Restoration. University of Oregon. Ecosystem Workforce Program Briefing Paper Number 22

Montalvo, A. M., S. L. Williams, K. J. Rice, S. L. Buchmann, C. Cory, S., N. Handel, G. P. Nabhan, R. Primack, and R. H. Robichaux. 1997. Restoration biology: a population biology perspective. Restoration Ecology 5:277–290. Moore, 6

G. 2009. The Waccamaw River's Blue Trail. Carolina Live News. Available from:

http://www.carolinalive.com/news/story.aspx?id= 106

315410#.UWGXQ8rJJ90 [NMBA]

National Mitigation Banking Association website. **http://www.mitigationbanking.org/,** 128 accessed September 5, 2012. North Carolina Coastal Land Trust. 2013. Website accessed February 24, 2013. Available from: http://www.coastallandtrust.org/ [NCEEP] North Carolina Ecosystem Enhancement Program. Accessed April 11, 2013. Available from: http://portal.ncdenr.org/web/eep North Carolina Natural Heritage Program. Accessed April 11, 2013. Available from: http://portal.ncdenr.org/web/nhp/home

[NRCS] United States Department of Agriculture – Natural Resources Conservation Service. 84

Waccamaw Subbasin: An Assessment of the Waccamaw Subbasin. May 17, 2010 [Accessed March 12, 2012]. Available from: http://www.esri.sc.edu/Projects/usda/ conservation_documents/RWAs/Waccamaw.pdf North Carolina Sea Grant. 2002. COASTWATCH High Season 2002 Issue. Available from:

http://www.ncseagrant.org/home/coastwatch/coastwatch-articles?task=showArticle&id= 12

568 Petursdottir T, Aradottir A, and Benediktsson K. 2013.

An Evaluation of the Short-Term Progress of Restoration Combining Ecological Assessment and Public Perception. Restoration Ecology 40

Vol. 21, No. 1, pp. 75–85

Pregernig M. 2002. Perceptions, Not Facts: How Forestry Professionals Decide on the Restoration of Degraded Forest Ecosystems, Journal of Environmental Planning and Management, 45:1, 16

25-38 Plum Creek. 2012a. About Us. Accessed February 24, 2013. Available from:

97

http://www.plumcreek.com/AboutPlumCreek/tabid/54/Default.aspx

Plum Creek. 2012b. Sustainable Forestry Initiative, Objective 6. Accessed February 24, 2013. Available from: http://www.plumcreek.com/Environment/nbspSustainableForestrySFI/ SFIObjectives/SFIObjective6/tabid/219/Default.aspx [RBRP] North Carolina Ecosystem Enhancement Program. 2008. Lumber River Basin Restoration Priorities [RMS] Resource Management Services. 2012a. History. Accessed February 24, 2013. http://www.resourcemgt.com/About-Us/History [RMS] Resource Management Services. 2012b. Sustainable Forestry. Accessed February 24, 2013. Available from: http://www.resourcemgt.com/Asset-Management/Sustainable- Forestry [RMS] Resource Management Services. 2012c. Regional Managers. Accessed February 24, 2013. Available from: http://www.resourcemgt.com/About-Us/Leadership/Operations/US- Operations/Regional-Managers/Tony-Doster

Riggs SR, Ames DV, Brant DR, and **Sager ED. 2000. The Waccamaw Drainage System: Geology** 59

And Dynamics of A Coastal Wetland, Southeastern North Carolina. East Carolina University. Report Submitted To North Carolina Department of Environment and Natural Resources Division of Water Resources. [SCDHEC]

South Carolina Department of Health and Environmental Control. 2013. **SCDHEC Watershed** 34

Assessments: Pee Dee River Basin, Waccamaw River watershed. Available from:

www.scdhec.gov/environment/water/ shed **.htm.** 153

[SCDNR] South Carolina Department of Natural Resources’ 56

Heritage Preserve website.

Waccamaw River Heritage Preserve and Lewis Ocean Bay **Heritage Preserve.** 146

Accessed March 25, 2012. Available from: https://www.dnr.sc.gov/mlands/heritage. [SER] Society for Ecological Restoration. Accessed January 14th, 2013. Available from:

http://www.ser.org/resources/resources-detail-view/ adoption-of **-ser-primer%** 95

27s- definition-of-er [SCFC] South Carolina

Forestry Commission. 2010. South Carolina's Statewide Forest Resource Assessment and Strategy Conditions, Trends, Threats, Benefits, and Issues. [SCFC] **South Carolina Forestry Commission.** 7

2013. Website available from: http://www.state.sc.us/forest/. Accessed February 24, 2013. Sustainable Forestry Initiative.

2010. Requirements for the SFI 2010-2014 Program Standards, Rules for Label Use, Procedures and Guidance. Available from: **http://www.sfiprogram.org/** 30

files/pdf/sfirequirements2010-2014pdf/ Tidwell T and Brown H. 2011. Moving Toward a Restoration Economy. Journal of Forestry; Oct/Nov 2011; 109, 7; 386 – 391 The Campbell Group. 2013. About Us. Accessed February 24, 2013. Available from: https://www.campbellgroup.com/about/press-releases.aspx?mediaID=M104 The Campbell Group. 2006. Press Release. Accessed February 24, 2013. Available from: https://www.campbellgroup.com/about/press-releases.aspx?mediaID=M104 The Nature Conservancy. 2013a. About Us. Accessed February 24, 2013. Available from: http://www.nature.org/about-us/index.htm The Nature Conservancy. 2013b. Winyah Bay and Pee Dee River Basin. Accessed February 24, 2013. Available from:

http://www.nature.org/ourinitiatives/regions/northamerica/ unitedstates/ southcarolina **/placesweprotect/** winyah-bay **.xml** 86

The Nature Conservancy. 2013c. Sandy Island Preserve. Accessed February 24, 2013. Available from:

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/ southcarolina /placesweprotect/ sandy -island- preserve .xml 12

The Nature Conservancy. 2013d. Southeastern Coastal Plain Brochure. Accessed February 24, 2013. Available from: http://www.nature.org/newsfeatures/se20coastal20brochure2. pdf The Nature Conservancy. 2011. Winyah Bay and Pee Dee River Basin Fact Sheet. Available from:

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/ southcarolina /placesweprotect/ 12

winyah-bay-fact-sheet-2011.pdf The Nature Conservancy. 2010. The Southeastern Coastal Plain Brochure. Accessed February 24, 2013. Available from: www.nature.org/newsfeatures/se20coastal20brochure2.pdf The Nature Conservancy.

2000. Biodiversity Hotspots in the Continental US and Hawai'I. Available from: http://gis.tnc.org/data/MapbookWebsite/map_page.php?map_id=53 25

Thepaut B, Libes S, Young H, Fuss D, and Jayakaran A. 2012. Plant Survival In The Floodplain Restoration Of Crabtree Swamp, Horry County, SC.

Proceedings of the 2012 South Carolina Water Resources Conference 43

at the Columbia Metropolitan Convention Center. [USACE]

United States Army Corps of Engineers, Charleston District. 1977. Waccamaw River 24

Basin Navigability Study. Report No. 7. Prepared by Stanley Consultants. 45 p.

[USACE] United States Army Corps of Engineers, 145

Charleston District. 2009. Horry County, South Carolina Concept Study of a Flood Reduction Diversion Canal. 10 p. [USDA-NRCS]

United States Department of Agriculture – Natural Resource **Conservation** Services. Wetland **Reserve Program** website. **http://www.nrcs.usda.gov/wps/portal/nrcs /main/national/programs/easements/wetlands,** 26

accessed September 23, 2012. United States Department of the Interior. 2011. America's Great Outdoors. Fifty-State Report. Accessed April 1, 2013. Available from:

http://www.slideshare.net/USInterior/americas- great-outdoors-fiftystate-report 85

[USFWS]

United States Fish and Wildlife Service. 72

2012. Website

available from: http://www.fws.gov/ 72

waccamaw. Last Updated: May 2nd, 2012. Waccamaw Riverkeeper. 2012a. http://www.winyahrivers.org/waccamaw.html, accessed on March 25, 2012. Waccamaw Riverkeeper. 2012b. Personal Communication. April 17th Waccamaw Watershed Academy. 2013a. Waccamaw River Sub-Basin. Accessed February 24, 2013. Available from: http://www.coastal.edu/wwa/issues/sub-basin.html Waccamaw Watershed Academy. 2013b. Waccamaw Riverkeeper. Accessed February 24, 2013. Available from: http://www.coastal.edu/wwa/riverkeeper.html Waccamaw Watershed Academy. 2013c. Accessed February 24,

2013. Available from: http://www.coastal.edu/ Wear D. 2007. Trends in Southeastern Forests. Workshop on Southeast Regional Planning & Sustainability (SERPS). Available from: http://workshops.serdp-estcp.org/serps/docs /Trends_in_Southeastern_Forests.pdf

Wear D, Greis J, eds. 2002. Southern Forest Resource Assessment. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p. Wear D and Greis J. 10

2011.

United States Forest Service: Southern Forest 154

Futures Project. Technical Report. Chapters 1 – 17.

Wear D, Carter D, and Prestemon J. 2007. The U.S. South's timber sector in 2005: a prospective analysis of recent change. Gen. Tech. Rep. SRS-99. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 29 p. 5

Weinberg A and Larson C.

2008. Forestland for sale: challenges and opportunities for conservation over the next ten years. New York: Open Space Institute, Inc. 22 p. 32

Wenger S. 1999. A Review of the Scientific Literature on Riparian Buffer Width, Extent and 48

Vegetation. Office of Public Service & Outreach, Institute of Ecology. University of Georgia. Revised Version. Available from: http://www.rivercenter.uga.edu/service/ tools/buffers/buffer_lit_review.pdf X. APPENDICES A.

Initial Email for Public Agencies, Universities, and/or Non- Governmental Organizations: Dear _________: [Only if appropriate:

As you may know, in addition to my job	1

at Tidewater Environmental Services Inc,]

I am currently in my second year of a two-year graduate program through Duke University's Nicholas School of the Environment. My final master's project is	1

evaluating the participation and effectiveness of wetland conservation and restoration programs on timber lands within the Waccamaw River watershed.

I am interested in learning more about the extent and	38

effectiveness of wetland conservation and restoration programs within the Waccamaw River watershed, as well as your organization's relationship with timber companies. My research

will be used to determine the extent of conservation and restoration on	47

timber lands within the watershed and understand the effectiveness of federal and state wetland programs (such as the Wetland Reserve Program). Information gathered during these interviews will be useful in identifying opportunities and challenges of wetland programs and planning future restoration efforts within the Waccamaw River watershed. If you or other colleagues

would be interested in contributing to the project, please respond to this e-mail so I can provide more details. Then, if you decide to participate, I will	1

conduct a semi-structured interview by telephone. Interviews should not take more than 30 minutes.

Thank you for your time and please let me know if you have any questions. I look forward to hearing from you. Sincerely, Elizabeth Blair Goodman **DEL-MEM** 13 **Nicholas School of the Environment** Example **questions for** 1

semi-structured interviews with representatives of

public agencies, universities, **and non-profit conservation organizations working** 46

in the Waccamaw River watershed. These interviews will be conducted on the telephone and documented with thorough notes. 1. Provide 2 to 3 examples of successful wetland initiatives your organization has accomplished on timber lands within the past 10 years 2. How did your organization define success for these initiatives? 3. What are your organization's current initiatives within the watershed? 4. Through my work in the watershed, I've noticed an emphasis on wetland conservation instead of wetland restoration. Is this perception correct? Does your organization prioritize conservation or restoration? If so, why? 5. Do you believe wetland restoration is warranted within the watershed? If so, why? 6. Does your organization communicate with timber companies within the watershed? If so, how often? What type of communication methods do you use? Such as face-to-face, email or print newsletters, telephone calls? 7. What is your organization's relationship with timber companies? 8. Does your organization use federal or state

programs, such as the Wetland Reserve Program, to 44

conduct wetland conservation or restoration? If so, what motivated your organization to participate in these programs? How does your organization measure the effectiveness of these programs? 9. Does your organization participate in compensatory mitigation as a means to conduct wetland conservation or restoration within the watershed? If so, what motivated your organization to participate in these programs? If so, how does your organization measure the effectiveness of these programs? 10. Does your organization face obstacles to participating in these programs? If so, how does your organization address these obstacles? 11. Are there any other organizations I should talk to about wetland programs on timber lands within the watershed? B. Initial Email for Timber Companies Dear _________: [Only if appropriate:

As you may know, in addition to my job 1

at Tidewater Environmental Services Inc,]

I am currently in my second year of a two-year graduate program through Duke University's Nicholas School of the Environment. My final master's project is 1

evaluating the participation and effectiveness of wetland conservation and restoration programs on timber lands within the Waccamaw River watershed.

I am interested in learning more about the extent and 38

effectiveness of wetland conservation and restoration programs within the Waccamaw River watershed, as well as your company's relationship

with federal and state agencies, universities, and non-profit organizations. 134

My research

will be used to determine the extent of conservation and restoration on 47

timber lands within the watershed and understand the effectiveness of federal and state wetland programs (such as the Wetland Reserve Program). Information gathered during these interviews will be useful in identifying opportunities and challenges of wetland programs and planning future restoration efforts within the Waccamaw River watershed. If you or other colleagues

would be interested in contributing to the project, please respond to this e-mail so I can provide more details. Then, if you decide to participate, I will 1 conduct a semi-structured interview by visiting your office or by telephone, whichever option is most convenient for you. Interviews will be recorded with your consent. Interviews should not take more than 1 hour.

Thank you for your time and please let me know if you have any questions. I look forward to hearing from you. Sincerely, Elizabeth Blair Goodman DEL-MEM 13 Nicholas School of the Environment Example **questions for**	1

semi-structured interviews with timber land managers and company representatives with large (>1000 Acres) landholdings in the Waccamaw River watershed. I will conduct the interviews in person, if practicable. Interviews will be recorded with the interviewee's consent. Example Questions: 1. How long have you owned or managed timber lands within the Waccamaw River watershed? 2. Does any component of your company include wetland conservation or restoration initiatives on your timber lands? If so, which component? 3. What motivated your company to include wetland conservation or restoration as an initiative? 4. Do you believe wetland restoration is warranted within the watershed? Why or why not? 5. Does your company communicate with

public agencies and non-profit conservation organizations	60

within the watershed? 6. Can you describe your organization's relationship with

public agencies and non-profit conservation organizations?	60

If so, how often? What type of communication methods do you use? Such as face-to-face, email or print newsletters, telephone calls? 7. Has your company conserved or restored wetlands on their timber lands in the past? If yes: 8. Please describe the extent (acres) and location of wetland conservation and restoration. 9. Does your company conduct more conservation than restoration? If yes, what factors influence greater conservation than restoration? If no, what factors contribute to greater participation in restoration projects? 10. Did you utilize federal or state grants or cost-share programs, such as the Wetland Reserve Program? If so, please explain which programs. 11. Was the conservation or restoration

conducted as part of a compensatory mitigation project?	121

12. Did you collaborate with public agencies? Non-profit organizations? If yes, how did this collaboration affect your participation in the programs? 13. What factors influenced your decision to participate in these programs? 14. How does your company measure the effectiveness of these programs? Do you feel that past projects were effective based on these metrics? 15. Did your company face obstacles to participating in these programs? If so, how does your company address these obstacles? If no: 16. What factors have prevented you from conserving or restoring wetlands on your timber lands? 17. Have

federal or state agencies or non-profit organizations 45

approached you about conserving or restoring wetlands on your timber lands? 18. Has your relationship with

federal or state agencies or non-profit organizations 45

affected your participation in wetland conservation or restoration programs? a. Does your company participate in wetland conservation or restoration in other regions or watersheds? b. If yes, do you participate more or less than within the Waccamaw River watershed? c. What factors affect greater participation in other regions and watersheds compared to the Waccamaw River watershed? d. Are your relationships with public agencies or non -profit conservation organizations different in these regions or watersheds? If so, has this affected your level of participation in these programs? 19. Are you aware of other programs or incentives in other regions that are not available within the Waccamaw River watershed? 20. Are there other timber companies I should talk to about wetland programs on timber lands within the

watershed? 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 3

42 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87

sources:

1 178 words / 1% - Internet from Tue Mar 23, 2010
dukespace.lib.duke.edu

2

61 words / < 1% match - CrossCheck
Mae A. Davenport. "Building Local Community Commitment to Wetlands Restoration: A Case Study of the Cache River Wetlands in Southern Illinois, USA", Environmental Management, 02/03/2010

3

42 words / < 1% match - Internet from Fri Aug 05, 2011
asepa.gov

4

41 words / < 1% match - Internet from Sun Nov 29, 2009
pubs.usgs.gov

5

41 words / < 1% match - Internet from Tue Apr 06, 2010
www.srs.fs.usda.gov

6

39 words / < 1% match - Internet from Thu Nov 12, 2009
library.eri.nau.edu

7

38 words / < 1% match - Internet from Tue Jul 31, 2012
southernfireexchange.org

8

36 words / < 1% match - Internet from Tue Oct 19, 2010
www.danriver.org

9

33 words / < 1% match - Internet from Wed Mar 24, 2010
dukespace.lib.duke.edu

10

32 words / < 1% match - Internet from Sun Oct 10, 2010
www.inr.oregonstate.edu

11

32 words / < 1% match - Internet from Tue Jan 19, 2010
www.botany.hawaii.edu

12

31 words / < 1% match - Internet from Sat Jan 19, 2013
www.nycwetlands.net

13

29 words / < 1% match - ProQuest
Shephard, Morgan H. "An analysis on the effectiveness of Sandy Island as mitigation for the Carolina Bays Parkway", Proquest, 20111108

14 25 words / < 1% match - Internet from Tue Jun 07, 2011
www.capefearrcd.org

15 25 words / < 1% match - Internet from Mon Jun 29, 2009
www.horrycounty.org

16 25 words / < 1% match - Internet from Tue May 12, 2009
cmsdata.iucn.org

17 24 words / < 1% match - Internet from Tue Sep 11, 2012
www.scribd.com

18 24 words / < 1% match - Internet from Sun Mar 11, 2012
ohiowetlands.org

19 24 words / < 1% match - Internet from Sun Jun 10, 2012
www.horrycounty.org

20 24 words / < 1% match - Internet from Sun May 09, 2010
www2.for.nau.edu

21 23 words / < 1% match - Internet from Fri Apr 19, 2013
apps.usq.edu.au

22 23 words / < 1% match - Internet from Wed Mar 24, 2010
www.plumcreek.com

23 23 words / < 1% match - Internet from Fri Sep 03, 2010
www.corporateregister.com

24 22 words / < 1% match - Internet from Sun Nov 11, 2012
swampschool.mobi

25 22 words / < 1% match - Internet from Wed Nov 29, 2006
www.scwa2.com

26 22 words / < 1% match - Internet from Sun Aug 26, 2012
www.scribd.com

27 22 words / < 1% match - Internet from Sun Sep 28, 2003
www.cgaux.info

28 21 words / < 1% match - Internet from Thu Apr 08, 2010
www.maweb.org

29 21 words / < 1% match - Internet from Sun Dec 16, 2012
summer-school-soils.univ-paris-est.fr

30 20 words / < 1% match - Internet from Sun Apr 29, 2012
www.ferdun.info

31 20 words / < 1% match - Internet from Wed Sep 22, 2010
www.sfiprogram.org

32 20 words / < 1% match - Internet from Mon Aug 23, 2010
conserveonline.org

33 20 words / < 1% match - Internet from Sat Oct 22, 2011
www.teatown.org

34 19 words / < 1% match - Internet from Mon Jan 28, 2013
academic.emporia.edu

35 19 words / < 1% match - Internet from Sun Nov 26, 2006
weyerhaeuser.com

36 18 words / < 1% match - Internet from Mon Jan 21, 2013
pparfm.org

37 18 words / < 1% match - Internet from Fri Mar 02, 2012
www.coastal.edu

38 18 words / < 1% match - ProQuest
Jaji, Haroun-Al-Rash. "Managing natural resources and conflict in conflict-affected watersheds in the Philippines: The case of Agusan River Basin", Proquest, 2012.

39 17 words / < 1% match - Internet from Mon Sep 27, 2010
www.fs.fed.us

40	17 words / < 1% match - CrossCheck Arnalds, Olafur, Berglind Orradottir, and Asa L. Aradottir. "Carbon accumulation in Icelandic desert Andosols during early stages of restoration", Geoderma, 2013
41	16 words / < 1% match - Internet from Tue Jul 31, 2012 www.criminal-cases.com
42	16 words / < 1% match - Internet from Mon Apr 16, 2012 library.chemeketa.edu
43	16 words / < 1% match - Internet from Sat Aug 27, 2011 www.coursehero.com
44	16 words / < 1% match - Internet from Wed Oct 15, 2008 library.fws.gov
45	16 words / < 1% match - Internet from Sun Feb 01, 2009 www.sas.usace.army.mil
46	16 words / < 1% match - CrossCheck Michael J. Mortimer. "A Survey of Forestland Conservation Easements in the United States: Implications for Forestland Owners and Managers", Small-scale Forestry, 05/25/2007
47	16 words / < 1% match - Publications "FEDERAL REGISTER", Federal Register, 2011
48	15 words / < 1% match - Internet from Fri Jul 20, 2012 sammamishwa.gov
49	15 words / < 1% match - Internet from Sat Nov 13, 2010 www.privatelandownernetwork.org
50	15 words / < 1% match - Internet from Wed Jul 07, 2010 www.duke-energy.com
51	15 words / < 1% match - Internet from Sun May 16, 2010 www.glossary.com
	15 words / < 1% match - Internet from Mon Jun 21, 2010

52 www.coursehero.com

53 15 words / < 1% match - CrossCheck
Barb Crosbie. "Article", Canadian Journal of Fisheries and Aquatic Sciences, 10/1999

54 15 words / < 1% match - Publications
"Reissuance of Nationwide Permits.", Federal Register, Feb 21 2012 Issue

55 15 words / < 1% match - Publications
"FEDERAL REGISTER", Federal Register, 2011

56 15 words / < 1% match - ProQuest
Taylor, April L. "Improving wetland mitigation in the coastal plain of South Carolina with the watershed planning and mitigation banking aspects of the new mitigation rule", Proquest, 2012.

57 14 words / < 1% match - Internet from Fri Aug 10, 2012
elawreview.org

58 14 words / < 1% match - Internet from Mon Jul 30, 2012
cwsec-sc.org

59 14 words / < 1% match - Internet from Thu Aug 26, 2010
acmg.seas.harvard.edu

60 14 words / < 1% match - ProQuest
St. James, Elizabeth Anne. "Effect of hunting frequency on duck abundance, harvest, and hunt quality in Mississippi", Proquest, 20111108

61 14 words / < 1% match - CrossCheck
Lewis III, R.. "The Rehabilitation of the Tampa Bay Estuary, Florida, USA, as an Example of Successful Integrated Coastal Management", Marine Pollution Bulletin, 199912

62 13 words / < 1% match - Internet from Tue Sep 18, 2012
www.ecu.edu

63 13 words / < 1% match - Internet from Sun Nov 27, 2011
www.us-parks.com

64 13 words / < 1% match - Internet from Sat Sep 03, 2011

www.lolt.org

---

65 13 words / < 1% match - Internet from Tue Oct 12, 2010
www.citizendia.org

---

66 13 words / < 1% match - Internet
www.ncwater.org

---

67 12 words / < 1% match - Internet from Mon Jan 07, 2013
blogs.cdc.gov

---

68 12 words / < 1% match - Internet from Thu Oct 25, 2012
www.capabilitycompany.com

---

69 12 words / < 1% match - Internet from Tue Sep 11, 2012
usgovernmentbenefits.org

---

70 12 words / < 1% match - Internet from Wed Nov 30, 2011
coastal.edu

---

71 12 words / < 1% match - Internet from Sat Oct 10, 2009
www.ncseagrant.org

---

72 12 words / < 1% match - ProQuest
Bryan, Rebecca Dy. "Intraspecific and interspecific communication on prairie dog colonies black tailed prairie dogs and burrowing owls", Proquest, 2012.

---

73 12 words / < 1% match - Publications
"AMERICA'S GREAT OUTDOORS: SALAZAR CELEBRATES IMPORTANT STEPS IN SAN ANTONIO'S GREAT URBAN PARK VISIO", States News Service, June 25 2011 Issue

---

74 12 words / < 1% match - ProQuest
Lave, Rebecca Anne. "The Rosgen Wars and the shifting political economy of expertise", Proquest, 20111004

---

75 11 words / < 1% match - Internet from Sun Jan 27, 2013
www.coastallandtrust.org

---

76 11 words / < 1% match - Internet from Sun Dec 23, 2012

www.timberharvesting.com

77 11 words / < 1% match - Internet from Sun Aug 12, 2012
wwp.greenwichmeantime.hk.cn

78 11 words / < 1% match - Internet from Mon Jun 13, 2011
md1.csa.com

79 11 words / < 1% match - Internet from Wed Oct 12, 2011
www.lrc.usace.army.mil

80 11 words / < 1% match - Internet from Wed Apr 13, 2011
pinchot.org

81 11 words / < 1% match - Internet from Tue Aug 26, 2008
www.floridadep.com

82 11 words / < 1% match - CrossCheck
Hutto, Richard L., and R.T. Belote. "Distinguishing four types of monitoring based on the questions they address", Forest Ecology and Management, 2013.

83 10 words / < 1% match - Internet from Sat Jan 19, 2013
www.brunsco.net

84 10 words / < 1% match - Internet from Tue Dec 04, 2012
wiki.bugwood.org

85 10 words / < 1% match - Internet from Fri Nov 30, 2012
jordanrivercommission.com

86 10 words / < 1% match - Internet from Wed Sep 19, 2012
www.gullahgeecheecorridor.org

87 10 words / < 1% match - Internet from Fri Jun 01, 2012
www.absoluteastronomy.com

88 10 words / < 1% match - Internet from Sun Jun 10, 2012
www.horrycounty.org

89 10 words / < 1% match - Internet from Fri Dec 31, 2010
www.wrightsvillebeachmagazine.com

90 10 words / < 1% match - Internet from Tue Aug 17, 2010
ww2.cityofpasadena.net

91 10 words / < 1% match - Internet from Tue May 12, 2009
bulk.resource.org

92 10 words / < 1% match - Internet from Mon Mar 29, 2010
www.systemdynamics.org

93 10 words / < 1% match - Internet
www.plumcreek.com

94 10 words / < 1% match - Internet from Sun Feb 03, 2013
link.springer.com

95 10 words / < 1% match - CrossCheck
Jaunatre, Renaud, Elise Buisson, Isabelle Muller, Hélène Morlon, François Mesléard, and Thierry Dutoit. "New synthetic indicators to assess community resilience and restoration success", Ecological Indicators, 2013.

96 10 words / < 1% match - ProQuest
Chambers, Samuel No. "Social and spatial relationships driving landowner attitudes towards aquatic conservation ", Proquest, 2012.

97 9 words / < 1% match - Internet from Thu Jan 24, 2013
myenvironment.net.au

98 9 words / < 1% match - Internet from Wed Jan 23, 2013
www.coastallandtrust.org

99 9 words / < 1% match - Internet from Fri Oct 01, 2010
www.knightfdn.org

100 9 words / < 1% match - Internet from Sun Mar 07, 2010
www.winyahrivers.org

101 9 words / < 1% match - Internet from Sun May 02, 2010

notebook.lausd.net

102 9 words / < 1% match - Internet from Wed Feb 28, 2007
chasdoc.org

103 9 words / < 1% match - CrossCheck
Frederick Steiner. "State wetlands and riparian area protection programs", Environmental Management, 03/1994

104 9 words / < 1% match - CrossCheck
Emile Elias. "The impact of forest to urban land conversion on streamflow, total nitrogen, total phosphorus, and total organic carbon inputs to the converse reservoir, Southern Alabama, USA", Urban Ecosystems, 07/14/2011

105 8 words / < 1% match - Internet from Wed Mar 06, 2013
en.wikipedia.org

106 8 words / < 1% match - Internet from Mon Jan 21, 2013
www.postopliving.com

107 8 words / < 1% match - Internet from Fri Nov 16, 2012
www.fws.gov

108 8 words / < 1% match - Internet from Sun Jan 06, 2013
www.winyahrivers.org

109 8 words / < 1% match - Internet from Tue Sep 11, 2012
www.waterkeeper.org

110 8 words / < 1% match - Internet from Tue Nov 22, 2011
digitalcommons.butler.edu

111 8 words / < 1% match - Internet from Thu Oct 27, 2011
www.ci.bellevue.wa.us

112 8 words / < 1% match - Internet from Sat Oct 22, 2011
www.prep.unh.edu

113 8 words / < 1% match - Internet from Tue Mar 06, 2012
www.sustainability.duke.edu

114 8 words / < 1% match - Internet from Wed Jun 15, 2011
gistech.delmar.edu

115 8 words / < 1% match - Internet from Tue Dec 07, 2010
scholar.lib.vt.edu

116 8 words / < 1% match - Internet from Mon Oct 18, 2010
www.alamedacreek.org

117 8 words / < 1% match - Internet from Sun Aug 22, 2010
www.townofleland.com

118 8 words / < 1% match - Internet from Sun Jun 20, 2010
www.lakelandtn.gov

119 8 words / < 1% match - Internet from Fri Jun 05, 2009
wire.enr.state.nc.us

120 8 words / < 1% match - Internet from Wed Mar 31, 2010
www.dec.ny.gov

121 8 words / < 1% match - Internet from Sat May 24, 2008
www.usace.army.mil

122 8 words / < 1% match - Internet from Thu May 27, 2010
www.fs.fed.us

123 8 words / < 1% match - Internet from Mon Apr 26, 2010
www.lib.ncsu.edu

124 8 words / < 1% match - Internet from Sun Nov 04, 2012
pdf.wri.org

125 8 words / < 1% match - Internet
dogwoodalliance.org

126 8 words / < 1% match - Internet from Wed Nov 18, 2009
www.answers.com

127 8 words / < 1% match - Publications
"Waldökologie, Landschaftsforschung und Naturschutz, Heft 10 (2010)", , 2013

128 8 words / < 1% match - CrossCheck
BenDor, T.K.. "A survey of entrepreneurial risk in U.S. wetland and stream compensatory mitigation markets", Environmental Science and Policy, 201105

129 8 words / < 1% match - CrossCheck
Sun, X.. "Knowledge of three regeneration programs and application behavior among Mississippi nonindustrial private forest landowners: A two-step sample selection approach", Journal of Forest Economics, 200908

130 8 words / < 1% match - CrossCheck
Bruce Evan Goldstein. "The network imaginary: coherence and creativity within a multiscalar collaborative effort to reform US fire management", Journal of Environmental Planning and Management, 12/2009

131 8 words / < 1% match - Publications
British Food Journal, Volume 114, Issue 8

132 8 words / < 1% match - ProQuest
Anderson, Eric S. "Spatial prediction of forest soil carbon: Spatial modeling and geostatistical approaches", Proquest, 20111109

133 8 words / < 1% match - Publications
Dwivedi, Puneet Alavalapati, Janaki R.R.. "Impact of carbon value on the profitability of slash pine plantations in the southern United States:", Canadian Journal of Forest Research, May 2009 Issue

134 8 words / < 1% match - Publications
Stafford, Jeannie. "A passion for Amargosa toads.", Endangered Species Bulletin, Fall 2012 Issue

135 8 words / < 1% match - ProQuest
Ward, Heather Elizabeth McDowell. "Creating the Papahanaumokuakea Marine National Monument: Discourse, Media, Place-making, and Policy Entrepreneurs", Proquest, 20111003

136 8 words / < 1% match - CrossCheck
James O Luken. "Dionaea muscipula (Venus Flytrap) Establishment, Release, and Response of Associated Species in Mowed Patches on the Rims of Carolina Bays", Restoration Ecology, 12/2005

137 8 words / < 1% match - Publications
"Base supporters seek more in study.", Havelock News (Havelock, NC), May 12 2010 Issue

138 7 words / < 1% match - CrossCheck
Jerad D. Bales. "IDENTIFICATION OF CHANGES IN STREAMFLOW CHARACTERISTICS", Journal of the American Water Resources Association, 2/2001

139 7 words / < 1% match - CrossCheck
"Program and Abstracts", Journal of Vertebrate Paleontology, 2012

140 7 words / < 1% match - Publications
"TRANSPORTATION DEPARTMENT TO TRANSFER OWNERSHIP OF SANDY ISLAND PRESERVE TO THE NATURE CONSERVANCY.", States News Service, Jan 26 2010 Issue

141 7 words / < 1% match - ProQuest
Dwivedi, Puneet. "Environmental and economic suitability of forest biomass-based bioenergy production in the Southern United States", Proquest, 20111108

142 7 words / < 1% match - ProQuest
Reeves, Reginald. "GIS mapping of "two worlds": Comparing expert and non-expert conservation priorities", Proquest, 20111108

143 7 words / < 1% match - ProQuest
Horrie, Mitchell G. "Stakeholder collaboration in suburban prairie restoration: Three case studies from Cook County, Illinois", Proquest, 20111004

144 7 words / < 1% match - Publications
Jacobson, Rachel. "Endangered and Threatened Wildlife and Plants; Proposed Endangered Status for the Neosho Mucket, Threatened Status for the Rabbitsfoot, and Designation of Critical Habitat for Both Species", Federal Register, 2012

145 7 words / < 1% match - ProQuest
Meitzen, Walter F. "Propagation of Vallisneria americana (Michx.): Vegetation management in South Carolina Piedmont reservoirs", Proquest, 2012.

146 7 words / < 1% match - Publications
"ARCHERY DEER-HUNTING OPPORTUNITIES ABOUND IN COASTAL REGION.", States News Service, August 17 2011 Issue

147 7 words / < 1% match - Publications
"Conservation group aids Topsail Beach, N.C., effort to buy land.", Star-News (Wilmington, North Carolina) (, Sept 22 2005 Issue

148 6 words / < 1% match - Internet from Fri Apr 12, 2013
portal.ncdenr.org

149 6 words / < 1% match - Internet from Thu Aug 09, 2012
portal.ncdenr.org

150 6 words / < 1% match - Internet from Thu Jun 25, 2009
co.whatcom.wa.us

151 6 words / < 1% match - ProQuest
Dantzler, David Walter. "Developing environmental education, nature-based tourism, and outdoor recreation initiatives on a soild waste management site in Conway, South Carolina", Proquest, 20111108

152 6 words / < 1% match - ProQuest
Aslan, A. "Development and Application of Vegetative Buffer Width Modeling using Geographic Information Systems", Proquest, 2012.

153 6 words / < 1% match - ProQuest
Schrag, Jeffrey Michael. "Predictor modeling of naturally ocurring radium in private residential drinking water wells of the inner coastal plain of South Carolina", Proquest, 20111108

154 6 words / < 1% match - Publications
Jordan, Lewis Clark, Alexander, III Schi. "Regional variation in wood specific gravity of planted loblolly pine in the United States.(Report)", Canadian Journal of Forest Research, April 2008 Issue

155 6 words / < 1% match - ProQuest
Majsztrik, John Christopher. "Modeling nitrogen, phosphorus and water dynamics in greenhouse and nursery production systems", Proquest, 20111109

156 6 words / < 1% match - ProQuest
Duberstein, Jamie A. "Composition and ecophysiological proficiency of tidal freshwater forested wetlands: Investigating basin, landscape, and microtopographic scales ", Proquest, 2012.

157 6 words / < 1% match - CrossCheck
Khorshed Alam. "Public attitudes toward restoration of impaired river ecosystems: Does residents' attachment to place matter?", Urban Ecosystems, 04/16/2011

5 words / < 1% match - Internet from Thu Jun 29, 2006

158 www.ncseagrant.com