RIPARIAN BUFFER WIDTH AND LANDOWNER PREFERENCE IN MACON COUNTY, NORTH CAROLINA

by

ANNE ELEANORE CHESKY SMITH

Under the Direction of Ted Gragson

ABSTRACT

When aggregated, how individual landowners decide to manage their land can have dramatic implications for stream health regionally. In this study, I interviewed 31 western North Carolina landowners who had participated in a riparian buffer restoration program more than a decade ago. I compared the landowners' reported preferences for managing their riparian zones to the current average width of their riparian buffer. The results of this study show that even among those who invested in riparian buffer restoration work on their property, lack of understanding of how or why to maintain a riparian buffer as well as individual preferences for narrower buffers often outweighed the goals of the restoration. Narrower average buffer widths were generally attributed to management that met a personal aesthetic preference or allowed visual or physical access to the river. Among landowners who actively managed their land, the most successful buffers were those under conservation easement.

INDEX WORDS: riparian buffer, Macon County, North Carolina, conservation easement

RIPARIAN BUFFER WIDTH AND LANDOWNER PREFERENCE IN MACON COUNTY, NORTH CAROLINA

by

ANNE ELEANORE CHESKY SMITH

BA, University of North Carolina at Asheville, 2005

MA, Appalachian State University, 2010

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF ARTS

ATHENS, GEORGIA

2016

RIPARIAN BUFFER WIDTH AND LANDOWNER PREFERENCE IN MACON COUNTY, NORTH CAROLINA

by

ANNE ELEANORE CHESKY SMITH

Major Professor: Ted Gragson

Committee: Don Nelson
Seth Wenger

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
May 2016

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Introduction

During the summer of 2015, I accepted an internship with the Land Trust for the Little Tennessee (LTLT), now known as Mainspring Conservation Trust. LTLT was founded in 1997 to conserve the waters, forests, farms, and heritage of the Upper Tennessee and Hiwassee River Valleys. The January 2016 name change reflects the growing geographic area the land trust serves. The trust works in partnership with public agencies and private landowners to conserve land with a mission of preserving the water quality, natural beauty, ecological integrity, and rural character of the southern Blue Ridge for the next generations (mainspringconserves.org).

As part of this internship I also worked in partnership with the Coweeta Long-Term Ecological Research (LTER) program, located in Macon County and overseen by the University of Georgia, and the Macon County Soil and Water Conservation District (Macon SWCD), a governmental organization that develops and oversees conservation programs in the county using local, state, and federal funds. Macon SWCD accomplishes conservation goals primarily by providing technical assistance and services to landowners, free literature, and conservation-oriented public educational programs.

Prior to 1995, Macon SWCD primarily protected water quality in the county by working with landowners to install livestock-exclusion fencing and alternative water sources for livestock with funding from the North Carolina Agriculture Cost-Share Program. This program continued after 1995, but expanded to include the installation of whole-tree revetments and woody riparian

buffers of native tree species to stabilize eroding stream banks. The program received initial funding from the North Carolina Division of Water Quality's Section 319 program.

Beginning in 1995, Macon SWCD began recruiting landowners with property abutting the water to the program. Further funding from the USFWS Partners for Fish and Wildlife Program and the North Carolina Clean Water Management Trust Fund allowed the program to continue for over 10 years. Landowners who opted to have restoration work done on their property agreed to share costs and to maintain the whole-tree revetments and planted buffers for 10 years from the date of installation. Approximately $900,000 from the state and federal agencies was used to treat 86 sites, installing over 11 miles of planted riparian buffers and three miles of whole-tree revetments by the end of the program. With the expiration of the maintenance agreements on the last of the sites in 2014, LTLT and Macon SWCD sought a better understanding of the efficacy of the revetment and woody riparian buffer planting program.

As limited follow-up visits with landowners were conducted even during the 10-year maintenance period, little was known about whether landowners were maintaining the buffers during or after the maintenance period or if they had reverted to the types of management--grazing, mowing/weed eating to the edge of the stream--that had resulted in the need for intervention in the first place. As other cost-share and technical assistance programs in the county continue to use the 10-year-contract model, there was also interest in better understanding the efficacy of these types of contracts. Besides determining the effectiveness of the project, the objective of the internship was to compile lessons learned from the project that could be used to help design future projects and aid in monitoring and evaluation.

Representatives from LTLT, Macon SWCD, and Coweeta LTER performed assessment tasks jointly. LTLT and Macon SWCD collaborated to compile the GIS database of parcels that had restoration work performed on them as part of the project and to identify the current landowners. LTLT and Coweeta LTER developed the study protocols and conducted the physical and biological measurements within each riparian buffer. With input from all representatives, I designed, conducted, and analyzed interviews with the current landowner of the properties on which restoration work had been done.

We collected physical/biological data on approximately half of the properties on which work had been done. However, I was either unable to reach landowners for the other half of properties or the landowners opted out of participating in the study. Because many of these sites were publically owned, I was not able to gather interview data on them. All in all, I performed 31 semi-structured interviews, and because two landowners owned multiple parcels, I was able to gather interview data on 34 parcels that encompassed the following general topics: 1) history of the property and ownership; 2) understanding of and satisfaction with the buffer work; and 3) past and present management and use of the property.

I transcribed the interviews and analyzed their content, presenting a final summary of results to staff at LTLT, Macon SWCD, and Coweeta LTER. We also collected data on the plant species that grew along each transect and conducted social synoptic surveys within each buffer zone. Though we collected far more data than what was used to formulate this thesis, what could be learned from the data collected was limited due to lack of prior data. For instance, one goal of the original study was to determine the status of the whole-tree revetments and tree plantings. However, exact locations of revetments were mostly unknown and if successful (or entirely unsuccessful) would now be invisible. Similarly, with tree plantings landowners were generally

able to identify the trees that were planted during the project and report their general survival rate (low - primarily due to predation by beavers) exact numbers and locations were unknown and often unreported in the paperwork. Additionally, in many cases, additional projects to restore the bank had been undertaken by the landowner making it difficult to assess the efficacy of the original treatment.

However, the content of the interviews provided sufficient information that if combined with the complementary physical data collected by the staff from LTLT and Coweeta LTER could go beyond the "lessons learned" goal of my internship and hopefully elucidate broader themes from the interviews as they related to the condition of the landowner's riparian buffer. So, in order to determine whether there was a correlation between landowner attitude and buffer condition, for this thesis, I linked the qualitative interview data with the average buffer width of each parcel, which was determined by compiling the quantitative physical data collected by LTLT and Coweeta LTER for each parcel. The result of linking these data sets follows in Chapter 2.

Structure

This three-chapter, manuscript-style thesis begins in the first chapter with an introduction of how the following research came about. Also in the first chapter is a review of the literature that further defines the objectives of the research. The second chapter is a manuscript of an article that will be submitted to the journal *Society and Natural Resources* and contains the results of the study. The third and final chapter is a conclusion to the thesis that summarizes the major results as well as looks towards directions for future research and policy considerations.

Literature Review

Landscape Transition

Many landscapes across the United States are transitioning from agricultural to residential use and undergoing exurbanization. Exurbanization is a process of urban residents moving to rural areas while maintaining an urban way of life. According to Berube et al (2006), "Exurbs…lie somewhere beyond the suburbs. At the urban-rural periphery, outer suburbs bleed into small-town communities with an agricultural heritage." As of 2006, approximately 37% of the population in the United States lived at this rural-urban interface (Sutton et al 2006) and exurbanization has become the fastest growing type of land acquisition in the country (Lohse and Merenlander 2009; Theobald 2003). This type of land use change often creates disconnected low-density residential development along the urban-rural gradient (Irwin and Bockstael 2007).

With an ability and willingness to commute longer distances and the rise of telecommuting more homebuyers seek the natural amenities that can be found in rural areas (Radeloff et al 2010). Seasonal residents are also drawn to these areas for constructing second homes. As land use transitions from agricultural to residential, so does the diversity of values, goals, and normative preferences shown by landowners (Bolstad and Swank 1997; Nassauer 2001; Theobald 2000). While long-term residents may value land for its agricultural utility, new migrants may primarily value the same land for its aesthetic qualities. As such, newcomers in exurban communities tend to differ from generational residents in how they manage their land. For instance, in exurban Montana, landowners who had lived in the area over multiple generations were focused on how to irrigate more efficiently whereas newcomer interests were centered on recreation, aesthetics, and conservation (Gosnell, Haggerty, and Byorth 2007).

Because of these differing values, changes in landownership can also change how land is managed (Gosnell, Haggerty, and Byorth 2007).

Exurbanization creates housing booms in rural areas that can lead to environmental degradation. There has been increasing concern about the impact of exurbanization on water because with increases in population come increases in water consumption, which places direct pressure on regional water supplies (Berube et al. 2006, Gragson and Bolstad 2006, Gosnell and Abrams 2009; Vercoe et al 2014). As populations grow in rural areas, particularly after influxes of amenity migrants, commercial development increases alongside residential development, which also increases impervious surfaces and stream sedimentation to the detriment of stream health and water quality (Lohse and Merenlender 2009; Nassauer et al. 2004).

As more agricultural land is subdivided and converted to residential use to make room for new residents, ensuring maintenance or restoration of riparian zones by landowners with a variety of land management values and behaviors can be problematic (Webster et al 2012). As such, management of riparian zones by private landowners has been identified as a critical area for research (Audrey, Briggs, and Kroesen 2009; Groffman et al. 2003).

Role of Riparian Buffers

In southern Appalachia, most stream banks are now located on private property. As land is further subdivided in the exurbanization process, the ways in which the areas directly adjacent to streams--riparian zones--are managed at the parcel level can have substantial consequences for water quality and stream health when aggregated to the region as a whole. The southern Appalachian Mountains are a water tower for the southeastern United States (Webster et al 2012). The area has abundant precipitation and a dense network of streams (Viviroli et al 2007).

As a result, rivers draining from the region provide an important source of drinking water in the United States (Webster et al 2012).

Riparian, or vegetative, buffers directly benefit stream health and regional water quality. The presence of water influences the vegetation that grows in the buffer, and an ideal riparian buffer contains native grasses, shrubs, and trees. These areas--especially when they include a mix of herbaceous vegetation mixed with deep-rooted trees--prevent sediment, nitrogen, phosphorus, pesticides, and other pollutants from entering the stream. As such, stream and riparian zone management can help ensure high-quality drinking water (Webster et al 2012). Besides filtering pollutants, the leaves and woody debris that come from riparian buffers also provide important energy and nutrients to animal communities that live in or near the stream (Lowrance et al. 1997; Mayer, Reynolds, Canfield, & McCutcheon 2005; Mayer, Reynolds, McCutchen, and Canfield 2007). Trees in riparian buffers shade the streams and keep them cool; this is especially important for trout populations in North Carolina (McLarney 2003). Riparian buffers also provide habitat, food, and travel corridors for wildlife (Prugh, Hodges, Sinclair and Brashares 2008).

Recommended riparian buffer width varies depending the resource the buffer is meant to protect. Four literature reviews conducted by the U.S. Army Corps of Engineers New England Division, the University of Georgia's Institute of Ecology, the U.S. Army Engineer Research and Development Center, and the UK Forestry Commission indicate that though the ideal buffer width varies in different environments and is dependent upon the goal (e.g. water quality, bank stabilization, wildlife habitat) of the buffer, in general, buffers should extend back at minimum 10 meters from the stream bank (U.S. Army Corps of Engineers 1991; Wenger 1999; Fischer and Fischenich 2000; Broadmeadow and Nisbet 2004).

Buffer ranges for erosion control, water quality, aquatic habitat, and terrestrial habitat have been established based on factors like slope, soil type, and land use. To prevent erosion, effective vegetative buffers range from 10 meters to 30 meters. A 15-meter buffer adequately filters nitrates in many cases, and a buffer of 16 meters or greater effectively removes a majority of nutrients and most pesticides. To protect aquatic wildlife, both trout and invertebrates, buffers were most effective if they were at least 11 meters wide. To adequately shade streams and control stream temperatures, buffers need to be at least 10 meters wide. For most terrestrial wildlife, a buffer width of at least 110 meters is necessary to provide habitat and adequate corridors. In short, minimum buffer width to prevent erosion, filter contaminants, protect aquatic wildlife, and shade streams is at absolute minimum 10 meters, though wider buffers of at least 15 meters are more effective (U.S. Army Corps of Engineers 1991; Wenger 1999; Fischer and Fischenich 2000; Broadmeadow and Nisbet 2004; Lee, Smyth, and Boutin 2004).

Human Reactions to Buffers

Research clearly demonstrates that activities within riparian buffers directly impact stream health and water quality and that maintaining a vegetated riparian buffer along waterways benefits stream health, However, at the household level many southern Appalachian landowners are not maintaining vegetative riparian buffers on their property and show clear preferences for stream management that consists of mowing lawns to stream edges, clearing riparian vegetation, using stream water for irrigation, allowing livestock direct stream access, and removing large woody debris—logs, branches, and limbs—from in and along the stream banks on their property (Webster et al 2012). Human behavior on a local scale, then, can dramatically influence hydrological processes at the watershed level when aggregated, especially as land in southern Appalachia is increasingly subdivided and more landowners own smaller tracts (Clinton et al.

2010; Flebbe 1999; Wallace et al. 1993; Walker et al. 2009). In this way, actions by individual landowners can compound to cause severe degradation of stream health and water quality across the region.

Human preferences for riparian zones vary in the literature. Kaplan (1977) found that people greatly preferred open tree settings surrounding water to scenes in which a fence blocked access to the water and prevented lawn maintenance. More recently, however, Sullivan et al (2004) found that among stakeholder groups composed of farmers, residents, and academics all groups highly approved of both tree and grass buffers in riparian settings. And in a study by Kenwick, Shammin, & Sullivan (2009) both residents and planners in Illinois showed high approval of tree buffers along waterways in both rural and suburban settings. Residents preferred forested riparian buffers to "no buffer" by 48% in rural areas and 90% in suburbs for reasons of aesthetics, ecological benefits, and wildlife habitat.

Differing preferences for riparian zones have been noted between farmers and non-farm residents on agricultural lands. Non-farm residents showed a clear preference for more "natural" settings, while farmers preferred a more manicured landscape (Ryan 1998; Nassauer 1989, 1997; Nassauer, Kosek, and Corry 2001). Both farm and non-farm residents, however, preferred some vegetation in buffers over barren stream banks (Sullivan et al. 2004).

Though residents may prefer natural buffers in general, these preferences may not extend to property that they own. Armstrong and Stedman (2012) also examined farm and non-farm landowners and surveyed their willingness to have riparian buffers on their property. They found that land use--residential versus agricultural--was key in determining whether landowners were willing to install riparian buffers. Residential riparian landowners were much less willing to install riparian buffers than were agricultural landowners. This difference was attributed to lack

of knowledge of financial and programmatic support for installing buffers as well as incompatibility with aesthetic or normative practices.

Riparian buffers are not common on residential properties, which is generally attributed to landowner preferences for water views and cleared shorelines (Nassauer et al. 2001). In fact, a recent study conducted in Macon County, North Carolina, found that 57% of survey respondents removed vegetation from riparian zones on their property. Removal of vegetation was attributed to either: 1) appearance; 2) stream access; and/or 3) stream visibility (Evans 2013). Of survey respondents, landowners who resided in the area seasonally removed riparian vegetation at almost twice the rate of landowners who resided in the area full time. Those who had lived in the area under five years reported the lowest frequency of cutting riparian zones (Evans 2013).

Often riparian landowners show stronger support for the goals of riparian zones than for riparian buffer management in practice (Dutcher et al. 2004; Hairston-Strang and Adams 1997; Schrader 1995). This is attributed to a variety of factors. While riparian landowners are often conservation-minded, they also often do not have access to reliable and/or understandable information on riparian zone management, and lack of information about how to manage stream banks has often been identified as the most prevalent reason for clearing riparian vegetation (Buckley and Crone 2008; Hairston-Strang and Adams 1997; Johnson 1996; Larson and Santelmann 2007; Rosenberg and Margerum 2008; Shandas 2007). Added maintenance--labor and cost--was another significant concern about vegetative buffers. Respondents expressed a preference for buffer financing and management to be done by government rather than local landowners (Kenwick, Shammin, and Sullivan 2009). Additional barriers to natural resource management on privately-owned parcels included fear of decreased property values, limited availability of resources, and increased risk. As such, landowners tended to continue to maintain

buffers as they had historically been managed (Dutcher, Finley, Luloff, and Johnson 2004). Riparian landowners identified tax relief, monetary compensation, and participation in developing the intervention programs as key policy options for aiding individual landowners in riparian zone management (Schrader 1995; Hairston 1996). What is not clear, however, is under these policy conditions, whether landowner willingness to install buffers actually leads to long-term maintenance of these buffers.

For landowners, increasing vegetation in riparian zones can improve riparian ecosystem health as well as prevent erosion and mitigate flooding. On the other hand, waterways without vegetation provide increased land area for farming and building as well as unobstructed views of the water. Chapter 2 seeks to give a more detailed understanding of landowner willingness to maintain riparian buffers on their own property and how this willingness is reflected in the width of the landowner's riparian buffer. It also examines specific factors that contribute to riparian vegetation maintenance or lack thereof.

CHAPTER 2

RIPARIAN BUFFER WIDTH AND LANDOWNER PREFERENCE IN MACON COUNTY, NORTH CAROLINA[1]

[1] Smith, A.E.C. To be submitted to *Society and Natural Resources*.

Abstract

When aggregated, how individual landowners decide to manage their land can have dramatic implications for stream health regionally. In this study, I interviewed 31 western North Carolina landowners who had participated in a riparian buffer restoration program more than a decade ago. I compared the landowners' reported preferences for managing their riparian zones to the current average width of their riparian buffer. The results of this study show that even among those who invested in riparian buffer restoration work on their property, lack of understanding of how or why to maintain a riparian buffer as well as individual preferences for narrower buffers often outweighed the goals of the restoration. Narrower average buffer widths were generally attributed to management that met a personal aesthetic preference or allowed visual or physical access to the river. Among landowners who actively managed their land, the most successful buffers were under conservation easement.

Introduction

Because water and other materials filter through riparian zones before entering streams, maintaining a vegetative buffer along stream banks provides extensive benefits to both stream health and water quality including regulating stream temperature, preventing erosion, filtering water draining into the stream of pollutants, and providing habitat for wildlife (Knoepp and Clinton 2009; Shandas 2007; Hession et al 2003; Houser et al 2005, Walker et al 2009). While most ecological benefits of riparian buffers accrue to human populations and ecosystems as a whole, there are also benefits for individual property owners—most notably slowing floodwaters

and preventing erosion and loss of property (Flebbe 1999; Clinton, Vose, and Fowler 2010; McLarney 2003; Walker et al 2009).

In 1995, Macon County, North Carolina's Soil and Water Conservation District began a new program guided by the USDA to install whole-tree revetments and/or plant native tree species along eroding stream banks to create woody riparian buffers. Between 1998 and 2004, with approximately $900,000 in funds provided from state and federal sources, 86 public and private sites in Macon County received either one or both treatments. In total, the county planted 11 miles of native tree species riparian buffers and installed three miles of whole-tree revetments. Landowners recruited to the program agreed to maintain the revetments and buffers for 10 years. The contracted maintenance period has now ended for all treated sites.

Despite financial and labor investments by governmental entities and private-property owners, it is possible that individual preferences for destructive riparian zone management have outweighed individual investment in riparian restoration. If this is the case, landowners may then have reverted back to the prior riparian zone management practices that required intervention in the first place--even though they have assumed some of the cost and agreed to maintain the restoration work for a period of time. Literature addressing landowner maintenance of restored riparian buffers is limited, however.

Revisiting landowners and assessing the condition of their riparian buffers after maintenance contracts have expired may then lead to a better understanding of how landowner preferences for riparian buffer vegetation is associated with buffer width. This paper examines the average riparian buffer width on privately-owned parcels and explores the attitudes of landholders towards restored buffers on their property along western North Carolina waterways. I begin with a review of how riparian areas on private property have been viewed by landowners

across the United States. Next, I group landowners by average riparian buffer width and discuss the major themes that emerged from semi-structured interviews with each landowner about their attitudes towards riparian buffer management on their property. I conclude by exploring implications of the results and directions for further research.

Literature Review

Landscape Transition

Many landscapes across the United States are transitioning from agricultural to residential use and undergoing exurbanization. Exurbanization is a process of urban residents moving to rural areas while maintaining an urban way of life, and it has become the fastest growing type of land acquisition in the country (Lohse and Merenlander 2009; Theobald 2003). As of 2006, approximately 37% of the population in the United States lived at this rural-urban interface (Sutton et al 2006).

During the exurbanization process, land use tends to shift from farming and timber to tourism (Esparza 2009, Esparza and Carruthers 2000, Costello 2007, McCarthy 2008). This transition from agricultural to residential development increases not only the number of people and homes in a community, but also land use heterogeneity and the diversity of values, goals, and normative preferences shown by landowners (Bolstad and Swank 1997; Nassauer 2001; Theobald 2000). As rural land is fragmented and sold, newer landowners often have different expectations about conservation and resource use (Boucquey et al 2012). While long-term residents may value land for is agricultural utility, new migrants may primarily value the same land for its aesthetic qualities. For instance, in exurban Montana, landowners who had lived in the area over multiple generations were more focused on how to irrigate more efficiently

whereas newcomer interests were centered on recreation, aesthetics, and conservation (Gosnell, Haggerty, and Byorth 2007). Because of these differing values, changes in landownership can also change how land is managed (Gosnell, Haggerty, and Byorth 2007).

Changes in land management can lead to environmental degradation, and there is mounting concern about the impact of exurbanization on water. With increases in population come increases in water consumption, which puts direct pressure on regional water supplies (Berube et al. 2006, Gragson and Bolstad 2006, Gosnell and Abrams 2011; Vercoe et al 2014). Also, as populations grow in rural areas, commercial development increases alongside residential development, thereby also increasing impervious surfaces and stream sedimentation to the detriment of stream health and water quality (Lohse and Merenlender 2009; Nassauer et al. 2004).

Role of Riparian Buffers

Riparian, or vegetative, buffers are seen as one solution towards combating the negative environmental effects of exurbanization because buffers prevent sediment, nitrogen, phosphorus, pesticides, and other pollutants from entering the stream, especially when they include a mix of herbaceous vegetation mixed with deep-rooted trees. As such, maintaining riparian buffers can help ensure high-quality drinking water. Besides filtering pollutants, the leaves and woody debris that come from riparian buffers also provide important energy and nutrients to animal communities that live in or near the stream (Lowrance et al. 1997; Mayer, Reynolds, Canfield, and McCutcheon 2005; Mayer, Reynolds, McCutchen, and Canfield 2007; Webster et al 2012). Trees in riparian buffers shade streams and keep them cool; this is especially important for trout

populations in North Carolina (McLarney 2003). Riparian buffers also provide habitat, food, and travel corridors for wildlife (Prugh, Hodges, Sinclair and Brashares 2008).

Buffer widths for erosion control, water quality, aquatic habitat, and terrestrial habitat have been established based on factors like slope, soil type, and land use. To prevent erosion, effective vegetative buffers range from 10 meters to 30 meters. It is important to note, however, that streams naturally migrate and banks naturally erode. For small landowners, preventing erosion prevents loss of property, but stream restoration work also fundamentally alters riparian systems. But, besides controlling erosion, buffers filter pollutants. Buffers of 15 meters filter nitrates in many conditions, though 30 meters provides more consistent control. A buffer of 16 meters or greater effectively removes a majority of nutrients and most pesticides. To protect aquatic wildlife, both trout and invertebrates, buffers are most effective if they are at least 11 meters wide. To adequately shade streams and control stream temperatures buffers need to be at least 10 meters wide. For most terrestrial wildlife, a buffer width of at least 110 meters is necessary to provide habitat and adequate corridors (U.S. Army Corps of Engineers 1991; Wenger 1999; Fischer and Fischenich 2000; Broadmeadow and Nisbet 2004).

Though the ideal buffer width varies in different environments and depends upon the resource it is meant to protect as well as upon the goal of the buffer (e.g. water quality, bank stabilization, wildlife habitat), in general, buffer width to prevent erosion, filter contaminants, protect aquatic wildlife, and shade streams is at absolute minimum 10 meters, though wider buffers of at least 15 meters are more effective (Broadmeadow and Nisbet 2004; Fischer and Fischenich 2000; Lee, Smyth, & Boutin 2004; U.S. Army Corps of Engineers 1991; Wenger 1999).

Human Reactions to Buffers

However, at the household level many southern Appalachian landowners are not maintaining vegetative riparian buffers on their property and show clear preferences for stream management that consists of mowing lawns to stream edges, clearing riparian vegetation, using stream water for irrigation, allowing livestock direct stream access, and removing large woody debris—logs, branches, and limbs—from in and along the stream banks on their property (Webster et al 2012).

The southern Appalachian mountains have abundant precipitation and a dense network of streams (Viviroli et al 2007). Rivers draining from the region provide an important source of drinking water (Webster et al 2012). As land is further subdivided in the exurbanization process, the ways in which riparian zones are managed at the parcel level can have substantial consequences for water quality and stream health when aggregated to the region as a whole. As such, management of riparian zones by private landowners has been identified as a critical area for research (Audrey, Briggs, and Kroesen 2009; Groffman et al. 2003; Clinton et al. 2010; Flebbe 1999; Wallace et al. 1993; Walker et al. 2009).

Human preferences for riparian zones vary in the literature. Kaplan (1977) found that people greatly preferred open tree settings surrounding water to scenes in which a fence blocked access to the water and prevented lawn maintenance. More recently, however, Sullivan et al (2004) found that among stakeholder groups composed of farmers, residents, and academics all groups highly approved of both tree and grass buffers in riparian settings. And in a study by Kenwick, Shammin, & Sullivan (2009) both residents and planners in Illinois showed high approval of tree buffers along waterways in both rural and suburban settings. Residents preferred

forested riparian buffers to “no buffer” by 48% in rural areas and 90% in suburbs for reasons of aesthetics, ecological benefits, and wildlife habitat.

Differing preferences for riparian zones have been noted between farmers and non-farm residents on agricultural lands. Non-farm residents showed a clear preference for more “natural” settings, while farmers preferred more a more manicured landscape (Ryan 1998; Nassauer 1989, 1997; Nassauer, Kosek, and Corry 2001). Both farm and non-farm residents, however, preferred some vegetation in buffers over barren stream banks (Sullivan et al. 2004).

Though residents may prefer natural buffers in general, these preferences may not extend to property that they own. Armstrong and Stedman (2012) also examined farm and non-farm landowners and surveyed their willingness to have riparian buffers on their property. They found that land use--residential versus agricultural--was key in determining whether landowners were willing to install riparian buffers. Residential riparian landowners were much less willing than were agricultural landowners. This difference was attributed to lack of knowledge of the sources of financial and programmatic support available for installing buffers as well as the incompatibility of buffers with aesthetic or normative practices.

Riparian buffers are not common on residential properties, which is generally attributed to landowner preferences for water views and cleared shorelines (Nassauer et al 2001). In fact, a recent study conducted in Macon County, North Carolina, found that 57% of survey respondents removed vegetation from riparian zones on their property. Removal of vegetation was attributed to either: 1) appearance; 2) stream access; and/or 3) stream visibility (Evans 2013). Of survey respondents, landowners who resided in the area seasonally removed riparian vegetation at almost twice the rate of landowners who resided in the area full time. Those who had lived in the area under five years reported the lowest frequency of cutting riparian zones (Evans 2013).

Often riparian landowners show stronger support for the goals of riparian zones than for riparian buffer management in practice (Dutcher et al. 2004; Hairston-Strang and Adams 1997; Schrader 1995). This is attributed to a variety of factors. While riparian landowners are often conservation-minded, they also often do not have access to reliable and/or understandable information on riparian zone management, and lack of information about how to manage stream banks has often been identified as the most prevalent reason for clearing riparian vegetation (Buckley and Crone 2008; Hairston-Strang and Adams 1997; Johnson 1996; Larson and Santelmann 2007; Rosenberg and Margerum, 2008; Shandas 2007). Added maintenance--labor and cost--was another significant concern about vegetative buffers. Respondents expressed a preference for buffer financing and management to be done by government rather than local landowners (Kenwick, Shammin, and Sullivan 2009). Additional barriers to natural resource management on privately-owned parcels included fear of decreased property values, limited availability of resources, and increased risk. As such, landowners tended to continue to maintain buffers as they had historically been managed (Dutcher, Finley, Luloff, and Johnson 2004). Riparian landowners identified tax relief, monetary compensation, and participation in developing the intervention programs as key policy options for aiding individual landowners in riparian zone management (Schrader 1995; Hairston 1996). What is not clear, however, is under these policy conditions, whether landowners who install buffers actually maintain these buffers in the long term.

Research Questions

This study seeks to give a more detailed understanding of landowner willingness to maintain riparian buffers on their own property and how this willingness is reflected in the width

of the landowner's riparian buffer. It also examines specific factors that contribute to riparian vegetation maintenance or lack thereof.

This study seeks to answer the following questions:

1. What is the current width of the riparian buffer on properties on which restoration work was performed more than a decade ago?
2. How much has land ownership changed since these projects were established?
3. What is the current landowner's attitude toward the project site?
4. What management is taking place in the riparian buffers?
5. Is there a correlation between landowner investment/attitude and buffer condition?
6. How is land use type associated with buffer condition?

Methods

Site Description

This research focuses on Macon County, North Carolina, located in the southern portion of the Blue Ridge Mountains within the southern Appalachian region. Millions of years of erosion resulted in a mountainous region covered in temperate deciduous forest. This forest structure is colder and wetter than nearby piedmont areas in the southeast and hosts high levels of biodiversity.

Macon County is 520 square miles, 45% of which is publically owned lands, primarily located within the Nantahala National Forest. Seventy-five percent of the land is forested with the remainder primarily in agricultural pasture (Kirk, Bolstad, and Mason 2012). The county has an expansive network of waterways that feed the northern-flowing Little Tennessee River. The county is within the Little Tennessee Watershed.

The area is currently experiencing high exurbanization pressure from the nearby cities of Atlanta, Charlotte, Greenville, Asheville, and Knoxville (Webster et al 2012). The 2010 census listed the county's population at 33,922. Between 1980 and 2010, Macon County was one of the fastest growing counties in North Carolina, experiencing a 68% increase in population as well as a 245% increase in median household income, increased education levels, and increased per capita water use. With increases in population density came a 14% decrease in farm acreage and a 9% decrease in the number of farms between 1997 and 2007. During the same period, the value of farm land and buildings increased 100%.

Over the last 20 years, the county's Soil and Water Conservation District carried out a project in which they assumed 75% of the cost to install vegetative buffers along 11 miles of privately owned stream banks in the county. The work included tree revetments, livestock exclusion fencing, and native tree plantings. Under this program landowners were obligated to maintain the buffers for 10 years from their installation date. The 10-year maintenance period had ended for all properties by 2014. There were over 80 properties and property owners with degraded stream banks in the county who voluntarily agreed to a cost-share contract with the county for riparian restoration. The bulk of these landowners still reside on the property on which the work was originally done.

Data Collection and Analysis

This project was carried out as a joint project of the Land Trust for the Little Tennessee (LTLT), the Macon County Soil and Water Conservation District (Macon SWCD), and the Coweeta Long-Term Ecological Research (Coweeta LTER) program. Keldar Monar from LTLT and Danny Reategui from Coweeta LTER conducted the physical and biological measurements

of the planted buffers using study advice and protocols from Coweeta LTER. With advice from Jason Love at Coweeta LTER, Ted Gragson at UGA/Coweeta LTER, and Dennis Desmond at LTLT, I designed, conducted, and analyzed the landowner interviews and surveys. I then linked the datasets to determine correlation between landowner investment and attitudes and buffer width.

Landowner participants were found by contacting the current owners of the 86 properties that had restoration work done on them during the original project period between 1999 and 2004. Of the original 86 properties, seven were publically owned and one was owned by LTLT. Of the remaining 78 privately owned properties, four landowners owned multiple properties (three landowners owned two parcels and one landowner owned three parcels) and four landowners were eliminated from the study because of changes in property lines. For this study, then, there were 69 individual landowners that I attempted to contact by telephone and schedule interviews with in May and June of 2015.

In contacting landowners for this study, I had the names and addresses of those who currently owned the parcel on which work was done. We first sent a letter on Macon County Soil and Water letterhead to all 86 landowners we hoped to engage in the study explaining what we hoped to accomplish and notifying that they would soon be contacted by phone to schedule visits and interviews. I then used internet phone lookup websites to locate phone numbers for as many landowners as possible for follow up phone calls within two weeks of mailing the letters. I was able to speak to 33 landowners either when I first made the phone call or after they returned my call. All landowners I spoke to at least initially agreed to participate. However, when they were contacted a few weeks later to schedule a time for a site visit and interview, two landowners were unreachable.

Based on landowner reactions during phone calls and interviews some landowners worried that there could be negative consequences to participation such as increased taxes or penalties if their buffer was not in good condition. On the other hand, many of those who did choose to participate had specific concerns about their stream bank that they wanted the county to address despite my explanations of interviewee anonymity.

Of the 69 landowners I attempted to contact, I was able to interview 31, including the three landowners that owned two properties, bringing the total number of parcels for which interview information was gathered to 34, or approximately half of the privately owned parcels. Interviews ranged from 15 minutes to one hour in length, with most lasting approximately 30 minutes and resulting in a total of 16 hours of interview.

Interviews were conducted between July 13, 2015 and August 8, 2015 and followed a semi-structured questionnaire format. They were most often conducted on-site followed by a walking tour of the landowner's property. During the walking tour, I recorded observations about the landowner's buffer zone including information on built property and/or animals within the buffer zone, observed management of the buffer zone, and vegetation within the buffer zone. Four interviews were conducted via telephone because these landowners were out of town during the interview period. Their property was visited for visual assessments within a week of the interview.

All interviews were transcribed and analyzed using a grounded theory approach to determine dominant themes associated with satisfaction with the restoration work that occurred on the property as well as individual values about water and preferences for stream and riparian buffer management. I avoided using software or techniques that translated words into numbers because I was interested in landowner's subjective relationships to streams on their property.

Buffer width was assessed by Kelder Monar and Danny Reategui during the summer of 2015 for all parcels on which interview data was gathered. Monar and Reategui measured three 30-meter transects per property, unless the property had less than 100 meters of stream frontage, in which case they conducted as many transects as possible without the transects overlapping. The transects were conducted parallel to the stream bank, approximately midway between the bank and the outer edge of the buffer. If the buffer conditions were similar along the entire length of the property's stream frontage, they spaced them as evenly as practical at the upstream end, downstream end, and center of the property's buffer. If the buffer conditions varied (such as mature forest vs. early successional vegetation versus lawn with trees) on different parts of the buffer, they sited the transects so that each cover type was represented in approximate proportion to its presence in the buffer. They then recorded a GPS point for the midpoint of each transect.

Average buffer width for each property was calculated and used to place landowners into one of four groups: landowners with buffers that averaged over 15 meters in width; landowners with buffers that averaged 10 – 15 meters in width; landowners with buffers that averaged 5 - 10 meters in width; and landowners with buffers averaging less than 5 meters in width. The analyzed qualitative data from the interviews was then used to compare landowner attitudes towards the buffers with riparian buffer width.

Results

Several major themes emerged during the content analysis of the semi-structured interviews within the four average buffer width groupings. These themes are illustrated with direct quotations from participants.

Land Ownership Change

All properties surveyed had at some time over the last two decades been subject to a riparian buffer restoration effort aiming to increase riparian buffer width beyond the 10-meter recommendation. However, the average buffer width for all properties in which transect and interview data was collected was 7.17 meters in width, below the recommended/desired buffer width of at least 10 meters. While this may be surprising considering that the program was voluntary and landowners had to pay part of the cost of the restoration work, 20% of the properties surveyed (7 of 35) had changed hands between when the work was performed and when the data was collected. Of the seven properties that changed in ownership, no average buffer width exceeded 10 meters. Buffer width ranged from 0.93 meters to 8.81 meters with an average buffer width for all properties with landowner change of 5.36 meters. Among the landowners who purchased the property after the restoration work had occurred knowledge of the project was limited.

Among these landowners, management of the riparian buffer areas on their property was similar. All mowed and/or weed wacked within the 10-meter riparian buffer zone and identified that they managed their property this way so that they would have a view of the creek, access to the creek, or because they thought it looked better and cleaner that way. One landowner with only .93 meters on average of riparian buffer acknowledged that:

> I'm losing land, I know that, it's almost one foot a year that washes away. I have no idea what could be done, I've heard of those gabion baskets—it's kinda like a chain link fence basket that you attach to the side of the creek and then you fill it up with rocks. I wouldn't want to plant a bunch of trees along here and block my view.

All but one landowner—who had an average buffer width of 6.68 meters—reported having problems with erosion and flooding on their property. One landowner said:

> ...if you guys are willing to help me stop the erosion and tell me what to plant I would do it and manage it that way, but right now we just mow it to use the property and that's how it was done when we bought the property.

These results also highlight a lack of knowledge among these landowners of how to maintain a riparian buffer or the benefits of maintaining a riparian buffer.

Land Use, Landowner Attitudes, and Average Riparian Buffer Width

Removing the properties with land ownership change from the data set, the average buffer width for all surveyed properties increased slightly from 7.17 meters to 7.66 meters, though still falling below the recommended 10-meter threshold, indicating that for the majority of landowners participation in the riparian buffer restoration program did not necessarily correlate to maintaining a 10-meter riparian buffer in the long term. This is further supported as there were only six sites of the 28 original landowner properties surveyed (28%) with an average buffer width over 10 meters. Notably, of these six properties, 50% have a conservation easement on at least the riparian zone on the parcel (Table 1).

Table 1. Number of Parcels Under Easement by Category

Average Buffer Width	**Total # Parcels**	**# Under Easement**
Over 15 meters	3	1
10 – 15 meters	3	2
5 – 10 meters	11	2
Under 5 meters	9	0

Over 15 Meters

There were three sites with an average buffer width greater than 15.0 meters. Of these, one site, which had been uninhabited and unmanaged for over a decade, had an average buffer width greater than 30.0 meters. When the restoration work on this property was originally done, the property was being used for crops. The landowner reported:

> It was 40 feet I think they required for a buffer…and that needed to not be tilled. But they didn't say that I couldn't mow it, so I would mow it and keep it to where it was a great place to park my truck under the trees.

Due to flooding and lost crops the business failed and the land was abandoned. It is likely, then, if the buffer measurements had been taken while the farming operation was still viable, this property would not have an average buffer over 15 meters.

The other two properties with riparian buffers over 15 meters in width had been managed similarly since the time the restoration work was completed. One property had an average buffer width of just over 18 meters, with only one of nine data points falling beneath 10 meters in width (7.3 meters). The buffer, however, was primarily made up of overstory and the majority of the buffer was mown. The landowner stated:

> The multiflora rose grew up after they planted [the trees]. It was high; it was just solid; it killed all the trees and you can see even up in those trees where I cut it out. The rose killed it all. If they wanted the trees to grow they would've had to monitor, just like any garden. The next year it was probably covered up and then 4-5 years later it was everywhere.

The landowners reported that in their understanding they were supposed to "just let it grow." To combat the multiflora rose, they eventually began mowing the area around the trees. Now they keep the area mowed for recreational purposes.

The third property just made it into this category with an average buffer width of 15.42 meters. The width is slightly deceiving because in one of the three transects all buffer widths were over 30 meters. This transect was taken on forested land. If that transect is eliminated from the data set, the other points range from 6.3 meters to 9.4 meters and produce an average buffer width of 8.13 meters. Notably, this property has been placed under conservation easement since the restoration work had occurred. The more than 60-acre tract, which is still owned by same family who acquired the property in the 1800s, was placed under easement because the owners did not want it to be divided up or developed.

After the easement was placed on the property, the landowners were required to fence their cattle from the creek at a distance of at least 10 meters. The easement also dictated how the buffer should be managed and the landowner recalled that:

> We mow around the fence, but that's the only thing we have been allowed to do within the boundaries [of the easement]. We tried to put some rocks down [on the bank]...it was within the 15 foot buffer and [we] were putting rocks in there to keep it from washing and [the conservation trust] said we couldn't do that. Well, we were doing something helpful and I think if we do anything that is a benefit it should be okay.

In sum, the properties in this category (average buffer width 15 meters and above) all had deceptively wide buffers. Because buffer width was measured to the edge of the overstory, a mown buffer with a large overstory was still considered an intact vegetative buffer. Additionally, because the buffer width is an average of all widths recorded on the parcel, a landowner who

mows to the edge of the stream was included in this category because of an unmaintained portion of the parcel. Lack of maintenance was also responsible for the widest buffer. As such, in this category, the width of the buffer was not indicative of the landowners' attitudes towards riparian buffers.

10 Meters to 15 Meters

There were three sites with an average buffer width between 10.0 and 15.0 meters. Of these, the two properties with wider buffers had riparian easements on them. On the parcel with the greatest average buffer width in this category (12.29 meters), buffer widths at nine points ranged from 9.4 meters to 15.6 meters, with only one point under 10 meters. The landowners decided to put the riparian zone on their property under easement because:

> It seemed like a good way to put our money where our mouth is. We weren't going to do anything with it anyway, but on the reasonable assumption that we are probably not going to live forever it seemed like for someone who cares about the river it was clearly the right thing to do.

Though the landowners reported that all the trees that were planted during the restoration work died almost immediately due to drought, they also confirmed that the buffer:

> In general is doing quite well and I contrast it with the neighbors which has a hit and miss sort of a buffer and which is suffering a good deal more erosion. We don't manage [the buffer] because it is there to be left alone…[and] that's the way it's supposed to be. You're protecting your river, you're providing habitat, and also I suppose you're getting a certain amount of screening from [the] road across the river. Primarily it is a

> conservation motivation, taking care of the river….People have all these sentimental attachments to streams and then they put their damn deck out over the stream and riprap under it and wonder what's wrong.

The second parcel in this category had an average buffer width of 11.63 meters with a range from 9.7 to 13.8 with only two points under 10 meters. The parcel is part of a larger investment property and the landowner does not reside on it. The landowner noted that:

> From a value standpoint it is very important [to have property on the river]. I think it increases the [financial] value by 50%.

The parcel is kept in hay and mown infrequently outside the buffer by a neighboring farmer. The buffer is primarily shrub level – only two trees were recorded along the three transects and providing little or no shade to the stream. The landowner placed the riparian easement on the property:

> ...because I think the river is obviously a big asset to the property and it needs to be protected and…they were going to plant trees which I understand is important for the shading of the river and trying to keep the temperature of the water down for the fish and to keep other things from growing. I never really researched it, but I think it's on a floodplain. Even as an investment it wouldn't be a good idea to build right on the river because I think it would detract from the view of the river. You wouldn't want to look at a house that is beside the river, you would want to look at the river.

The final property in this category had an average buffer width of 10.06 meters and ranged from 4.3 meters to 20.5 meters in width - where the wider buffer points fell on an

unmanaged portion of the property and raised the average over 10 meters in width. The landowners mentioned:

> We don't actively do anything [to manage the riparian zone] except what we've done with planting more trees. If a tree falls across the river we cut it and we put in a beaver fence so they won't eat the trees….And we just like the way it looks mowed and we could let it go but the property is worth more this way.

In the 10-meter to 15-meter buffer width category, landowner attitudes did appear to influence the condition of the buffer. The two properties with conservation easements on their riparian zones indicated a strong preference not only for healthy streams, but also for not developing land close to the river. These buffers were also aided by monitoring and further financial help by the local land trust holding the easement, which may have also influenced the overall condition of the buffer. The non-easement property in this category did have several points with narrower widths and indicated a preference for mown grass in the buffer.

In sum, among landowners who had invested in riparian zone restoration work and had an average buffer width of greater than 10 meters on their property, attitudes towards these buffers varied even among those that had voluntarily placed a conservation easement on the land. All in all, though several properties made it into the over 10-meter average buffer width primarily due to general neglect of part or all of their buffer, at least two landowners (33%) showed a definitive preference for and took direct action towards maintaining a woody riparian buffer of at least 10 meters on their property.

5 Meters to 10 Meters

There were 11 sites with an average buffer width between 5.0 and 10.0 meters. Of these parcels, the two with the widest average buffers were both primarily used as residences. One had an average buffer width of 7.71 meters. The other had an average buffer width of 8.05 meters in width with a range from 2.9 meters to 11.8 meters in width. These landowners noted that:

> You can see we've lost 22 trees already and lost a piece of ground big enough to park a full size pick-up truck on and we're about to lose more. By the time [the county] got done jerking us around there was nothing we could do because it was undercut and we don't have the financial resources to do anything about it. We try to keep debris out of it so it doesn't alter the course anymore than it already has….and I planted about 50 more trees and I put all these rocks here [on the bank]…, but we're sorry we ever got property that's adjacent to the river.

Six of the remaining ten properties with average buffer widths between 5 and 10 meters were residences with active livestock farming occurring on the property. Among these properties the narrowest buffer width measurement was 1.3 meters and the widest was 18.8 meters. All were also recipients for livestock exclusion fencing funding and – except for at one spot on one property – no livestock were allowed access to the water or the buffer area. In some cases the buffer ran up to the fencing while in others there was a mown strip along the outside of the fence. Because all fencing as part of this program was dictated to run at least 10 meters from each stream, it is probable that buffer widths less than 10 meters are a product of erosion.

Two properties had conservation easements. On one of these sites, the average buffer width was 7.3 meters. This landowner reported:

> We did several places where we did [revetments], that didn't last very long. I put all the rock along here and where we really had a bad place I put large rock and riprap….[Now] there's places that I need to do next time I can find some concrete or whatever. It's too expensive to do with rock, but a lot of times I can find concrete when they are tearing it up.

The other site was much more recently placed under conservation easement. The average buffer width for this property was 7.22 meters with the narrowest measured buffer width being 2.4 meters and the widest 18.8 meters. When the easement was placed on the property, the pasture was fenced 10 meters from the river and the landowner had to allow the buffer to grow. The landowner reported that having the trees in the buffer was desirable, but that it would be preferable to mow the herbaceous layer for access to the river. Due to erosion of the buffer, the easement mandated that the landowner move the fence further from the bank to maintain the 10-meter buffer, costing them more pastureland. Another landowner with a 6.21-meter average buffer width reported:

> Stuff was planted on the back side of the fence and over time the bank would eat in and we've moved the fence away from the creek. Anytime I can get any kind of vegetation behind [the fence] it's better than not.

In other cases, bank had eroded underneath fencing – though without a conservation easement on the property, the fence had not been relocated. No landowner reported relocating the fence closer to the stream – though one in this category indicated considering it so that her horses could access shade under the planted trees.

The remaining three properties in this category were used primarily as private residences and all had average buffer widths of approximately 5.50 meters. Though one said that he didn't cut anything off the bank to keep it from washing, another landowner reported that:

> They said to me if we do the trees 30 feet then you have to pay for it, but if we do it 50 feet, it's free. So that's why I did 50 feet. Unfortunately, I really hate these trees because it makes it very difficult for me to cut my grass. I took some down because they were getting in the way. They just sprouted garbage. But all those trees are cut and trimmed [down to shrub size]. But I let the cane grow up. It's better than the trees. It holds everything in there, so it works out fine. Most people cut it right down so they can see the river all the time because that's how tourists, they like that. But I don't care about the river. What am I going to look at?

Much of this property had buffer widths of under five meters because the planted trees had been cut down to low shrub size and mown around. One section near the edge of the property had been allowed to grow for privacy and increased the average buffer width for the entire parcel.

On the majority of the final property in this category, there was no buffer. Of the six data points taken, four were of a 0.0 meter buffer width. The average was elevated by a forested section at the edge of property of over 30 meters. Removing this data point, the average buffer width decreased to 0.58 meters – the second narrowest average buffer width recorded. On this property, the landowner mowed to the edge of the bank except for on the edges of the property and reported that on the slope of the bank:

> I have these big extension clippers that I clip all these shoots off. I like to take that down so that you can see the river. I leave the roots in there. I don't kill them. I want them to grow up in there and help hold it together.

For many agricultural landowners in this category the buffer width was determined by the location of the livestock exclusion fencing. Though erosion may have ultimately decreased the width of the buffer, the fence also created a tangible barrier protecting the buffer from livestock as well as from human intervention.

For residential landowners in this category, getting financial help to stop or reverse erosion on their property tended to be the major motivator for initially having the restoration work performed on the bank. However, all primarily managed their riparian zones by mowing as close to the bank as the trees would allow and several mentioned using or wanting to use rock to stabilize the bank. Rock was thought to hold in the bank while also allowing the property owner to maintain lawn up to the stream.

Under 5 Meters

There were nine sites with an average buffer width between 0.0 and 5.0 meters. Five of these properties had average buffer widths of over 4.0 meters. One property with an average buffer width of 4.93 meters had a width ranging from 0.4 meters in places where the bank had heavily eroded under pasture fencing to 10.2 meters. The landowner noted:

> I left a buffer between the stream and the fence on both sides of the road. It varies, but on average I would say it is probably 25 feet or about 30 feet. I fenced the livestock out of it and on this side of I've got it so you can drive a gator between the fence and the creek….And there's spots where there's not 25 feet and there's spot where it's a lot more.

> There's one spot up near the end that's washing. It's really bad because our fence is over it now.

Similarly, another parcel used for cattle had an average buffer width of 4.7 meters, but a range of widths from 0.7 meters to 11.9 meters. The landowner reported:

> The cows can't get to the bank because of the electric fence. Just past the fence I go out with a weed wacker or a spray. I don't go all the way to the river because it is too steep. In front of the electric fence the cows eat it down.

Two additional properties with average buffer widths between 4.0 and 5.0 meters both mentioned that they mowed as close to the bank as they could, but that because it was unstable due to erosion they were afraid to get too close. Another landowner with an average buffer width of 4.53 and a range of width from 0.0 meters to 9.6 meters shared:

> We weed wack where it gets real high but the stronger trees we don't touch them, we let them go. In fact we've added eight trees this last year. We're going to do more this winter and we are just going to keep going until we shadow that whole creek. We're happy to do it because we love the fact that we can sit here and listen to that creek at night and watch it during the day. It worries me because I think we have to get rid of one tree because if it goes it is going to uproot and wants to take the deck and that one tree over here is going to take our bedroom because the roots are big.

The four properties with the narrowest average buffer width all had sections of buffer less than one meter in width. One landowner, with an average buffer width of 1.16 meters, who used the property as campground reported:

> It is a business and it depends on the scenic beauty and the recreational value that the stream provides, so we leave it, let it grow as much as possible, but still have to be able to use it as a campground.

Another with an average buffer width of 2.11 meters replied:

> I'm not an enviro-wacko where you have to have a 25-foot riparian buffer between you and the water. I'm a homeowner, a landowner, who likes to see the creek. So I maintain it that way. I have a few little wild patches that I keep a little wild and let the growth do what it will, but basically I like to see it.

A third landowner with an average buffer width of 2.2 meters noted:

> I cut all this lawn because I don't want snakes when I come down here, but I love it. But if you drive upstream and you see the same creek that's running here and they've got concrete and it is so clean and secure. And the people got their houses built right up next to it. Why wasn't mine done like that? I've got beautiful land. I'd love to put a little house here [beside the creek].

Finally, the property with the narrowest average buffer width—0.13 meters—had only 30 meters of stream frontage and so only one transect was conducted on the parcel, which was mown to the edge of the bank. Interestingly, the landowner noted:

> I belong to the Federated Franklin's Woman's Club and we had a speaker last year from the Little Tennessee River Association and he talked to us about the value of not clearing your bank because it changes the water temperature and effects what's in the water, so

> our neighbor was going to clear it and I said they tell you not to do that, it helps protect the species.

On residential parcels in this category, most landowners continued to mow around the trees directly up to the edge of the stream because the project only consisted of planting native trees, but did not include planting understory shrubs or grasses. While some landowners exhibited a definite preference for the detrimental types of management that allowed them to see, hear, or access the stream, others seemed unsure of recommended management techniques and simply continued to manage the area as they had always managed it. For agricultural landowners in this category, the location of fencing dictated the current width of buffer.

Importance of Owning Property on the Water

Notably, though half of those interviewed in this study were native to North Carolina while the other half had owned property in Florida just prior to purchasing their Macon County, NC, property, over 60% of those from Florida had average buffer widths under five meters as opposed to only 8% of those from North Carolina. Landowners who had relocated to the area from Florida often indicated that they had lived near the water in Florida and wanted to live near the water in North Carolina as well. They also expressed astonishment in how low the price for land on the water was in North Carolina. For 8 of the 11 landowners from Florida (73%) it was "very important" to own property on the water.

Of the people who said that owning a property on the river was "very important" or essential, 55% had average buffer widths under 5 meters and 73% had average buffer widths under 10 meters. While for a couple landowners living near the water was important because they grew up next to the river – and more specifically the river they currently lived near, more often the river was very important to landowners because landowners enjoyed the sight and

sound of the river and the recreational opportunities it provided. The added financial value of "owning" the river was also cited as being very important.

Conclusions and Recommendations

When aggregated, how individual landowners decide to manage their land and why can have dramatic implications for stream health regionally. These results show that even among those who voluntarily, and with some financial investment, had riparian buffer restoration work performed on their property, individual preferences for narrower buffers and uncertainty of how to manage buffers often outweighed the initial goals of the restoration work.

The findings from this study point to a number of general recommendations for developing programs and incentives for establishing and protecting riparian buffers on privately-owned property before, during, and after restoration work is performed. Farm and non-farm residential landowners were represented in approximately equal proportions in this study and there was no significant difference in the distribution of average buffer width among these populations. However, buffer width for farm landowners tended to be dictated by the location of livestock exclusion fencing, highlighting the importance not only of locating the fence an appropriate distance from the stream, but also in stabilizing stream banks behind this fencing to ensure that the width is maintained during high water and potential erosion events as most landowners did not want to relocate their fences or sacrifice additional agricultural land.

For non-farm, residential landowners, though only 23% of the properties had buffers over 10 meters in width, these higher widths were attributed most often to either neglect or conservation easements on the property that not only restricted development in the buffer, but also provided monitoring, labor, and continued financial help to maintain the riparian buffer. Though land trusts, like LTLT, often do not pursue riparian easements because the acreage is

generally low and, as such, do not make financial sense for the trust, it appears that among landowners who actively manage and use their land, the most successful buffers were those which were under easement. If water quality is a major concern of land trusts, aiming to place uninterrupted riparian easements on larger tracts of land before they are divided up and sold in the exurbanization process may prove easier and more financially sound than trying to negotiate easements on dozens of smaller tracts in the future.

Narrower (under 5 meter) average buffer widths were generally attributed to management of the buffer that allowed the landowners to hear and/or see the river, access the river for recreation, or to meet a personal aesthetic preference. Those who indicated it was very important or essential to have property with water and that they would not have purchased a property without a stream were also more likely to be from Florida and to have a narrow average buffer width (under 5 meters). Still, these landowners at one time all elected to participate in the stream bank restoration program due most often to concerns about flooding and/or loss of property. For many of these landowners, narrow buffer width was also partially a result of a lack of understanding of how to maintain the buffer to prevent erosion after the restoration work was completed.

Adequately informing landowners of maintenance requirements as well as funding follow up visits to aid in monitoring and maintenance of the buffer may improve resulting buffer width. However, stricter requirements may also have the opposite effect and some landowners may instead opt out of any county program in favor of stabilizing their bank with a rock or concrete wall. As such, rather than using a one-size fits all approach, buffer restoration programs may be more successful if they focus not only on meeting needs for stream health and water quality, but also focus on meeting landowner needs for erosion and flood-control while accounting for

individual landscaping preferences. In sum, developing a more flexible framework for restoration that works in tandem with landowner preferences and provides them the needed resources to deal individually with their concerns may be more successful in the long term.

CHAPTER 3

CONCLUSION

It is well documented that maintaining a vegetative buffer along waterways provides extensive benefits to both stream health and water quality. These benefits include stream temperature regulation, erosion prevention, water pollutant filtration, and wildlife habitat protection (Knoepp and Clinton 2009; Shandas 2007; Hession et al 2003; Houser et al 2005; Walker et al 2009). Many of these benefits are shared by human populations and ecosystems as a whole; however, there are also benefits for individual property owners such as slowing floodwaters and preventing erosion and loss of property (Flebbe 1999; Clinton, Vose, and Fowler 2010; McLarney 2003; Walker et al 2009). Private property owners experiencing problems with flooding and erosion, then, may be able to prevent damage and reverse property loss by restoring vegetated buffers along their stream banks while simultaneously improving water quality and stream health on their parcel. However, for individuals, the process can be overly costly, time consuming, and complicated.

To address these barriers, during the late 1990s and early 2000s, Macon County SWCD, with funding from state and federal sources, undertook a cost-share riparian restoration program, which primarily targeted private landowners. This program, and other like it, worked towards eliminating barriers to riparian buffer restoration by covering 75% of the cost of any restoration measure performed on private property as well as providing most or all of the labor. Riparian zones were restored by planting native tree and shrub buffers, installing livestock exclusion fencing, and stabilizing stream banks with whole-tree revetments. Once the work was completed,

landowners were expected to take on the responsibility of maintaining the restoration for a period of 10 years. Between 1998 and 2004, 86 riparian sites were treated in Macon County.

Despite financial and labor investments by governmental entities and private-property owners, it is possible that even among those who voluntarily, and with some financial investment, had riparian buffer restoration work performed on their property, individual preferences for narrower buffers that meet an aesthetic preference; allow the landowner to utilize the buffer zone for recreation or agriculture; and/or allow the landowner to see, hear, or access the river often outweigh the initial goals of the restoration work. For this study, I revisited approximately half of the Macon County landowner participants after the 10-year maintenance contracts on restored riparian buffers had expired, to reconcile the present-day condition of the restored riparian buffers with landowner attitudes towards the buffers. In doing so, I hoped to form a better understanding of whether individual preferences for stream bank appearance and/or utility outweigh environmental and/or economic considerations in determining how individuals manage privately-owned natural resources.

Though it was the goal of funding agencies for this project to increase riparian buffer zones on private and public land to over 10 meters in width, the goals of private property owners who enrolled in the program often differed from those of the county. Private property owners tended to be more concerned with erosion, flooding, and the associated loss of property, resulting in an average buffer width of under 8 meters for all private properties surveyed. In many cases this average width was not consistent along the bank, but rather consisted of several very wide spots near the outer edges of the property and several very narrow spots closer to the home. Property owners for the most part did not actively attempt to dismantle or destroy the restoration work that had been performed, but many did continue to mow the buffer area underneath any

planted overstory. Also, most landowners did not actively attempt to maintain the buffer and beavers or drought often killed many or all of the planted trees.

The findings from this study point to a number of general recommendations for establishing and protecting riparian buffers on privately-owned property. Though there was no significant difference in the distribution of average buffer width among farm and non-farm parcels, buffer width for farm landowners tended to be dictated by the location of livestock exclusion fencing. This highlights the importance not only of locating the fence an appropriate distance from the stream from the outset, but also the importance of stabilizing stream banks behind the fencing and mandating that the fence remain 10 meters from the stream bank.

For residential landowners, though only approximately a quarter of buffers exceeded 10 meters in average width, higher widths were most often associated with either neglect/lack of any management or with landowners who had placed an easement on their buffer zone (and often beyond). Easements restrict development in the buffer and also provide resources to maintain the riparian buffer. Riparian easements, however, often do not make financial sense for conservation organizations to pursue because of the low amount of acreage they represent. It appears, though, that for landowners who actively use their land, easements resulted in the most successful long-term buffers. Because land trust, like LTLT, identify protecting water quality as part of their mission, riparian easements may provide more financial "bang for the buck," especially as land continues to be divided in the exurbanization process. Placing long, uninterrupted riparian easements on larger tracts of land may prove to be a more sound and easier investment than negotiating easements on smaller tracts as they are subdivided.

Narrower (under 5 meter) average buffer widths were generally attributed to management of the buffer that allowed the landowners to hear and/or see the river, access the river for

recreation, or to meet a personal aesthetic preference. Those who indicated it was very important or essential to have property with water and that they would not have purchased a property without a stream were also more likely to have a narrow average buffer width (under 5 meters). Narrow buffer width also appeared to be associated with whether or not the landowner had moved to Macon County from Florida or whether their last residence had been in North Carolina. Landowners who moved to the area from Florida tended to have narrower buffer widths than those that were from western North Carolina. All of these generally resulted from the landowner's desire to have direct access either visually, aurally, or physically to the water. Still, these landowners at one time elected to participate in the stream bank restoration program due most often to concerns about flooding and/or loss of property. For many of these landowners, narrow buffer width was a result of a lack of understanding of how to maintain the buffer to prevent erosion after the restoration work was completed or if even they should maintain the buffer or "just leave it alone."

Adequately informing landowners of maintenance requirements as well as funding follow up visits to aid in monitoring and maintenance of the buffer may improve resulting buffer width. However, stricter requirements could have the opposite effect. Landowners may decide against utilize county aid to stabilize their bank and may instead choose to privately fund a rock or concrete wall. Buffer restoration programs may be more successful, then, if they are flexible enough to account for individual landscaping preferences. In sum, developing a restoration framework that not only provides resources, but works in tandem with landowner preferences may be more successful long term.

REFERENCES

Armstrong, A., and R. C. Stedman. 2012. Landowner willingness to implement riparian buffers in a transitioning watershed. *Landscape and Urban Planning.* 105: 211-220.

Audrey, A., M. Briggs, and K. Kroesen, K. 2009. Preparing for human expansion into exurban riparian areas. In *The planner's guide to natural resource conservation*, eds. A.X. Esparza and G. McPherson, New York, NY: Springer.

Berube A., A. Singer, J.H. Wilson, and W.H. Frey. 2006. *Finding exurbia: America's fast-growing communities at the metropolitan fringe*. The Brookings Institute: Washington, DC.

Bettcher, M. and B. Brooks. 2012. *An assessment and mapping of conservation investments and habitat restoration efforts over time along the Upper Little Tennessee River.* Highlands Biological Station, Highlands, NC.

Bolstad, P. V., and W.T. Swank. 1997. Cumulative impacts of land use on water quality in a southern Appalachian watershed. *Journal of the American Water Resources Association* 33(3): 519-533.

Boucquey, N., L. M. Campbell, G. Cumming, Z. A. Meletis, C. Norwood, and J. Stoll. 2012. Interpreting amenities, envisioning the future: common ground and conflict in North Carolina's rural coastal communities. *Geojournal* 77(1):83-101.

Broadmeadow, S., and T.R. Nisbet. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practice. *Hydrology and Earth System Sciences* 8(3): 286-305.

Buckley, M. C., and E. E. Crone. 2008. Negative off-site impacts of ecological restoration: Understanding and addressing the conflict. *Conservation Biology* 22(5):1118-1124.

Clinton, B. D., J. M. Vose, and D. L. Fowler. 2010. *Flat branch monitoring project: Stream water temperature and sediment responses to forest cutting in the riparian zone.* Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station.

Costello, L. 2007. Going bush: the implications of urban-rural migration. *Geographical Research* 45(1): 85-94.

Dutcher, D. D., J.C. Finley, A. E. Luloff, and J. Johnson. 2004. Landowner perceptions of protecting and establishing riparian forests: A qualitative analysis. *Society and Natural Resources* 17: 329–342.

Esparza, A. X. 2009. Exurbanization and Aldo Leopold's humanland community. In *The planner's guide to natural resource conservation*. eds. A. X. Esparza and G. McPherson, 3-26. New York: Springer.

Esparza, A., and J. Carruthers. 2000. Land use planning and exurbanization in the rural mountain west: Evidence from Arizona. *Journal of Planning Education and Research* 20(1): 23-36.

Evans, S. 2013. Exurbanizing Water: Stream management decision-making among Newcomer and Generational landowners in southern Appalachia. PhD Dissertation, University of Georgia.

Fischer, R.A., and J.C. Fischenich. 2000. *Design recommendations for riparian corridors and vegetated buffer strips.* U.S. Army Engineer Research and Development Center, Environmental Laboratory. Vicksburg, MS.

Flebbe, P. A. 1999. Trout use of woody debris and habitat in Wine Spring Creek, North Carolina. *Forest Ecology and Management* 114: 367-376.

Gosnell, H., and J. Abrams. 2009. Amenity migration: Diverse conceptualizations of drivers, socioeconomic dimensions, and emerging challenges. *GeoJournal* 76: 303-322.

Gosnell, H., J.H. Haggerty, and P.A. Byorth. 2007. Ranch ownership change and new approaches to water resource management in southwestern Montana: Implications for fisheries. *Journal of the American Water Resources Association* 43(4): 1-14.

Gragson, T. L., and P. Bolstad. 2006. Land use legacies and the future of southern Appalachia. *Society and Natural Resources* 19(2): 175-190.

Groffman, P. M., D.J. Bain, L.E. Band, K. T. Belt, G.S. Brush, J.M. Grove, R. V. Pouyat, I.C. Yesilonis and W. C. Zipperer. (2003). Down by the riverside: Urban riparian ecology. *Frontiers in Ecology and the Environment* 1(6): 315-321.

Hairston, A. B. 1996. Response to water protection rule changes in the Oregon Forest Practices Act: Landowner-operator opinions and streamside conditions. PhD dissertation, Oregon State University.

Hairston-Strang, A.B., and P.W. Adams. 1997. Oregon's Streamside Rules: Achieving Public Goals on Private Land. *Journal of Forestry* 95(7): 14-18.

Hession, W. C., J.E. Pizzuto, T. E. Johnson, and R.J. Horwitz. 2003. Influence of bank vegetation on channel morphology in rural and urban watersheds. *Geology* 31(2): 147-150.

Houser, J.N., P.J. Mulholland, and K.O. Maloney, K.O. 2005. Catchment disturbance and stream metabolism: Patterns in ecosystem respiration and cross primary production along a gradient of upland soil and vegetation disturbance. *Journal of the North American Benthological Societ*y 24: 538-541.

Irwin, E.G., and N.E. Bockstael. 2007. The evolution of urban sprawl: Evidence of spatial heterogeneity and increasing land fragmentation. *Proceedings of the National Academy of Sciences* 104: 20672–20677.

Johnson, J., 1996. Riparian habitat: Applied research efforts in the Upper Peninsula of Michigan. In *At the water's edge: The science of riparian forestry*, ed. S. P. Laursen, 73–75. St. Paul: University of Minnesota Press.

Kaplan, R., 1977. Preference and everyday nature: method and application. In *Perspectives on Environment and Behavior*, ed. D. Stokols, 235–250. Plenum: New York.

Kenwick, R.A., R. Shammin, and W.C. Sullivan. 2009. Preferences for riparian buffers. *Landscape and Urban Planning* 91: 88–96.

Kirk, R.W., P.V. Bolstad, and S.M. Manson. 2012. Spatio-temporal trend analysis of long-term development patterns (1900-2030) in a southern Appalachian county. *Landscape and Urban Planning* 104: 47-58.

Knoepp, J. D., and B.D. Clinton. 2009. Riparian zones in southern Appalachian headwater catchments: Carbon and nitrogen responses to forest cutting. *Forest Ecology and Management* 258: 2282-2293.

Larson, K. L. and M. V. Santelmann. 2007. An Analysis of the Relationship Between Residents' Proximity to Water and Attitudes about Resource Protection. *The Professional Geographer* 59(3): 316-333.

Lee, P., C. Smyth, and S. Boutin. 2004. Quantitative review of riparian buffer width guidelines from Canada and the United States. *Journal of Environmental Management* 70: 165–180.

Lohse, K. A., and A.M. Merenlender. 2009. Impacts of exurban development on water quality. In *The planner's guide to natural resource conservation,* eds. A. X. Esparza and G. McPherson, 159-179. New York: Springer.

Love, J. 2003. *A biological assessment of riparian buffers and whole-tree revetments in the Little Tennessee watershed.* LTLT, Franklin, NC.

Lowrance, R., L.S. Altier, J.D. Newbold, R.R. Schnabel, P.M. Groffman, J.M. Denver, et al. 1997. Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. *Environmental Management* 21: 687–712.

Mainspring Conservation Trust. (n.d.). Retrieved April 20, 2016, from http://www.mainspringconserves.org/

Mayer, P. M., S.K. Reynolds, Jr., T.J. Canfield, and M.D. McCutcheon. 2005. *Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of current science and regulations.* Cincinnati, OH: US Environmental Protection Agency.

Mayer, P. M., S.K. Reynolds, M.D. McCutchen, and T.J. Canfield. 2007. Meta-analysis of nitrogen removal in riparian buffers. *Journal of Environmental Quality* 36: 1172–1180.

McCarthy, J., 2008. Rural geography: globalizing the countryside. *Progress in Human Geography* 32(1):129-137.

McLarney, W. 2003. *Whole tree revetments as fish habitat in the Upper Little Tennessee River Watershed*. LTLT, Franklin, NC.

Nassauer, J.I. 1989. Agricultural policy and aesthetic objectives. *Journal of Soil and Water Conservation* 44(5): 384–387.

Nassauer, J., S. Kosek, and R. Corry. 2001. Meeting public expectations with ecological innovation in riparian landscapes. *Journal of the American Water Resources Association* 37(6): 1439-1443.

Nassauer, J. I., J.D. Allan, T.H. Johengen, S.E. Kosek, D. Infante. 2004. Exurban residential subdivision development: Effects on water quality and public perception. *Urban Ecosystems* 7: 267-281.

Prugh, L. R., K.E. Hodges, A.R. E. Sinclair, and J.S. Brashares. 2008. Effect of habitat area and isolation on fragmented animal populations. *Proceedings of the National Academy of Sciences* 105: 20770–20775.

Radeloff, V.C., S.I. Stewart, T.J. Hawbaker, U. Gimmi, A.M. Pidgeon, C.H. Flather, R.B. Hammer, D.P. Helmers. 2010. Housing growth in and near United States protected areas limits their conservation value. *Proceedings of the National Academy of Sciences of the United States of America* 107: 940–5.

Rosenberg, S. and R. Margerum. 2008. Landowner Motivations for Watershed Restoration: Lessons From Five Watersheds. *Journal of Environmental Planning and Management* 51(4): 477-496.

Ryan, R.L. 1998. Local perceptions and values for a Midwestern river corridor. *Landscape and Urban Planning* 42: 225–237.

Schrader, C.C. 1995. Rural greenway planning: The role of streamland perception in landowner acceptance of land management strategies. *Landscape and Urban Planning* 33(1): 375-390.

Shandas, V. 2007. An Empirical Study of Streamside Landowners' Interest in Riparian Conservation. *Journal of the American Planning Association* 73(2): 173-184.

Sullivan, W.C., O.M. Anderson, and S.T. Lovell. 2004. Agricultural buffers at the rural urban fringe: an examination of approval by farmers, residents, and academics in the Midwestern United States. *Landscape Urban Planning* 69: 299–313.

Sutton, P.C., T.J. Cova, and C.D. Elvidge. 2006. Mapping 'exurbia' in the conterminous United States using nighttime satellite imagery. *Geocarto International* 21: 39–45.

Theobald, D. M., N.T. Hobbs, T. Bearly, J. A. Zack, T. Shenk, W. E. Riebsame. 2000. Incorporating biological information in local land-use decision making: Designing a system for conservation planning. *Landscape Ecology* 15: 35-45.

Theobald, D. M. 2003. Targeting conservation action through assessment of protection and exurban threats. *Conservation Biology* 17(6): 1-13.

U.S. Army Corps of Engineers. 1991. *Buffer strips for riparian zone management.* Waltham, MA.

Walker, J. T., J.M. Vose, J. Knoepp, C.D. Geron. 2009. Recovery of nitrogen pools and processes in degraded riparian zones in the Southern Appalachians. *Journal of Environmental Quality* 38: 1391-1399.

Wallace, J. B., J. W. Grubaugh, and M. R. Whiles. 1993. Influences of coarse woody debris on stream habitats and invertebrate biodiversity. In *Biodiversity and coarse woody debris in southern forests: Proceedings of the workshop on coarse woody debris in southern forests: Effects on Biodiversity.* US Department of Agriculture, Forest Service, Southern Research Station.

Webster, J.R., E.F. Benfield, K. Cecala, J.F. Chamblee, C. Dehring, T. Gragson, J. Hepinstall, C.R. Jackson, J. Knoepp, D. Leigh, J. Maerz, C. Pringle, and H.M. Valett. 2012. Water quality and exurbanization in southern Appalachian streams. In *River Conservation and Management*, eds. P. J. Boon and P. J. Raven, 91-106. Chichester: Wiley-Blackwell.

Wenger, S. 1999. *A review of the scientific literature of riparian buffer width, extent and vegetation*. Institute of Ecology, University of Georgia. Athens, GA.

Vercoe, R., M. Welch-Devine, N. Heynen, R.D. Hardy, J. Demoss, S. Bonney, K. Allen, J.P. Brosius, D. Charles, B. Crawford, S. Heisel, R. de Jesús-Crespo, N. Nibbelink, L. Parker, C. Pringle, A. Shaw, L. Van Sant. 2014. Acknowledging trade-offs and understanding complexity: Exurbanization issues in Macon County, North Carolina. *Ecology and Society*. 19(1).

Viviroli D., H. Durr, B. Messerli, M. Meybeck. 2007. Mountains of the world, water towers for humanity: typology, mapping, and global significance. *Water Resources Research* 43: 1–13.