River of Dreams? Factors of Riparian Buffer Adoption in a Transitioning Watershed

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RIVER OF DREAMS? FACTORS OF RIPARIAN BUFFER ADOPTION IN A TRANSITIONING WATERSHED

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Andrea Lee Armstrong

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ABSTRACT

Urbanization results in diversification of land use, landowner goals, and property management behaviors. As such, water quality related to land use may be less tied to agricultural practices when landscapes transition into other land uses. Much research, however, addressing water quality conservation has focused on agricultural landowners, with little research on the attitudes, behaviors, and conservation practices of hobby or non-farmers. My thesis examines the factors that drive private landowner adoption of riparian buffers in an urbanizing watershed. I use mixed qualitative and quantitative methods to test adoption-diffusion theory, with supporting applications of self-efficacy theory and social identity theory. My findings suggest that adoption of conservation practices such as riparian buffers may apply to non-traditional farmers, with important exceptions and additions of certain factors. Landowners' willingness to adopt riparian buffers is increased with positive outcome expectations, or the perceptions of how and what riparian buffers will improve. More generally, this research calls attention to how little non-farmers know about riparian buffers and that this practice is largely associated with Chesapeake Bay restoration rather than local water quality conservation.

BIOGRAPHICAL SKETCH

Andrea Armstrong, known as Annie or Ann, has always loved streams. As a little girl in the beautiful Butternut Valley of Upstate NY, she played and explored the creeks of her parents' small farm with her best friend, younger sister Kelly. In many respects, the early years of Ann's field explorations set the course for her academic pursuits. She enjoyed math and science in high school (despite not liking high school very much), and tackled the complexities of natural resources management for her Bachelor's of Science at Cornell, class of 2006. Ann moved to Washington, D.C. after graduation, where she worked for the U.S. Department of Justice, Environment and Natural Resources Division, for two years as a FOIA and Clean Water/Air Act paralegal specialist. Alas, the big city did not win over the Upstater. Without looking back, Ann returned to the streams and valleys of her youth in 2008 for graduate studies and to be closer to her family. Ithaca, NY will always be a special place to Ann.

Ann hopes to publish at least three non-fiction books throughout her lifetime, the titles of which she believes will reflect her interests and journeys, personal and professional: *Wools of New Zealand*, *Watershed Science: A Social-Ecological Approach to Water Resources Management*, and *Heaven on Earth: A Guide to the Beers of Upstate New York.*

To the Butternut Valley

ACKNOWLEDGMENTS

I could not have been luckier than to have Dr. Rich Stedman for my Master's advisor. I think we made a great research team, except that neither of us have the ability to say no to an enticing research idea. I look forward to working with Rich down the road. Many additional thanks to Dr. Max Pfeffer and Dr. Todd Walter for your guidance and support as my committee members.

I owe many thanks to the CEAP project team, particularly Dr. Rob Brooks and Dr. Joe Bishop of Penn State's *Riparia*. It was worth the winter, snow-filled travel to meet my study participants, the residents of the Spring Creek watershed. I was fortunate to share a three hour dinner with Spring Creek couple on a cold February night—they also helped me push my car out of a snow bank at the end of the interview. I am additionally thankful for meeting the farmer on Cedar Run who showed me a dead, tagged, frozen bobcat that he found next to his stream. I might be a cat person if they all were wild.

Very few people have the chance to go to school for free, and for that I would like to thank the USDA – NRCS CEAP program, the Doris Duke Foundation, and the Department of Natural Resources. I also thank the Mellon Foundation for their assistance with my mail survey.

Friends are more important than money, and I am rich in friends: Heather Triezenberg was a wonderful office mate and mentor, the fun crew in 306, my fantastic cohort, all of my knitting club girls who deserve a round on me, the Rythers, the Van Dines, Pepper and Woods, and my family (who are also my friends). Mom and Dad, thank you for supporting my ideas and goals. Kelly, thank you for playing Skip-Bo. And Brian, thank you for your encouragement, love, and bike rides.

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CHAPTER ONE

INTRODUCTION

Watershed management is an integrated, comprehensive approach to protecting or improving ecological, chemical, and physical integrity of aquatic systems and human health within a catchment area rather than political boundaries (National Research Council, 1999). This management approach calls for interconnections among land use and water quality, upstream and downstream resources, and political entities at all levels of government. Biophysical research supports this management approach, as many natural processes are wholly contained within watershed boundaries of various scales. In turn, policy approaches use watershed boundaries to identify and manage processes or occurrences of water quality degradation.

A common watershed management tool is riparian buffers. Riparian buffers are permanent corridors of vegetation that occur on land adjacent to streams, rivers, lakes, wetlands, and other surface water bodies. Traditionally, agricultural watersheds and individual properties have been targeted by policy-based programs for riparian buffer implementation. While this effort has had measurable reductions in water contamination, it may not be a comprehensive approach to riparian conservation. Urbanization of agricultural lands creates a new scenario in which riparian areas are parcelized and managed by non-agricultural landowners with different sets of values, attitudes, and objectives.

The goal of this thesis was to examine the factors that influence non-agricultural adoption of riparian buffers. Throughout this research, I compare landowner typologies based upon three types of agricultural land uses: traditional farmers, hobby farmers, and non-farmers. This typology is a conceptual tool to facilitate comparisons and identify attitudinal and behavioral patterns based on empirical observation. Using this typology, I conducted a mixed-methods analysis of landowner perceptions and attitudes towards riparian buffers on their properties.

Chapter Two provides background information pertaining to this research with an overview of watershed management in the Chesapeake Bay watershed, which includes my study area, the Spring Creek watershed of Central Pennsylvania. The Chesapeake Bay Program is a multi-state, federal, and regional collaboration that seeks to improve water quality in the Bay and its tributaries. The Chesapeake Bay Program and other riparian restoration policies have traditionally focused predominantly on agricultural sources of non-point source water pollution. Recently, these efforts have shown steps towards addressing urban and non-agricultural sources, though these are minor in comparison to agricultural-targeted outreach. The Spring Creek watershed is rapidly urbanizing as it transitions from agricultural to residential land uses, with projected population increases over the next twenty years.

Also included in Chapter Two is a description of riparian buffers and Best Management Practices (BMPs). Riparian buffers are placed in the area adjacent to streams and rivers within the greater riparian ecosystem. Riparian buffers effectively remove sediment, pesticides, and nitrogen from upland surface water runoff, and are considered an important interface between aquatic and upland systems. They are also corridors that link headwaters to downstream water bodies, and are therefore critical for wildlife habitat and pollutant filtration.

In Chapter Three I put forth a theoretical framework for my research. I identify and discuss adoption-diffusion theory, social identity theory, and efficacy as potential frameworks for understanding non-farmer adoption of riparian buffers. I consider how these theories were previously applied, and identify points of interconnection. I also introduce the concept of transitioning landscapes and position my research within the social-ecological framework. From here, I examine how institutions influence landowner behaviors through local policy networks. The social-psychological and social-ecological frameworks described herein guide my research questions, hypotheses, and thesis statement.

Chapter Four outlines the methods employed in this thesis. I used a mixed-methods approach to understanding riparian landowner behavior. The first component of my research included a qualitative phase that consisted of semi-structured, in-person interviews. This approach was a preliminary exploration of riparian landowner beliefs, attitudes, and perceptions of riparian buffers. I used interview data to inform a mail survey, the quantitative portion of this research. Here I describe the study population, sample selection, and questionnaire. I also outline a non-respondent telephone survey analysis that assessed differences among survey respondents and those who did not complete the questionnaire.

Chapter Five includes results from the qualitative phase. I provide a general description of participants that included their landowner typology (non-farmers, hobby farmers, or traditional farmers), parcel sizes, and adoption histories. I also present results from interviews with institutional representatives who were active in riparian buffer implementation. I found that agricultural landowners belong to well-established information networks supported by agricultural institutions; however, hobby farmers and non-agricultural landowners rely more upon informal information sources. Adopting landowners reported different types and scales of improvements resulting from their buffer project. This variation relates to landowners' self-efficacy, which was shaped by many factors including stream flow, parcel size, current land use, and nearby downstream land uses. In general, landowners' perceptions of water quality outcomes relate to water quality and habitat enhancement, and are often spatially limited to their individual stream reach or the Spring Creek watershed. This contrasts policy-based water quality targets that focus predominantly on the Chesapeake Bay.

In Chapter Six, I present findings from the mail survey instrument, which entailed the quantitative portion of my research. I outline the results from the non-respondent survey analysis, which showed a slight response bias towards landowners who are concerned about water quality. I present a description of survey respondents, highlighting their general location within the watershed, parcel size, sociodemographic characteristics, and attitudes towards water resources and riparian buffers. I then describe bivariate relationships among stream flow, parcel size, and landowner typologies (non-farmer, hobby farmer, traditional farmer). Lastly, three multivariate models are presented that predict characteristics of those who have heard about riparian buffers, landowner willingness to adopt riparian buffers, and change in landowner adoption willingness.

The OLS regression model explaining adoption willingness showed that non-agricultural landowners are less willing to adopt riparian buffers than agricultural landowners. This is a reflection of the overarching policy paradigm that targets agricultural landowners with technical and financial support. The two factors most indicative of the amount heard about riparian buffers were greater perceived knowledge of Chesapeake Bay water quality and being a residential landowner, a negative predictor. Despite those findings, adoption willingness is positively related to landowners' perceived knowledge about water quality in their stream. This suggests that landowners may be more willing to adopt riparian buffers if outreach efforts focus on local water quality and less on Bay restoration. Another finding that emerged from the quantitative analysis shows a social desirability for riparian buffers based on the proportion of close friends one has in his or her neighborhood.

In Chapter Seven I discuss and integrate my findings from the qualitative and quantitative phases. I relate these findings to the adoption-diffusion framework, which shows some transferability to non-agricultural systems based on the importance of innovation and private property attitudes as well as characteristics of the innovation in the adoption decision. I identify and discuss how my findings depart from the traditional adoption-diffusion model, particularly in terms of landowner typology, the insignificance of environmental attitudes, and the importance of outcome expectations. I discuss my findings in terms of efficacy, including self-efficacy and outcome expectancy, as well as social identity theory. Both of these serve as supporting theories to guide interpretation of my findings.

Also in Chapter Seven, I examine the influence of policy-based outreach that has effectively targeted agricultural landowners for riparian buffer implementation since the 1990's. Local organizations are key players in riparian buffer implementation, yet most continue to tailor their programmatic and technical support to farmers, even in the face of urbanization and agricultural land conversion. I present a scenario in which policy-based programs encourage non-agricultural riparian buffers, and discuss the outcomes of this scenario for landowner adoption willingness. I discuss the implications of my thesis research for watershed management, particularly as it relates to the need for programmatic and organizational adaptation in light of increasingly heterogeneous landscapes. I conclude with a discussion of functional and environmental outcomes of riparian buffers on small parcels, and encourage changes to communication targets and practitioner flexibility in working with residential landowners to improve water quality.

CHAPTER TWO

BACKGROUND

Chapter Introduction

In this chapter I provide background information on the Spring Creek watershed of Central Pennsylvania, my study area. The watershed is located within the Chesapeake Bay watershed, and is therefore within policy and programmatic jurisdiction of Bay restoration efforts. I describe relevant local institutions and policies that promote water resources conservation. My research is one component of the Spring Creek Conservation Effects Assessment Project (CEAP), which integrates biophysical and social research to assess riparian Best Management Practice (BMP) performance. I then provide a description of the urbanizing Spring Creek watershed, in which past and projected population growth has led to from agricultural to residential land use conversion. Following this description, I provide background biophysical information on riparian buffers including their hydrological and biochemical functions. I relate my research to a growing field of urban ecology, and conclude with a description riparian buffer policy in the study watershed.

Watershed management in the Chesapeake Bay watershed

The Chesapeake Bay restoration initiative represents one of a growing number of regional watershed partnerships. Often, such watershed management aims to influence or regulate upstream behaviors to improve downstream water quality outcomes. This multi-level, large-scale system of watershed management is based upon biophysical linkages between upstream land use and downstream water quality

(Sabatier et al., 2005). Watersheds are an ideal unit of management in that water quality can be evaluated at one point, the watershed outlet, with conservation strategies applied to the upstream area according to the nature of that region's water quality challenges.

The Chesapeake Bay is the largest estuary in the United States, the third largest worldwide, and has the highest land-to-water ratio. The Bay watershed is 64,000 mi^2 and extends from Otsego Lake in Cooperstown, New York to Norfolk, Virginia (US EPA, 2010). It includes the Spring Creek watershed and about half of the land area in Pennsylvania (Figure 2.1). The Chesapeake Bay is a critically impaired water body with many tidal regions listed on Maryland and Virginia's Clean Water Act 303d impaired waters list (US EPA, 2010). Currently, a Total Maximum Daily Load (TMDL) for nutrients and sediment is being developed for the Chesapeake Bay and its tributaries, with expected completion by December 2010 (US Environmental Protection Agency, 2010). This TMDL will apply to all states within the Chesapeake Bay basin: Pennsylvania, New York, West Virginia, Maryland, Virginia, and the District of Columbia (US EPA, 2010).

Nitrogen, phosphorus, and sediments are the predominant threats to the Bay, with agriculture contributing the largest proportions of these contaminants at 38%, 45%, and 60%, respectively (US EPA, 2009). Between 1990 and 2000, the population within the Bay watershed increased eight percent, yet impervious surfaces increased 41% (US EPA, 2008). Based on this urbanization rate, restoration managers are examining non-agricultural threats to Bay water quality, one of which is suburban and urban development (Chesapeake Bay Program, 2009). The Spring Creek watershed, circled within Centre County in Figure 2.2, holds areas with high development pressure, as determined by the Chesapeake Bay Program. The watershed is in the upper quartile of urban nitrogen and phosphorus sources for all Pennsylvania watersheds within the Bay basin (Chesapeake Bay Program, 2008a).

Even though urban water pollution sources are documented, urban nitrogen, phosphorus, and sediment pollution controls have grossly underperformed, as they underachieved their reduction goals by 82%, 71%, and 49%, respectively, since implementation in 1985. Restoration managers attribute this failure to prolific land conversion and construction. In contrast, approximately 50% of all agricultural pollution reduction targets were met in 2009 (Chesapeake Bay Program, 2010b).

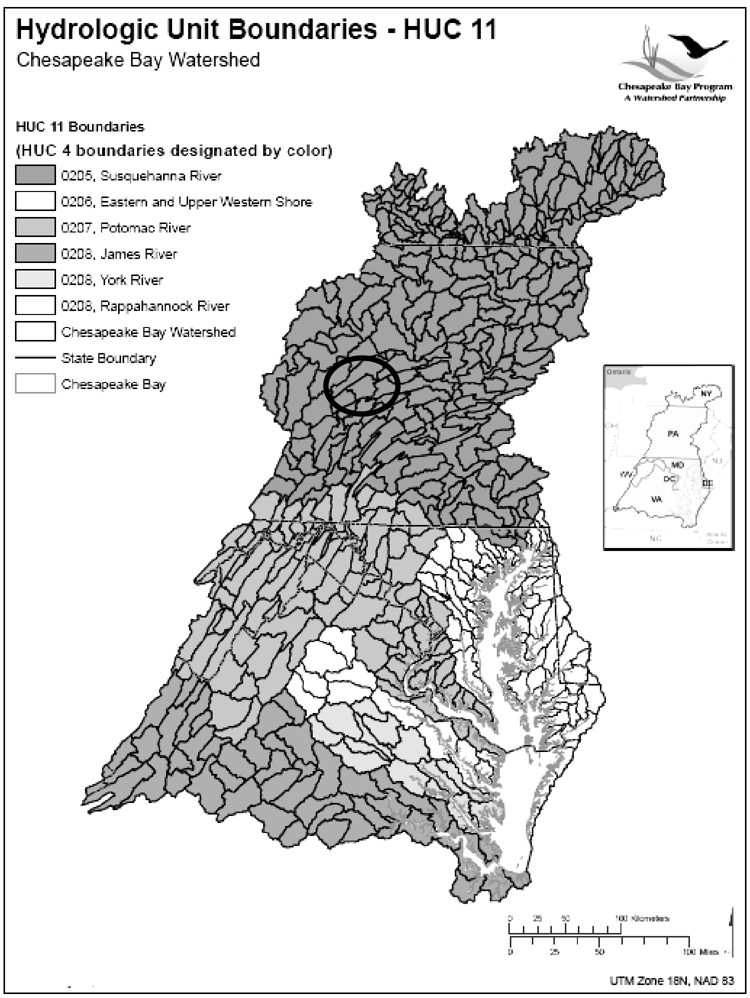

Figure 2.1. The Chesapeake Bay watershed with the Spring Creek watershed, circled. (Chesapeake Bay Program, 2008a)

The Chesapeake Bay Program. Watershed management can occur at the community or local watershed scale, or take on a regional, or basin-wide approach, as done in the last twenty years (O'Neill, 2005; Sabatier et al., 2005). One of the most visible examples of regional watershed policy is the Chesapeake Bay Program (CBP). Local, state, federal, and regional institutions collaborate under CBP to improve water quality and aquatic habitat in the Bay through various regulatory and voluntary mechanisms. With these interconnections in mind, I describe riparian buffer conservation efforts in the context of Chesapeake Bay watershed governance. This context may shed some light on constraints and opportunities for shaping landowner attitudes and perceptions in the Spring Creek watershed.

Within the Chesapeake Bay watershed, he most prominent governmental institution is the CBP, a partnership among the EPA, governors of Maryland, Virginia, Pennsylvania, their tri-state body known as the Chesapeake Bay Commission, and the District of Columbia. These entities are “signatories” for their sponsorship of Chesapeake Bay restoration agreements. The CBP was created under the Clean Water act, section 117, in 1987. At that time, the Executive Council, CBP’s governing panel set first quantified goals for Bay restoration. All agreements crafted by the CBP are formal, voluntary, and self-enforced by the signatory parties (CBP, 2008b).

In summer 2000, the Executive Council signed the Chesapeake 2000 agreement, now including New York, Delaware, and West Virginia, outlined a series of actions that was thought to restore the Bay by 2010. Understanding that restoration targets set forth in that agreement were not feasible, the CBP put forth the Chesapeake Tributary Strategies, a set of 36 tools for water quality and habitat improvements that are tailored to watershed-specific conditions (CBP, 2008b) The Strategies allocate nutrient limits to each state. Overall, the allocations call for a total reduction of nitrogen by 110 million pounds and phosphorus by 6.3 million pounds annually (CBP, 2008a). The Strategies also designate watershed units within the states, of which the Spring Creek watershed is a sub-unit of one of nine watersheds in Pennsylvania.

CPB has promoted riparian buffers since the 1987 Chesapeake Bay agreement (CBP, 1987). Riparian buffers were praised in a 1994 CBP Directive for their nutrient reduction and wildlife and aquatic habitat enhancement (CBP, 1999). One of the 36 restoration tools specified in the Strategies is forested riparian buffers. In addition to the Chesapeake 2000 goal of 10,000 miles by 2010, the three coalition states and the District of Columbia agreed in their Tributary Strategies to implement an additional 50,000 miles of riparian buffers within that timeframe. As of June 2009, the 10,000 mile goal was 62% complete (J. Okay, personal communication, June 5, 2009). It is questionable if the 2010 goal will be met.

In addition to setting targets, CBP provides technical assistance to state foresters and county conservation districts as a means of promoting riparian buffers (J. Okay, personal communication, June 5, 2009). The CBP also administers numerous grant programs, including implementation grants for nonpoint source pollution strategies outlined by the CBP, technical assistance grants, and the Small Watersheds Grants Program, which awards $20,000 to $200,000 for water quality improvement projects at the local watershed scale (CBP, 2010a). While many of these grants concern agricultural conservation, there are also funded projects that consider urban water quality influences (Chesapeake Bay Program, 1999). Along with technical support staff that work alongside state agencies, these grants are another mechanism for CBP involvement in on-the-ground activities.

Recently, federal enforcement of Bay restoration efforts were fortified with a May, 2009 Executive Order, which called upon the EPA to lead a federal effort for Bay restoration, planning, accountability, and enforcement (Executive Order No. 13508, 2009). The Order calls upon the EPA to make “full use of its authorities” under the Clean Water Act to restore Bay water quality, which may entail revising regulations or guidelines. Additionally, the Order calls for targets of the Bay's watershed for federal agricultural land retirement and conservation practice incentive programs. The Order also looks into the future with provisions for climate change adaptation, enhanced public access to the Bay, and expanded monitoring for ecosystem management.

Institutional actors of the Spring Creek watershed, and beyond. There are many institutions involved in water resources conservation in the Spring Creek watershed, Pennsylvania, and throughout the Chesapeake Bay basin. These institutions operate at local, state, regional, and federal levels, and often collaborate in many forms ranging from broad initiatives to individual riparian buffer projects. Locally, the four institutions most involved with water resources conservation are the Centre County Soil and Water Conservation District, ClearWater Conservancy, the State College Borough Water Authority, and the Spring Creek chapter of Trout Unlimited. Traditionally, conservation districts work mostly with farmers to reduce soil loss and water contamination associated with agricultural activities, where as the local watershed group and Trout Unlimited are member-based interest groups.

The ClearWater Conservancy is a local watershed organization and land trust that promotes environmental conservation in the Spring Creek watershed and surrounding area. The organization works towards its environmental goals through conservation easements, public outreach and education, among other activities. ClearWater Conservancy has been active since 1980 (ClearWater Conservancy, n.d.).

The State College Borough Water Authority (SCBWA) is the municipal water service provider for the State College Borough, Patton, Ferguson, College, Harris, and Benner Townships (SCBWA, 2008). The SCBWA maintains groundwater wells in the headwater regions of the Spring Creek watershed, charge customers for water usage, and educate residents about water conservation techniques. The SCBWA also addresses non-agricultural sources of water quality contamination through land acquisition and conservation easements, but not with riparian buffers.

Pennsylvania State University (PSU) Extension is also been involved in water resources conservation in the Spring Creek watershed. The organization is particularly involved in nutrient management for production agriculture as well as educating farmers on water resources conservation. In the early 1990s, PSU Extension and the local chapter of Trout Unlimited partnered for a streambank fencing initiative. This initiative unfolded with the project leader approaching farmers in-person to offer free streambank fencing and cattle crossings with a 10 year maintenance agreement (Carline & Walsh, 2007). A total of 17 landowners participated in this initiative, the first of its kind in the watershed.

The Commonwealth of Pennsylvania has many agencies involved in water resources conservation. A major source of conservation funding since 1999 is the Growing Greener program, which was extended in 2005 with Growing Greener II that provided a total $547.7 million in grants administered by the Pennsylvania Department of Environmental Protection (DEP) for watershed management. In turn, these grants are awarded to municipalities and local organizations involved in water resources conservation projects. While other Commonwealth agencies participate in Growing Greener II, DEP is the agency most-involved with riparian restoration and BMPs.

The Conservation Reserve Enhancement Program (CREP) is a state-federal partnership that encourages retirement of riparian areas from pasture or cropping systems. The first CREP in Pennsylvania began in 2000 with 20 counties in southeastern Pennsylvania in the Lower Susquehanna and Potomac watersheds (USDA FSA, 2003). In 2003, the CREP expanded to an additional 23 counties in central and northern Pennsylvania. The original and expanded CREP is collectively known as the Chesapeake Bay CREP, which targets agricultural landowners for nutrient and sediment reductions. According to the USDA Farm Service Agency's website, "Pennsylvania farmers will be able to join with other farmers and states in protecting the environmental resources of the Chesapeake Bay" (2003). The Pennsylvania Chesapeake Bay CREP will prevent 193,000 tons of sediment, 26 million pounds of nitrogen, and 418,000 pounds of phosphorus from entering the Bay, and will restore at least 35,000 acres of buffer strips adjacent to streams, wetlands, and other surface waters, based on loading estimates (USDA FSA, 2003). The program cost is estimated at $200 million over 10-15 years, $129 million of which comes from the USDA and the remainder from the state of Pennsylvania. As under the national requirements, the Chesapeake Bay CREP requires participants to maintain conservation practices for 10-15 years, and provides an annual rental payment based on the number of enrolled acres for the length of the contract (USDA FSA, 2003). Additionally, CREP adopters are provided one-time signing incentives of $100 to $150 per acre for land enrolled in riparian buffers. Landowners are eligible for CREP if their land is within 180ft of a stream or other surface water body if this land is idle, pasture, or cropland (PA Department of Environmental Protection, n.d.).

There are a number of institutions that work towards Chesapeake Bay recovery directly or indirectly within the Spring Creek watershed. The Chesapeake Bay Foundation (CBF) is the most prominent regional non-governmental organization that advocates for Bay restoration. CBF has offices in the three commission states, including their Harrisburg, PA office. Most of their riparian buffer education and outreach focuses on agricultural BMPs, such as streambank fencing. CBF promotes CREP on their website and through informational mailings to landowners. However, between 2004 and 2008, CBF administered the Trees for Streams program, which granted native riparian trees and shrubs to Pennsylvania non-agricultural landowners and watershed organizations (CBF, 2010). This program is no longer available due to lack of funding.

The Spring Creek watershed

The Spring Creek watershed (378 km^2, 93415 acres) of Centre County, Central Pennsylvania located in the Valley and Ridge physiographic province (Carline & M. C. Walsh, 2007). This watershed was selected for in-depth analysis of riparian conservation under USDA's Conservation Effects Assessment Program (CEAP), a nation-wide research initiative to catalog successes and failures of agricultural BMPs, and to improve upon water resources conservation. My research is one component of a CEAP project that integrates socioeconomic, in-stream biophysical data (e.g., macroinvertebrate and fish assemblages in relation to sedimentation), and landcover-hydrological processes to determine the effectiveness of upland and riparian land use on water quality. While much of the biophysical research considers agricultural influences on water quality, my research examines riparian buffers beyond the standard agricultural Best Management Practice (BMP) paradigm given the heterogeneous land uses. Accordingly, the location of my research is limited to the Spring Creek watershed in order to couple social conditions and processes with known water quality outcomes (Carline & Walsh, 2007) and concurrent studies.

The watershed is characterized by karst topography, or limestone valleys with numerous springs and sinkholes that serve as surface-groundwater linkages. The Spring Creek watershed consists of six sub-watersheds: Spring Creek, Slab Cabin Run, Cedar Run, Buffalo Run, Logan Branch, and one sub-surface watershed, Big Hollow (Figure 2.2). The streams that make up these sub-watersheds are perennial first or second order streams fed predominantly by groundwater, or intermittent streams that flow according to season and precipitation patterns. Spring Creek empties into Bald Eagle Creek, a tributary to the West Branch of the Susquehanna River. The Susquehanna River supplies 50% of freshwater entering the Chesapeake Bay (Pennsylvania Association of Conservation Districts, 2009).

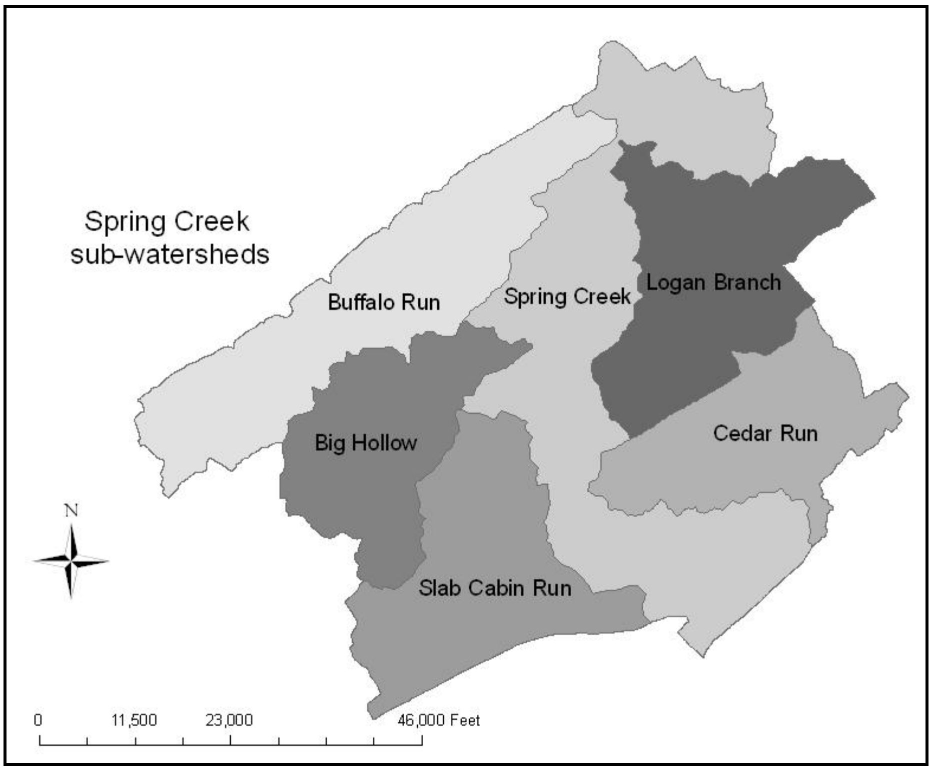

Figure 2.2. The Spring Creek watershed and its sub-watersheds.

<u>An urbanizing watershed.</u> The Spring Creek watershed is rapidly urbanizing. While agriculture remains the predominant landcover (49% as of 2000), two of the six sub-watersheds (Slab Cabin Run and Spring Creek) have over 40% urban landcover, or lands classified under the 2001 National Landcover Database as one of the four "developed" categories[1] (Chang & Carlson, 2005). Urban landcover is projected to

[1] The four developed categories are the following: developed, open space; developed, low intensity; developed, medium intensity; and developed, high intensity.

increase from 11.1% in 1996 to 23.2% by 2025, which represents 11,000 converted acres (Carlson, 2004). Sub-watershed and riparian land uses are generally similar, with the exception of a tributary within the Slab Cabin sub-watershed that is 53% urban landcover and 20% urban riparian land use (Chang & Carlson, 2005).

Between 2000 and 2008, Centre County's population increased by 6.6%, compared with 1.4% throughout Pennsylvania (U.S. Census Bureau, 2010). Carlson (2004) predicted that impervious surface area, a standard indicator of urbanization, will increase in the watershed from 6.9% in 1996 to 13.3% by 2025, which exceeds the 10% critical indicator of water quality degradation from urban influences. Prior to 2004, a survey conducted by the local watershed organization concluded that 20% of Spring Creek exhibited stormwater-related impairments (e.g., morphological changes such as stream incision, lower macroinvertebrate diversity) (Chang & Carlson, 2005), indicating that urbanization may already be influencing in-stream water quality.

The Spring Creek watershed includes two urban centers in the watershed, State College (population 39,500 in 2008) at the south of the watershed, and Bellefonte (population 6,200 in 2008) in the north. State College is the home of University Park campus of The Pennsylvania State University, in which 44,406 students were enrolled in 2008 (Penn State, 2008). The watershed includes 14 townships and two boroughs, with a majority of the watershed within five townships, Benner, Ferguson, Harris, College, and Patton (Figure 2.3). Based on Centre County population estimates, the population of these five townships will increase an average of 48.8% by 2030 (Table 2.1) (Centre County Planning and Community Development Office, 2008). The State College Borough was 92% developed (i.e., non-agricultural, non-forested) as of 2004, which suggests that adjacent, less-developed townships will absorb much of the projected population growth (Centre County Planning and Community Development Office [CCPCDO], 2008). This process may have already begun, as the Borough's population decreased 1.4% from 1990 to 2000, despite county-wide population increases.

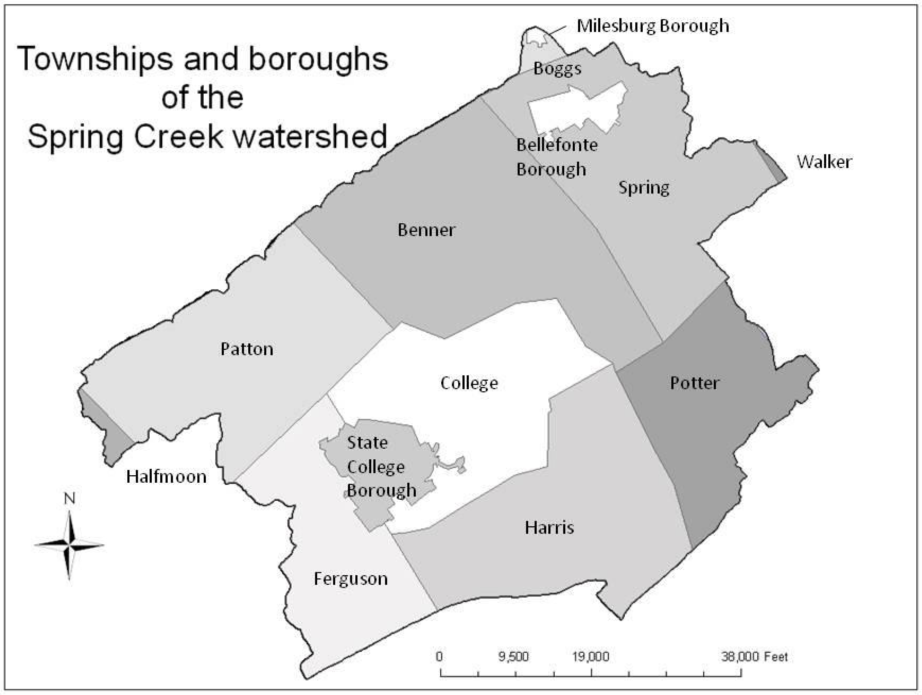

Figure 2.3. Townships and boroughs within the Spring Creek watershed.

<u>Sociodemographic characteristics</u>. The Centre Region Council of Governments (COG) is an inter-municipal body representing College, Ferguson, Halfmoon, Harris, and Patton Townships and the State College Borough. This planning region represents a reasonable approximation of the Spring Creek watershed, although some sociodemographic characteristics presented here may be biased towards the State College Borough. In 2000, the educational, health, and social services sector employed the greatest number of workers in the region, with the per capita income of \$18,348 compared to \$20,880 of Pennsylvania (CCPCDO, 2008). Centre Region is predominantly Caucasian (87.8%) with African American (3.0%) and Asian (6.6%)

residents.   Not surprisingly, the region's residents have high educational attainment with approximately 31% attaining graduate degrees, 27% with Bachelor's degrees, and 17% with a high school diploma as their highest degree, compared to 8%, 14%, and 38% attainment in Pennsylvania, respectively (CCPCDO, 2008; US Census Bureau, 2000).

Table 2.1. Population change in the five townships with largest areas in the Spring Creek watershed.

Township	2000 total population	2030 estimated population	% population change
College	8,489	10,530	24.0%
Ferguson	14,063	22,756	61.9%
Harris	4,657	4,680	49.2%
Patton	11,420	6,950	55.0%
Benner	5,217	8,033	54.0%
Total	43,846	52,949	48.8% (avg)

What are riparian buffers?

Riparian buffers are stream-side areas under permanent vegetation (J. D. Allan, 1995) that are often associated with agricultural Best Management Practices (BMPs) (Mayer et al., 2005). Buffers are one zone within the greater riparian ecosystem (Mitsch & Gosselink, 2000) (Figure 2.4). Riparian buffers can be conceptualized in two dimensions, as an interface between upland land uses and surface waters, and as corridors between headwaters and downstream water bodies.

The term "buffer" reflects the interface aspect of the riparian zone, as it refers to the riparian region's buffering capacity between terrestrial activities and nutrient contamination of aquatic ecosystems. A vast body of literature examines the interconnections between upland land uses (i.e., agricultural, urban) and land use change (Miltner et al., 2004; White & Greer, 2006) on stream health, as assessed by macroinvertebrate and fish biodiversity in relation to stream health (Moore & Palmer, 2005; Roth et al., 1996). In their survey of agricultural and urban headwater streams, Moore & Palmer (2005) found that streams in agricultural watersheds had higher biodiversity than urban streams; however, streams in urban catchments exhibited a strong, positive relationship between riparian buffer presence and macroinvertebrate biodiversity. This suggests an enhanced importance for riparian buffers in urban systems.

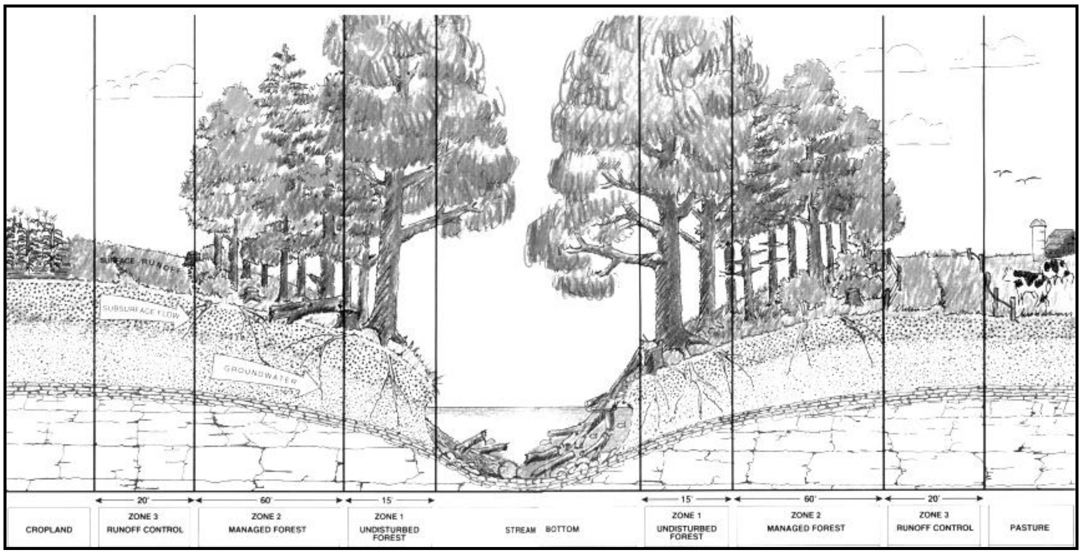

Figure 2.4. A riparian buffer zone as depicted from the interface perspective (Centre Regional Planning Agency, 2008).

While large-scale land use patterns are relevant to water quality and ecosystem health, this thesis focuses upon riparian areas and management strategies reserved for riparian landowners. The biophysical sciences literature distinguishes stream restoration from riparian restoration, with the former including channel reconfiguration, design, and reconnecting surface water flows to groundwater (Craig et al., 2008; Wenger et al., 2009). This debate is not the focus of this thesis. My work concerns only riparian conservation, meaning management behaviors that influence riparian habitat and functions, and does not consider stream restoration processes such as channel design.

The relationship between water quality and riparian buffers in agricultural landscapes has been studied at length (Verhoeven et al., 2006). This body of research has observed and modeled water quality improvements, particularly nitrogen (Verhoeven et al., 2006), phosphorus, and sediment reductions resulting from riparian buffers adjacent to agriculture (Line et al., 2000; Rao et al., 2009). Zhang et al. (2010) reviewed riparian buffer effectiveness under various conditions (slope, vegetation type, soil drainage), finding that buffer width was a significant predictor in pollutant (N, P, sediment) removal and explained 37, 60, 44, and 35% of the total variance in removal of sediment, pesticides, nitrogen, and phosphorus, respectively. Uncertainties remain surrounding the appropriate riparian buffer size for optimal water quality improvements. Effective buffer size is probably variable by groundwater flowpath, soil characteristics, and seasonal precipitation for subsurface nutrient removal (Mayer et al., 2007). Within the Valley and Ridge providence, forested riparian buffers are expected to remove medium-high levels of sediment and sediment-borne pollutants, medium levels of nitrate from groundwater, and medium-low levels of dissolved phosphorus (Lowrance et al., 1997). Recently, Roberts and Prince (2010) found that the effects of barren soil or evergreen forest riparian buffers that could be measured at the scale of the Chesapeake Bay watershed.

While the above studies have taken an interface approach to understanding riparian buffers, others have taken the corridor approach to measure riparian buffer functions and ecosystem services. Many of these corridor approaches consider riparian buffers as prime amphibian (Stoddard & Hayes, 2005) and bird habitat (Darveau et al., 1995). Water quality functions of riparian buffers are also examined from a corridor perspective, or one that accounts for upstream-downstream linkages.

In their review of riparian buffer filtration and transport capacities, Vidon et al. (2010) identify riparian buffers as potential hot spots for nitrogen, phosphorus, and mercury loading to surface waters. Similarly, Walter et al. (2009) found that riparian areas around first order or intermittent streams had wider contributing areas for phosphorus runoff than riparian zones near main channels.

Riparian buffers are a common prescription for ameliorating water quality pollution from upstream or upland land use practices. Many riparian buffer programs set minimum buffer widths, typically around 35ft, which reflects a greater policy emphasis on riparian buffer water quality functions rather than habitat enhancement, which would require wider buffers (typically 100ft minimum). Generally, riparian buffers are of a fixed width, with wider widths assumed more effective in pollutant filtration.

One type of riparian BMP is streambank fencing, which greatly reduces in-stream nutrient deposition and maintains channel geomorphology by livestock removal (James et al., 2007; Miller et al., 2010; Verhoeven et al., 2006). Many studies also show the benefits of streambank fencing to fish habitat (Opperman & Merenlender, 2004; Wang et al., 2002), and reduced sediment loading (Carline & M. C. Walsh, 2007). Riparian buffers modify in-stream temperature (Allan, 1995) and enhance habitat with allocthonous inputs, or leaves and woody debris (Angermeier & Karr, 1984). Because riparian buffers are believed to improve fish habitat, they are a popular conservation tool with conservation organizations, such as Trout Unlimited.

Streambank fencing is a predominant component of the USDA Conservation Reserve Enhancement Program (CREP), which pays farmers signing and annual ($100 per acre) monetary incentives to retire riparian areas under pasture or crops (USDA FSA, 2009). Another form of riparian restoration involves vegetative plantings. These plantings may consist of grass, shrubs, and/or trees that are maintained to form permanent streambank groundcover. Vegetative plantings often accompany streambank fencing in riparian restoration efforts, particularly for CREP buffers. Riparian buffers created through streambank fencing and vegetative plantings are commonly fixed-width, meaning that they are a uniform distance from the stream, often designed for mowing or maintenance convenience. These fixed-width buffers may or may not overlap with hydrologically sensitive areas that contribute more nutrients through surface runoff compared to non-sensitive areas (Agnew et al., 2006). This suggests that fixed-width buffers are not as efficient in achieving their intended conservation goals as variable width buffers (Walter et al., 2009).

In the last five years, there was an explosion of interest in urban ecology, which was precipitated by Long Term Ecological Research (LTER) projects in Baltimore, MD and Phoenix, AZ. Within this movement, ecologists have observed the importance of urban ecosystems (Goddard et al., 2010) and patch dynamics (Prugh et al., 2008) for biological conservation. My research compliments recent inquiry into water quality improvements associated with riparian buffers in urban systems (Cadenasso et al., 2008; Groffman et al., 2003; Kaushal et al., 2008). Some urban water quality impacts such as wastewater treatment are managed by cities and municipalities. However, suburban or urban riparian landowners also influence water quality through lawn mowing and fertilization practices (Groffman et al., 2004), and altering the hydrologic regime (i.e., impervious surfaces, lawn irrigation) (Roy et al., 2009). Social science and urban ecological interdiciplinarity are present and expanding approaches for urban water resources management.

Riparian buffers in the Spring Creek watershed

Riparian buffer ordinances are common regulatory tools that restrict development within riparian corridors. Pennsylvania is a home-rule state, meaning that land use decisions are made "at home" by local municipalities rather than state or county governments. Since January 2007, the COG has promoted a model riparian buffer ordinance to the member townships. The buffer ordinance designates two "zones": a zone 35ft from the stream and a corridor extending 65ft from the inner zone. Within these zones, townships would determine specific regulations on development or other land uses other than agriculture and forestry, which the PA Commonwealth already permits (Centre Regional Planning Agency, 2008). Notably, the ordinance applies to perennial and intermittent streams. This model ordinance grandfathers existing buildings, and is essentially a way for townships to restrict development in riparian corridors, rather than regulate existing uses (S. DeGregorio, personal communication, May 7, 2009).

The proposed ordinance was presented to each township council, which had the options to dismiss the ordinance, modify the ordinance prior to passage, or pass the ordinance as written. Prior to voting on the ordinance, township councils debated the ordinance in open meetings, and public hearings were held. Additionally, the COG mailed riparian residents whose property came under the riparian zone overlay an informational packet that included a summary of the proposed ordinance, maps describing the buffer overlay concept, and places to look for further information. In March 2009, Halfmoon Township was the first township within the study watershed to pass the buffer ordinance, with minor modifications. Since then, Ferguson Township passed the ordinance with one modification from the model language: properties in which the buffer overlay zone would occupy more than 50% of the total parcel area were exempted. Harris Township is considering the model ordinance for passage, while Patton Township is deliberating the model ordinance as an amendment to current subdivision regulations, meaning that the buffer would only apply to properties proposed for parcelization. College Township rejected the ordinance (Table 2.2). According to a newspaper article that recounted the vote, property owners expressed concerns that the ordinance intruded on their private property rights (Koons, 2009).

Many townships regulate behaviors on private property through property maintenance ordinances. This is a general category of ordinances that control defunct maintenance, such as "junk cars" or tall weeds (typically around 24 inches). Nine townships of the Spring Creek watershed have property maintenance ordinances. These are often townships with larger, denser populations (Table 2.2). It is possible that regulations on vegetation maintenance may be interpreted by some residents as outlawing riparian vegetation, which would often exceed this height limitation.

Table 2.2. Presence of relevant ordinances to riparian land use passed by townships and boroughs within Spring Creek watershed.

TOWNSHIP/Borough	Riparian Buffer Ordinance	Property Maintenance Ordinance
Bellefonte	None proposed	Yes
BENNER	None proposed	No
BOGGS	None proposed	Yes
Centre Hall	None proposed	Yes
*COLLEGE	Rejected: September, 2009	Yes
*FERGUSON	Passed: May, 2009	Yes
*HALFMOON	Passed: March, 2009	No
*HARRIS	Under deliberation	Yes
Milesburg	None proposed	Yes
*PATTON	Under deliberation	Yes (subdivisions only)
POTTER	None proposed	No
SPRING	None proposed	Yes
*State College	Passed: March, 1996	Yes
WALKER	None proposed	No

* indicates Centre Region Council of Governments member

Chapter Summary

In this chapter I introduce watershed management as a governance approach for managing water quality at local and regional scales. I then provided information on Chesapeake Bay restoration programs and policies, and demonstrated how these policies influence riparian management throughout the Bay watershed, including the Spring Creek watershed, my study location. I provided background sociodemographic and landcover information on the Spring Creek watershed, which is rapidly urbanizing. I give an overview of riparian BMPs, which have traditionally been implemented on agricultural land uses, and discuss the literature on water quality improvements associated with riparian buffers. I concluded with discussion of a riparian buffer ordinance in the study watershed.

CHAPTER THREE

LITERATURE REVIEW, THEORETICAL BACKGROUND, RESEARCH QUESTIONS AND HYPOTHESES

Chapter Introduction

In this chapter I present the theoretical basis for my research. I introduce adoption-diffusion theory, social identity theory, self-efficacy and outcome expectancy, and explore how these theories may collectively help explain riparian landowner behavior. I review literature related to water resources conservation and riparian buffer adoption related to the above theoretical fields. I also introduce the concept of transitioning landscapes, which describes social and biophysical changes that occur over space from a social-ecological perspective. I then discuss how institutions shape this framework through local policy networks. Social-psychological theories, institutional relationships, and the transitioning landscapes concepts are integrated in a theoretical framework. Based upon this framework I derive my research questions, thesis statement, and hypotheses.

Adoption-Diffusion Theory

Adoption-diffusion theory models the relationship between individual behaviors and the mechanisms by which innovations spread throughout a society. Innovations are ideas, practices, or objects that are perceived as new (Rogers, 1995). The theory takes an individual perspective to explain adoption behavior. The theory assumes that individuals are rational actors who behave to maximize their utility.

Rogers (1995) uses the innovation-decision process to explain the individual's decision about an innovation. Individuals enter an innovation-decision situation with sets of previous experiences, ideas of their needs, a general level of innovativeness, and knowledge of norms of the social systems to which they belong. The first step of the innovation-diffusion process is knowledge, where individuals learn of the innovation, which is followed by the second step, persuasion. At this step, individuals consider the characteristics of the innovation, such as its relative advantage and compatibility. Then, a decision is made to adopt the innovation or to reject the innovation, yet the theory acknowledges that this decision may be revisited for later adoption or discontinuance. Once a decision is reached, the innovation is implemented, which leads to the confirmation stage, where the individual aligns his or her behavior and attitudes to maximize comfort with the innovation. It is at the confirmation stage that adopters usually reject the adoption, if they are to de-adopt. Comparatively little research has considered adoption rejection as opposed to initial adoption (Rogers, 1995).

Diffusion is the process of communication about an innovation through certain pathways within a social system over time (Rogers, 1995). There are four cornerstones to the diffusion of innovations: the innovation itself, meaning its characteristics and uses; the social system in which diffusion takes place; communication networks within the society; and the rate of diffusion; and (Rogers, 1995). An innovation's characteristics are measured by relative advantage, or improvement associated with an identified set of outcomes over the practice it replaces; compatibility, or how consistent the innovation is with existing values, social norms, and needs of potential adopters; complexity, or how difficult an innovation is to use; trialability, or how the innovation may be implemented on a limited basis to decrease uncertainty; and observability, or the degree that an innovation's results can be seen by others. Adoption-diffusion theory has generally examined the people who adopt rather than the attributes of innovations. While scales to measure the importance of innovation attributes exist, Rogers (1995) notes that not all innovation attributes matter to different study populations or contexts, which make widespread scale applicability a challenge. Nonetheless, innovation attributes, particularly relative advantage, are important adoption factors.

Incentives often foster innovation adoption, particularly in agriculture, health, and family planning (Rogers, 1995). Institutions award incentives to increase adoption rates and target certain social groups for adoption. Some incentives are awarded to diffusers, or those who advertise a certain innovation, while most incentives, particularly in agriculture, offer incentives to potential adopters. In some cases, incentives are awarded for groups or communities, yet most of the time payments are awarded for individual adoption. Typically incentives are monetary-based, and are received immediately upon adoption (Rogers, 1995). An example of this is the USDA's CREP, which provides one-time signing incentives for program adoption with additional, yearly incentives awarded for a contract's duration. Rogers (1995) notes that though incentives increase the quantity of adopters in a system, the quality of adoption may be less than in a system of non-incentivized adoptions, as there is lower motivation to carry out the innovation once an incentive is obtained. The annual CREP incentive payments are one mechanism for re-incentivizing adoption.

A major component of the diffusion of innovations is the communication networks by which information about innovations travels. Communication channels may be mass media or interpersonal channels, such as face-to-face exchange. Individuals generally base their views of innovations upon interpersonal evaluations rather than scientific studies of the innovation, which suggests that the diffusion process is highly social and dependent upon the network to which a potential adopter belongs (Rogers, 1995). Within communication networks, information dissemination is more effective when the network is homophilous, or has similar beliefs and attitudes. However, some degree of heterophily must exist for an information gradient to exist between knowledgeable and unknowledgeable individuals.

Time is a critical component of the diffusion of innovations in terms of the rates of adoption across societies, how individuals adopt an innovation in relation to the rest of their society, and how individuals' opinions are shaped and modified. One way in which individuals' behaviors change is de-adoption—a process that receives little attention in the adoption literature. Time lends important depth to adoption-diffusion theory, where it is missing from other explanations of behavioral change (Rogers, 1995).

Lastly, the social system in which innovation decisions take place influence individuals' decisions, and abilities, to adopt. Social systems are defined in adoption-diffusion literature as a "set of interrelated units that are engaged in joint problem-solving to accomplish a common goal" (Rogers, 1995). Social systems may influence diffusion through normative behaviors, which may be a barrier or a conduit for change; charismatic individuals such as opinion leaders; change agents, or an individual who encourages innovation adoption in favor of a change agency; and social structures. The latter component of social systems is of particular interest to sociology and social-psychological studies in adoption-diffusion. One form of structure is communication structure, or the organized elements of patterned communication flow within a system (Rogers, 1995). A communication structure typically forms with homophilous individuals communicating more frequently with each other than with less-similar individuals. Communication structures allow for prediction of adoption behaviors based upon placement within the social structure and that group's knowledge of the innovation.

Development of adoption-diffusion theory. Adoption-diffusion research flourished from the 1940's through the 1960's, largely due to the technological advances of the Green Revolution, in which farmers around the world adopted commercial innovations for increased efficiency, productivity, and yields (Fliegel & Korsching, 2001). These studies took a social-psychological approach to explain adoption, in part due to findings that suggested individuals' tendencies to be innovative were a general trait that could predict adoption (Fliegel & Korsching, 2001). Early adoption-diffusion research focused upon commercial innovations, such as hybrid corn, that maximized profits for farmers or otherwise had a high relative advantage compared with earlier technologies or practices. In short, the outcome-profit maximization was assumed.

Early research documented the spread of technologies as a patterned, predictable process. Most notable of this era are the Iowa State Hybrid Corn Studies (Fliegel & Korsching, 2001; Ryan, & Gross, 1943), which were the first to identify socioeconomic characteristics such as education, farm size, income, communication sources, and readership of farm publications as predictors of commercial practice adoption. A body of work done by Rogers in the late 1950-early 1960s analyzed this relationship using adopter typologies based upon the timing of innovation adoption: innovators, early adopters, early majority, late majority, and laggards (Buttel et al., 1990). When plotted cumulatively, the total number of adopters of a successful innovation forms an S-shaped curve, where there are a few adopters at first, but then increases dramatically until half of the individuals in the system have adopted, then eventually leveling at a total level of adoption slightly less than the total population of the system (Rogers, 1995) (Figure 3.1, modified from Fliegel & Korsching (2001)).

The number of new adopters is normally distributed over time, with "Innovators" representing the first adopters and "Late adopters" adopting comparatively last.

Many social-psychological studies followed the foundational research that found correlations among attitudes, value-orientations and adoption typologies. By the 1950's, it was widely accepted that socioeconomic status was positively related to innovation adoption. Additionally, the influence of group membership, particularly ethnicity (Buttel et al., 1990) was found early on to influence adoption behavior. Related to group membership are information sources. Potential adopters generally gather information from early innovators and people within their social spheres of influence were more frequently sources of information than technical advisors (Buttel et al., 1990). Information sources were found to change based on innovation decision stage, where mass media sources (i.e., newspapers, magazines) were initially

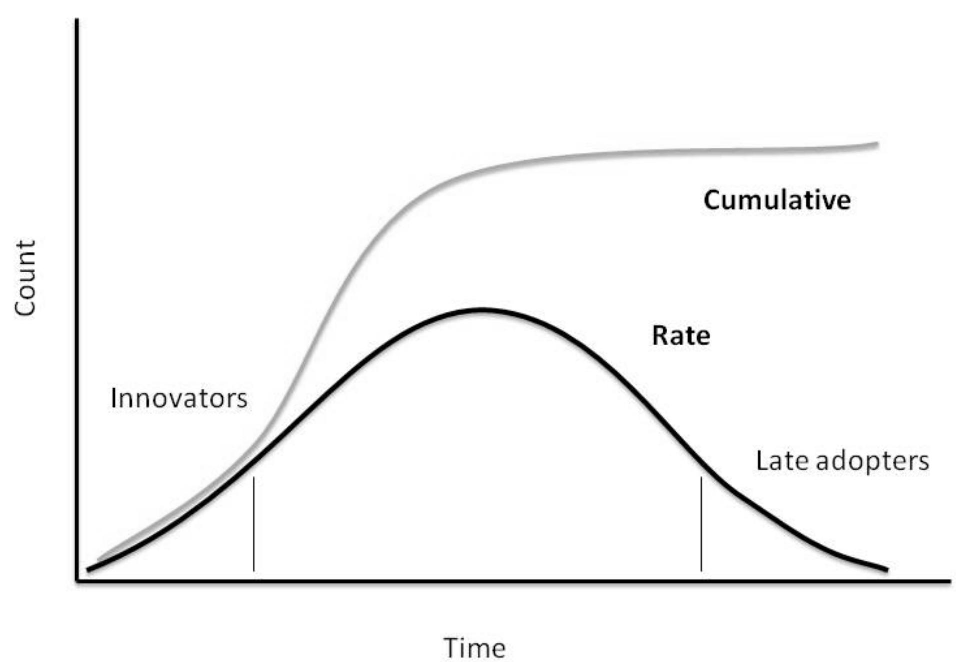

Figure 3.1. Adoption of innovations over time with "Innovator" and "Late Adopter" typologies.

the most influential. Other studies have found that adopters value technical assistance and information provided by professional sources (e.g., extension agents, state agencies) (Saltiel et al., 1994). However, as the potential adopter comes closer to adoption, he or she shifts information sources towards interpersonal sources (i.e., family, friends) in search of more trustworthy information (Fliegel & Korsching, 2001). Wenjert (2002) identified two sets of variables that influence the role of interpersonal networks on dissemination: network connectedness, or how close an individual is to the informant, and network closeness, or the number of friends, advisees, and interactions an individual has in their network.

Application to conservation behaviors. Conservation practices, such as those that reduce soil erosion or improve water quality, have functional and behavioral components to their implementation. Functionality is represented by the innovation's purpose, meaning what that innovation enhances. For example, a function of cover crops is to reduce nutrient runoff. Associated with function is behavioral change, or the new actions the adopter takes on. With the cover crop example, the behavioral component is reducing the amount of fertilizer applied to fields.

Conservation innovations differ from commercial innovations in terms of outcome maximization. Some practices require startup investment that may increase production costs and require maintenance (i.e., time and money), which pose initial setbacks to production maximization or how widely an individual adopter may apply that practice. While the benefits of certain innovations may eventually surpass initial costs, some individuals may not have the capital to meet start-up requirements. Secondly, conservation innovation outcomes are often more diverse than economic profit, which is the primary intended outcome of commercial innovation adoption. Conservation practices, particularly concerning water quality enhancement, are typically transferred to off-site, downstream water bodies. Here, downstream communities, habitats, and aquatic systems accrue innovation outcomes, while the upstream adopter bears the costs of adoption. Under certain water quality initiatives where downstream policies aggressively promote upstream conservation practices, potential adopters may resent the costs of adoption (Armstrong et al., in review).

As soil and water quality conservation practices became more prominent in the 1970's, adoption-diffusion research examined the applicability of the model to conservation innovations. This vein of research was an extension of past adoption-diffusion research on commercial innovations, despite the differences in these innovation types. Pampel and van Es (1977) found that sociodemographic characteristics of commercial innovation adopters poorly predicted conservation innovation adoption, suggesting that environmental values and farm profitability were more prominent factors in environmental innovation adoption. Nowak (1983, 1987) challenged this notion, and demonstrated that non-economic factors such as information diffusion, institutional constraints, and ecological applicability of particular practices can drive adoption decisions (Buttel et al., 1990). Across the adoption-diffusion literature, sociodemographic characteristics that repeatedly predict conservation practice adoption are education, farm acreage owned, innovativeness, and access to information (Buttel et al., 1990; Prokopy, 2008; Rhodes et al., 2007; see (Napier & Bridges, 2002) for contrast). Rosenberg and Margerum (2008) found that landowners most trusted source of information about conservation practices came from members of their social network, such as friends, family or neighbors. Age is typically considered in adoption-diffusion studies, yet it is commonly not a significant factor conservation practice adoption (Prokopy, 2008).

Reflecting a growing realization of multiple adoption motivations, other authors have called to move away from studies concentrated on landowner profit maximization (Parker et al., 2007; Sengupta et al., 2005) and have revealed positive relationships among environmental attitudes, innovation attitudes and adoption (Atari et al., 2009). Farmers may take on conservation practices out of intrinsic motivations, such as desired lifestyles (Greiner et al., 2009) and land attachment (Ryan, 1998) more so than for incentive payments. In a meta-analysis that examined the last 25 years of conservation practice adoption, Prokopy et al. (2008) found that environmental attitudes were consistent positive predictors of adoption, where attitudinal measurements of environmental awareness (Knowler & Bradshaw, 2007) and perception severity of environmental problems (Swanson et al., 1986), usually positively associated with BMP adoption.

Adoption-diffusion theory and riparian buffers. Riparian buffers are conceptually and practically different from other types of conservation practices. Riparian buffers have a spatial component in addition to functional and behavioral components found with other conservation practices. This space is effectively land that must be modified from its current use, whether from agricultural production (e.g., cropping, grazing) or some other form of landcover (e.g., lawn), and placed under permanent vegetation. While other conservation practices involve reconfiguration (e.g. barnyard improvements, rotational grazing), the pre-practice uses are modified only slightly compared to land retirement of riparian buffer implementation. Such redefinition of space may translate into productivity loss, and a sense of loss of autonomy or control over one's property.

Riparian buffers also have different demands upon adopters post-implementation. Vegetation plantings, a common component of buffer installation, are difficult to maintain, especially in the initial few years (Buchanan et al., In press). Unlike structural BMPs (e.g., stream crossings, fencing), vegetation can die or be washed-out by high flows, thus fostering higher uncertainties and perhaps a perception of poor outcome attainment among potential adopters. Maintenance behaviors such as mowing and weeding around young riparian plantings may be an obstacle for buffer adoption.

There are very few studies that consider riparian buffer adoption from sociological or social-psychological perspectives; however, there are many economic studies that analyze riparian buffer adoption, particularly willingness to install riparian buffers based upon financial incentives (Lynch et al., 2002; Suter et al., 2008). One of the first studies to examine riparian buffer adoption found that agricultural landowners who believe that riparian areas are important are more likely to try alternative land management strategies, such as riparian buffers (Schrader, 1995). Ryan et al. (2003) found that landowners are most motivated to adopt riparian buffers and other water quality BMPs based on personal stewardship ethics, commitment, and project feasibility. Lovell and Sullivan (2006), in their review of conservation buffer policy and research needs, which touched upon riparian buffers among other farming BMPs, perceived that riparian buffer aesthetics play a relatively unexamined role in adoption. The authors also note that adopting landowners' perceptions of watershed and regional environmental quality are poorly understood (Lovell & Sullivan, 2006).

Adoption-diffusion theory and non-agricultural landowners. To my knowledge, only one other study has considered non-agricultural landowners within the adoption-diffusion framework. Napier et al. (2008) examined landowners' willingness to spend money on conservation practices on their property of two or more acres. They revealed that most landowners were unwilling to spend any money on conservation practices; however, willingness was explained by positive conservation attitudes, knowledge of environmental impacts, and concern for nutrient management. The authors went on to compare the findings here to those conducted in adjacent agricultural watersheds, where conservation practice adoption did not fit the traditional adoption-diffusion model. Napier et al. (2008) put forth that non-farming landowners were unwilling to invest in conservation practices because their economic well-being was not threatened by property damage.

Limitations to adoption-diffusion research. Adoption-diffusion research has certain limitations. First, adoption of conservation practices research has almost exclusively considered agricultural landowners on homogeneous landscapes, meaning that research subjects were surrounded predominantly by other farmers. This calls into question our understanding of how information pertaining to conservation innovations travels in social systems comprised of myriad groups.

Adoption-diffusion theory has also failed to consider conservation practice maintenance, or the factors that drive practice upkeep. The theory treats adoption and non-adoption as mutually exclusive, though innovators may revisit their adoption decision over time and change to the alternative behavior (Rogers, 1995). In reality, adoption and non-adoption are more likely to represent a gradient of implementation behavior, where practices may be implemented but poorly upheld, or not maintained over their lifetime, leading to de-adoption (Jackson-Smith, In review). Cooper and Jacobsen (2009) analyzed maintenance intention of CREP adopters, finding that they were likely to either renew their CREP contract after the 10-15 year period, or at least keep the riparian area under CREP uses. Nonetheless, the role of maintenance is not considered in the innovation decision model.

Expanding adoption-diffusion theory. My work expands traditional notions of adoption-diffusion research to include non-agricultural landowners. To date, there is limited research on non-agricultural landowner perceptions, attitudes, and willingness to adopt conservation practices, including riparian buffers. Dutcher et al. (2004) interviewed landowners from a variety of land uses (forested, agricultural, rural residential), concerning their perceptions of riparian forests and found that landowners felt an obligation to their community to protect water quality, but that these landowners were largely unaware how their behaviors influenced water quality.

Wagner (2008) considered non-agricultural perceptions of riparian buffers in residential and commercial locations, finding that wildlife and water quality improvements, when recognized, were more important to study participants than riparian buffer aesthetics. This study suggests that riparian buffers are more socially acceptable if landowners or property users are aware of their environmental purposes (Wagner, 2008). In this vein, Kenwick (2009) considered riparian buffer aesthetic preferences across rural and non-rural Illinois residents based upon different vegetation (forested, grassed, or none) in agricultural fields and suburban residential areas. The study did not uncover differences in buffer appearance preferences between rural and urban respondents; however, this research did not exclusively consider riparian landowners, who have the ability to implement riparian buffers. Respondents were most likely to approve of riparian buffers for their aesthetic and wildlife habitat benefits, and were most likely to disapprove of riparian buffers because of associated maintenance requirements (Kenwick et al., 2009).

The Social-Ecological Framework: Transitioning Landscapes

Under the social-ecological framework (Liu et al., 2007), landscapes experiencing rapid biophysical changes (urbanization, reforestation, energy development) are concurrently experiencing social change. "Transitioning landscapes" is a concept that lends a spatial dimension to the linked biophysical-social changes. The Spring Creek watershed is a transitioning landscape, with measurable biophysical changes in landcover due to urbanization. Much work has described patterns of urbanization (Alig et al., 2004; White et al., 2009), particularly related to residential development (Gonzalez-Abraham et al., 2007; Gonzalez-Abraham et al., 2007; Hammer et al., 2009), degradation of riparian habitat (Elmore & Kaushal, 2008), stream hydrology (Jennings & Jarnagin, 2002) and water quality (Carlson, 2004).

Urbanization is a process, not a place, which occurs over time. Suburban areas are places that experienced change from one use (typically agricultural though sometimes forested or industrial land uses) to low-density residential landcover. The urban-rural fringe is a term commonly used to delineate areas that include elements of urban and rural attributes (both biophysical and social); experiencing change. However, this term is place-based, rather than process based. In fact, migration and land conversion, two demographic elements of urbanization, are well studied in the United States (Brown et al., 2005); however, there is comparatively little research on the social, non-economic processes. Only a few studies have examined the effect of sprawl on social ties (Freeman, 2001), and sense of community (Wilson & Baldassare, 1996). Similarly, many studies have examined the influence of urbanization on streams, yet few studies considered how urbanization influences landowner stream management behaviors in urbanizing areas (see Chapter Two).

<u>Strong and weak ties</u>. Social cohesion is constructed by strong and weak ties, with strong ties as the social foundation clusters or cliques within a community, and weak ties serving as the connections among these clusters (Granovetter, 1973). In a network of strong-weak ties, the diffusion of innovations occurs more readily between clusters through mutual weakly tied individuals rather than within clusters of strongly tied individuals (Granovetter, 1973).

These interactions occur over time and space. Space is part of the social process that creates social identity (discussed in the next section) and encourages place-based social identity (Uzzell et al., 2002). The neighborhood is one spatial scale at which these social identity processes, such as self-categorization, may occur. Neighborhood friendships foster sense of community, which is one dimension of social cohesion (Wilkinson, 2008). Trust and cohesion among neighbors takes time to grow, yet leads to strong ties. The length of years lived in a neighborhood is one element of sense of community (Wilkinson, 2007), with in-neighborhood social cohesion feeding place based identity (Uzzell et al., 2002). When social cohesion and social identity are strong within a neighborhood, environmental attitudes and behaviors are more common (Uzzell et al., 2002).

Under the social-ecological framework, there are feedbacks and thresholds (i.e., "tipping points") between biophysical processes and social behaviors (Cadenasso et al., 2008; Pickett et al., 2008). The transitioning landscape is a rapidly changing space with co-evolving behaviors and environmental conditions. Feedbacks between these social and ecological processes therefore influence the landscape. For example, while reforestation is taking place across much of the Northeast, it is less likely to occur in a suburbanizing area, where land is converted from forest and agriculture for residential uses, than in a less dense landscape with vacant agricultural fields. Similarly, biophysical processes influence social perceptions, as is the case for residents in the plains states, where they consider the agricultural landscape an interconnected social-physical entity (Atwell et al., 2009). Gobster et al. (2007) theorize that human interactions with their perceivable landscape shape aesthetic experiences with the surrounding area, which in turn shape attitudes, concerns, and behaviors.

There is an inherent spatial component to studying transitioning landscapes. Riparian buffers have varying hydrologic functions and capacities based on their position on the landscape (Walter et al., 2009) (see Chapter Two). Similarly, social factors such as attitudes and values may be spatially related to biophysical characteristics. Larson and Santelmann (2007) found that nearness to water explained residents' attitudes of resource importance and their willingness to provide economic support for conservation. Similarly, the distance between upstream conservation program participants and the target water body is negatively associated with management of common pool resources (Brucks et al., 2007). This is particularly relevant to riparian buffer adoption in the Spring Creek watershed that is 160 miles upstream from the Chesapeake Bay. Rickenbach and Kittridge (2009) found that the distance from landowners' households to their forest holdings had a negative relationship with enjoyment, production, and protection of their private forests.

Disproportionality. The concept of disproportionality is one in which two or more variables interact to form certain outcomes. Disproportionality focuses upon the confluence of outliers and how these outliers interact to create certain conditions. If this outlier interaction gives rise to conditions that, at fine or coarse scales, are different from more typical conditions, then disproportionality exists. In some situations, the outcomes of outlier interactions can determine the state of the overall system.

Disproportionality provides useful framework for watershed or landscape-scale analyses of social-ecological feedbacks. Nowak et al. (2006) applied the disproportionality to water quality conservation within an agricultural watershed. Landowner property management behaviors and biophysical conditions were examined over space (the watershed) and time. Harmful property management behaviors, such as excessive manure application, when coupled with hydrologically active areas prone to surface water runoff, contributed a disproportionate amount of nutrients to surface water bodies than similar management styles for less-sensitive conditions. In effect, outliers, or hot-spots drive system-wide outcomes, not typical behaviors or environments. This conceptual tool may help explain why watersheds in which there are high rates of conservation practice adoption still see excessive nutrient contamination.

Disproportionality can also be thought of in terms of social influence. Individuals, communities, or watersheds may have disproportionate access to policies, programs, and support from environmental initiatives, thus enabling them with greater capacity to address environmental issues. Economic or environmental outcomes may be attained by a small number of individuals, while a disproportionate segment of society is left with greater or even severe environmental damage (Freudenburg et al., 2009).

Water quality outcomes were recently considered from a disproportionality perspective in an urban landscape, where Baker et al. (2008) encouraged a management model that targets landowners with vulnerable behaviors (e.g., excessive lawn fertilization) for watershed management outreach. However, disproportionality has not been considered in a heterogeneous landscape, where riparian management behaviors vary in type and in appropriateness. Secondly, disproportionality does not engage landscape change. It assumes that biophysical conditions, such as land use and hydrology, remain constant as the effects of human behaviors are expressed over time. On a transitioning landscape, biophysical conditions such as impervious surface and hydrologic flow paths are changing in connection with social conditions. Disproportionality, considered in a social-ecological framework, is ripe for interdisciplinary research (Haberl et al., 2006).

Social Identity Theory

Social identity is an individual's notion that she or he embodies certain characteristics shared by those in a group to which she belongs (Abrams & Hogg, 1990; Tajfel & Turner, 1979). Social identity theory explains identity formation from inter-group situations, where as identity theory is limited to interpersonal identity formation (Brown, 2000). These shared characteristics are used by the individual in self-identification, yet also prescribe attitudes and behaviors that are taken on by the individual. Self-categorization theory grew out of social identity theory, yet is distinct in that it describes the process by which individuals place themselves within social categories (Hogg & McGarty, 1990). Because social identity and self-categorization theories are interrelated conceptually and historically, I will refer to them collectively as social identity theory with the knowledge that the two theories describe distinct social processes.

Social identity theory is a useful compliment to adoption-diffusion theory in that social identity theory helps explain individual behaviors as they relate to in-group and out-group characteristics. While adoption-diffusion theory focuses on the individual as the sole unit of analysis, social identity theory examines the individual in the relation to social surroundings. These surroundings include behaviors, attitudes, and categories of groups in with which the individual interacts.

Social identity theory is shaped around two sociocognitive processes: self-categorization and self-enhancement (Hogg & Terry, 2001). Self-categorization occurs through comparisons between the individual and a set of other individuals. Here, characteristics belonging to the self are compared to those of the group, with emphasis given to the characteristics at play in a given context in order to maximize accessibility and fit with that category (Hogg and McGarty, 1990). For example, a horse farmer may identify with other horse farmers more so than apple farmers to maximize their fit in a more similar, relevant type of farming. Social categories may be based on activities, attributes, or beliefs. Once self-categorization takes place, group membership lends defining characteristics to self-definition. These salient categories prescribe certain attitudes that are translated into behaviors consistent and compatible with group norms (Hogg & McGarty, 1990; Terry et al., 1999).

Accordingly, group behavior and individual behavior range along a continuum from stereotypic to idiosyncratic (Hogg, 1992). The groups that individuals belong to may support or discourage certain behaviors. Once an individual believes that a certain social identity is salient to one's self-conception, one's behavior is more likely to take on the norms of the group, which leads to representation of the groups' ideals by the individual (Hogg, 1992). While this process suggests behavioral conformity, a group member's self identity will motivate individual behaviors that will favor the group in inter-group comparisons (Hogg, 1992). As the individual identifies with the favored group, the individual also benefits from this comparison.

Categorization emphasizes group prototypicality, or the normative behaviors associated within a group (Hogg and McGarty, 1991). Prototypes help individuals maximize intra-group similarities and inter-group differences, thereby emphasizing distinct sets of groups which then define self-categorization (Hogg, 1992). Self-categorization takes place when an individual observes normative behavior, through the process of depersonalization, where behavior is attributed to the group rather than an individual. If the self-categorizing individual perceives that this behavior is salient, she or he takes on the normative behavior (Hogg and McGarty, 1991).

Self-categorization is dynamic process. Prototypes are continually constructed, re-examined, and reinforced with new inter-group comparisons. As normative behaviors change over time, social identity will also change based on social context. This identity change is in part influenced by the salient out-group, to which in-group prototypic behaviors are compared (Hogg & Terry, 2001). As the out-group changes their social identities, individuals will assess and modify their self-categorization for form a new, self-favoring identity.

The second component of social identity theory is self-enhancement. Self-enhancement is the basic principle that individuals want to attain favorable comparisons relative to the out-group. The sense that one group and their characteristics are more favorable than another group is constructed through continual comparisons between in and out-groups. Individuals within these groups then modify normative behavior to create or maintain a more favorable identity (Hogg, 1996). This positive distinction is necessary to maintain group identity. Additionally, this leads to ingroup bias, where members believe that their group is superior to competing outgroups, which enhances individual self-esteem (Brown, 2000).

Normative and informative behaviors are dual-processes that are seen as competing explanations for socially influenced behavior. Normative influence is conformity to in-group expectations (set by the self and others), while informational influence is derived from information and judgment on the relevance of that information (Turner, 1991). Long-term attitude change is attained through informational influence; however, it is empirically difficult to demonstrate a pure informational influence on behavior given that everyone holds pre-established values and norms (Turner, 1991).

<u>Social Identity Theory in Application.</u> Social identity theory has been examined extensively over the last 25 years, particularly in situations of regional or ethnic conflict (Brown, 2000), organizations and management (Hogg & Terry, 2001), and political science, to a lesser degree (Huddy, 2001).

Social identity theory has not readily been applied to conservation behavior. This is not surprising given that most research on conservation behavior has followed the adoption-diffusion paradigm and has taken place in rather homogenous, farming populations. However, social identity theory may be a particularly useful tool in deciphering how intermingled landowners shape their property management behaviors in relation to adjacent landowners. Despite theoretical relationships between social identity construction and intergroup communication, there has been surprisingly little research in this area.

Self-Efficacy and Outcome Expectancy

Self-efficacy. Self-efficacy theory links concepts from social-psychology and cognitive psychology to describe an individual's perception of his or her ability to execute a certain behavior (Bandura, 1977). This is not a general personality trait or attitude; rather, levels of self-efficacy change according to the specific situation (Maddux, 1995). There are three dimensions of self-efficacy: magnitude, strength, and generality. Magnitude represents the level of difficulty one perceives overcoming. For example, a smoker may think that she can resist when no one else is smoking, but unable to resist smoking when surrounded by the behavior. Self-efficacy strength is the amount of confidence held in one's ability to conduct the behavior. Generality represents how transferable efficacy expectancy is from a specific behavior, such as smoking, to another behavior requiring discipline, like regular exercise. An individual with greater self-efficacy sets greater goals (Pelletier et al., 2006). Similarly, if one believes that their behaviors are not likely to produce a certain outcome, they are less likely to adopt the behavior (Bandura, 1977; Pelletier et al., 2006).

Self efficacy is determined by three factors: personal experience with this behavior, "vicarious" or observed experiences, imagined experiences, and persuasion (Bandura, 1977; Bandura, 1995). Personal experience is the strongest determinant of self-efficacy, where mastery of a certain task is directly related to a sense of efficacy. Observed experiences influence self-efficacy if the individual perceives strong similarity between the self and the observed prototype behavior. For example, a person who wants to quit smoking would draw upon the efficacy of proximate smokers, rather than those who never smoked, in assessing her ability to quit. Self-efficacy is also determined by imagined experiences in which the behavior is cognitively acted-out and a level of efficacy is imagined. Lastly, persuasion from outside sources influences self-efficacy. The degree of influence from outside sources on self-efficacy depends on the sources' trustworthiness, expertness, and attractiveness (Bandura, 1995). Efficacy is positively related to goal-setting behaviors, how long a behavior continues, and how a behavior may persist in the face of challenge (Bandura, 1995). Stronger self-efficacy results in greater effort. Similarly, perceived self-efficacy increases with individuals' knowledge that certain standards are attainable, thus making self-efficacy a strong factor of motivation (Bandura & Cervone, 1986).

The theory of self-efficacy recognizes social influences on behavior, particularly social norms and socioeconomic status (House, 2002). Extensive psychological research has revealed a strong, positive relationship between self-efficacy and health behaviors (Marshall & Biddle, 2001). There are theoretical overlaps between health behavior and environmental behavior (Nisbet & Gick, 2008), particularly as they relate to reducing risk. Theoretically, risk and self-efficacy are negatively related; however, Tucker and Napier (2001) found that self-efficacy and perceived risk of agricultural chemical use were positively related, suggesting that other factors such as profit motive could override self-efficacy perceptions as determinants of behavior.

Outcome expectancy. Self-efficacy is a perception of one's ability to perform a certain behavioral change, where outcome expectancy is the perception that a behavior will produce a certain outcome (Bandura 1977). Outcome expectancy is positively related to self-efficacy and behavioral change, meaning that as one has more positive and stronger notions of behavioral outcomes, she is more likely to undertake the associated behavior (Bandura & Locke, 2003). There are two sub-types of outcome expectancy: means-ends beliefs and personal outcome expectancy, or self-efficacy. A means-ends belief is the notion that a successful behavior will produce a specific outcome. For example, the perception that published authors are famous is a means-ends belief. In contrast, self-efficacy is the belief that one's own behavior will produce a certain outcome, such as one's expectation that she will be famous when her book is published. Means-ends beliefs are poor predictors of behavior, yet are conceptually relevant to the decision making process (Bandura & Locke, 2003). Outcome beliefs are developed through a combination of means-ends beliefs and self-efficacy (Kirsch, 1995). In turn, these outcome expectancies influence the decision to undergo a particular behavior. Outcome value is an important factor of the efficacy-outcome expectancy relationship. Bandura (1995) refers to this as the "expectancy-value" relationship, where individuals take on behaviors that could result in valued outcomes (Figure 3.2).

Efficacy and outcome expectancy in application. Recent research has examined the relationship between self-efficacy and water resources conservation. In a post-hoc analysis of regional attitudes towards water consumption behaviors, Trumbo et al. (1999) demonstrated that respondents in two independent, Nevada surveys exhibited stronger self-efficacy for water conservation in drought than in wet seasons. Trumbo and O'Keefe (2001) found that self- efficacy was a positive

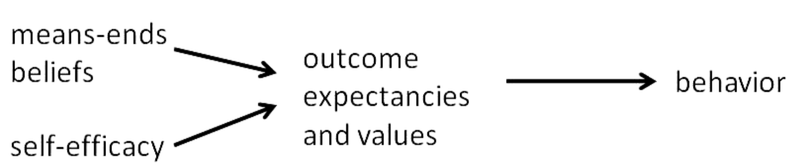

Figure 3.2. Outcome expectancies and values as determinants of behavior (Kirsch, 1995).

predictor of water use conservation in a study of three arid watersheds. However, the authors used a single, double-barreled attitude statement to measure self-efficacy, which calls into question the validity of this finding. Lam (2006), in an analysis of willingness to adopt a water quantity conservation innovation, found that self-efficacy variables did not influence adoption willingness. Outcome expectancy has received little attention in the conservation research arena. Syme et al. (1991) hypothesized that residents' outcome expectancies motivated participation in water allocation planning processes, yet their results showed that intention to participate was best predicted by attitudes towards the planning process rather than the outcomes of that process.

Theory overlaps. There are many potential synergies among adoption-diffusion theory, social identity theory, and efficacy. Self-efficacy readily fits within the adoption-diffusion framework's primary focus on the individual. Self-efficacy and adoption theory have been applied together in the past, mostly in the fields of information technology and computing (Venkatesh et al., 2000) or health behavior (Rhodes et al., 1999), under the theoretical framework of the theory of planned behavior (Ajzen, 1991). The theory of planned behavior is similar to adoption-diffusion theory in that it focuses on the individual and includes attitudes and social norms to explain behavior. However, the theory of planned behavior uses perceived behavioral control, or the perception that resources and opportunities available to support certain behaviors, where as self-efficacy is a more personal evaluation of ability.

In a heterogeneous landscape, where landowners face different regulations, incentive structures, and social identities, self-efficacy is more useful than perceived behavioral control. Self-efficacy focuses on the individual and that person or household's perceived ability to make a difference. While ability may be based on factors such as income, occupation, and knowledge, self-efficacy is associated with a particular outcome, where as perceived behavioral control is limited to the broader factors that influence nearly all individuals in the system. Self-efficacy allows us to observe how the individual translates behavioral control factors into outcomes, and whether or not the individual believes those outcomes are attainable.

Outcome expectancy could be useful in considering the adoption of innovations, as landowners are likely to draw upon past experiences, observations, and imagined results in their decision to adopt riparian buffers. Landowners' social identities in relation to property use are likely formed by ingroup - outgroup comparisons with neighbors and landowners across the landscape. Next, I explore how institutions shape landowner behavior, keeping in mind the theoretical constructs described above.

Institutions and Watershed Management

The social-structural approach to institutional analysis view institutions as constructs that embody normative, cognitive, and regulatory guidelines for social behavior ((Scott, 1995), as read in Vatn (2006)). At the opposite end of this ideological continuum is the individual-rational approach, which defines institutions as structures that create forums for individual decisions and actions (Vatn, 2006). This thesis takes a middle ground approach to analyzing organizations. Institutions, with the organizations and agents that operate within these arrangements, fundamentally influence individual behaviors and motivations through internalized sets of constraints and opportunities (Vatn, 2005). Institutions carry broad social guidelines such as conventions and norms. Conventions take many forms, yet are similar in that they prescribe actions in certain situations, where as norms are required actions based upon underlying values. These contrast regulations, or formally sanctioned rules (Vatn, 2006). However, individuals retain agency to make decisions within institutional arrangements.

Organizations are positioned within and influenced by overarching institutions. Institutions shape organizational structure (e.g., complexity), mission, and practice (Scott, 1995). This is certainly true in the present era of watershed management as the predominant model of water quality governance in the United States (National Research Council, 1999). Since the 1980's, the U.S. EPA has committed to collaborative, place-based watershed management for water quality outcomes (Sabatier et al., 2005).

Policy-based institutions implement programs and regulations to encourage, incentivize, or generally guide individual behaviors. Top-down policy approaches implement a program at administrative or agency levels with intentions of widespread behavioral change within a target population (Matland, 1995). In contrast, bottom-up policy approaches are based upon sociopolitical processes that give rise to collective movements for policy change (Lubell and Fulton, 2008). Regulatory approaches resemble a top-down approach to watershed management. Only recently has adoption been considered in relation to impending environmental regulation. Kara et al. (2008) found that corn grower adoption of grass buffer strips was significantly higher in states with more stringent regulations against agricultural pollution. As examined in adoption-diffusion research, institutions can incentivize behaviors, thus encouraging behavioral change from the bottom-up. While institutions play an important regulatory role in water quality management, I will focus upon local, non-regulatory institutional influences for this research.

Institutions, their actors, supporters, and ideals, transmit information. Typically, United States agricultural conservation policy follows the top-down model, where an incentive program is created by the USDA through Congressional appropriations, local institutions are informed about this program, and then the local policy agents educate eligible farmers about the program in hopes of enrollment (Napier, 2000). These local policy actors work directly with farmers to design, implement, and provide technical assistance for agricultural BMPs. As previously noted in review of the adoption-diffusion model, this approach has led to mixed results in terms of program adoption (Napier & Bridges, 2002) and water quality outcomes (Nowak et al., 2006), suggesting that changes or new approaches to the adoption-diffusion model are appropriate.

In turn, Lubell and Fulton (2008) considered local policy networks, meaning the local farming organizations, and their role in farmer adoption of water quality BMPs on California orchards. A local policy network was constructed by the researchers based upon farmers' trust and frequency of interaction with local agricultural agencies. The study used a probit analysis to find that farmers' exposure to the policy network was positively related to the probability of water quality BMP adoption. This suggests that local institutional actors can strengthen their policy networks and therefore enhance BMP adoption. Policy network-farmer interaction showed the greatest positive influence on the adoption of conventional BMPs, and less so for water quality BMPs.

Institutions also indirectly influence conservation behaviors on private property through collaborative policy arrangements. As seen in watershed management in the Chesapeake Bay, institutions often build collaborations to address water quality (Margerum, 2005). These collaborations may be action-based, meaning that they evoke change through direct action (i.e., streambank fencing); organizational, meaning that they manage environmental outcomes through programs and budget allocations; or policy-collaborative, like the Chesapeake Bay Program, which sets broad policies for environmental change. While an action-collaborative organization may have direct interaction with private landowners, policy-collaborative institutions guide the larger sociopolitical structures in which these interactions take place.

Organizations can also build capacity for future change. Stedman et al. (2009) found that community-based watershed organizations in Pennsylvania held potential for building local leadership and connections among other communities and watershed organizations, thus fostering capacity to address water quality issues within and around home watersheds. Ivey et al. (2006) argue that institutional arrangements influence surface water protection efforts by shaping local-level capacity based upon the level of engagement among conservation organizations with similar organizations, while concurrently collaborating with upper-level institutions (i.e., local and state or federal partnerships). Local action organizations are reliant upon external support, typically from programmatic or policy-focused institutions, to implement on-the-ground watershed strategies and initiatives, yet also support institutional purposes through on-the-ground implementation of programs and strategies (Michaels, 2001).

Much of the watershed governance literature focuses on how organizations collaborate for water quality using various organizational typologies (Clark et al., 2005; Margerum, 2005). The prevailing model of watershed management is multi-level, multi-stakeholder collaborations that involve input from diverse sets of governmental, organizational, and local stakeholders (Sabatier et al., 2005). In response to federal and state policies that support the watershed management and collaboration, the number and enthusiasm for watershed organizations has dramatically increased across the U.S. (Bonnell & Koontz, 2007; Genskow, 2009). These organizations are popular in that they may address multiple environmental problems (Stedman et al., 2009), use collaborative processes that emphasize citizen control (Koehler & Koontz, 2008; Sabatier et al., 2005), and build from pre-existing social structures to further water quality goals (Morton, 2008).

There are many studies that examine watershed stakeholders as collaborators in watershed management. Trust (Focht & Trachtenberg, 2005) and social learning (Armitage et al., 2008) among watershed officials and stakeholders are key elements in building successful collaborations. Yet few, if any, of these studies discuss the role of private landowners and their management behaviors in terms of stakeholders. Private landowner and watershed partnerships have been examined largely in the context of conservation practice adoption and the factors that motivate pro-environmental behaviors (Rosenberg & Margerum, 2008). Only recently has citizen participation in watershed modeling efforts been researched, finding that these models are improved with local input but that participants do not understand model capacity and limitations (Johnson, 2009).

Conceptual Relationships

The Spring Creek watershed is a transitioning, heterogeneous landscape made up of diverse types of landowners. Based upon the theories and literature presented above, I hypothesized relationships and drivers of landowner behavior. Figure 3.3 is a conceptual diagram of the conceptual relationships presented in this chapter, and how these relate to riparian buffer adoption.

Landscape change creates diverse sets of social identities through more heterogeneous land uses. Institutions and the organizations that they are affiliated with, may or may not respond to this land use change. Institutions shape notions of efficacy, including self-efficacy towards conservation behaviors and the expected outcomes of these behaviors. Landowners' social identity and efficacy perceptions then influence their adoption decision. This decision may also be incentivized or promoted by institutions. The adoption-diffusion of innovations is also shaped by attitudes, innovation characteristics, and sociodemographic characteristics of potential adopters. In turn, these characteristics, institutional, land use, and social contexts shape landowners' willingness to adopt riparian buffers.

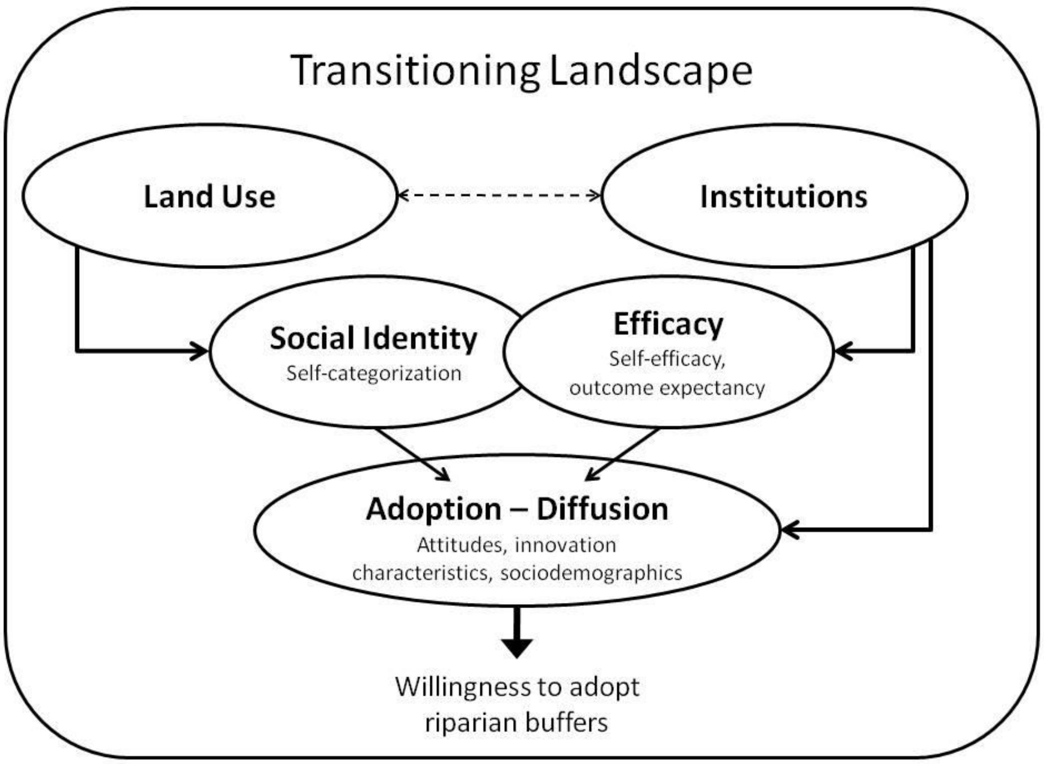

Figure 3.3. Conceptual relationships influencing landowner willingness to adopt riparian buffers.

Research Questions and Hypotheses

Questions: What factors drive non-agricultural landowner willingness to adopt riparian buffers? How do these factors differ from agricultural adoption behaviors?

Thesis: Landowners on a transitioning landscape exhibit diverse sets of opportunities and constraints for riparian buffer adoption. Land use heterogeneity structures social identity and policy opportunities that support or constrain adoption. Landowners' attitudes towards adoption are also influenced by efficacy perceptions, which include outcome expectancies at various spatial scales.

This thesis can be evaluated by testing the following hypotheses:

H0: Farmer and non-farmer riparian buffer adoption behaviors do not differ.

1. Landowner willingness to adopt riparian buffers will be greater when:

H1: Landowners exhibit pro-adoption characteristics:

- Landowners are more educated, younger, are traditional farmers, hold positive innovation attitudes, positive environmental attitudes, and do not emphasize private property attitudes; and

H2: Landowners are more aware of riparian buffers and knowledgeable about water quality.

- Local policy networks influence landowner awareness of riparian buffers.
- Awareness increases when landowners have heard more about riparian buffers and associated water quality improvements.

- Knowledge about water quality is influential at three scales: their stream, Spring Creek, and the Chesapeake Bay.

H3: Social identity and corresponding behaviors are pro-farming, pro-environmental, or stream recreation.

- Social identity in these groups fosters adoption willingness through greater access to policy programs, greater knowledge about water resources conservation, and greater concern for streams.

H4: Landowners hold more positive efficacy beliefs.

- Self-efficacy beliefs are based upon how a buffer "fits" on a property. Fit is derived from parcel-level characteristics (parcel size, stream length, and stream flow) as well as property management norms (e.g., aesthetics) and social desirability.
- Outcome expectancies relate to potential improvements from buffer adoption on landowners' properties.

2. Landowners become more willing to adopt riparian buffers when:

- They exhibit pro-adoption characteristics, particularly pro-environmental attitudes;
- They hold strong outcome expectancies for buffers on their properties;
- They have heard or read more about riparian buffers; and
- Their property characteristics "fit" in terms of size and surrounding land use with riparian buffer conservation.

Chapter Summary

In this chapter I presented a theoretical framework and literature that addresses the thesis statement. This framework includes adoption-diffusion theory, which has commonly assessed adoption of conservation practices on farms in homogeneous landscapes. This may not be particularly applicable in a transitioning, heterogeneous landscape. Therefore, I introduced social identity theory and efficacy as supporting theoretical approaches in this research. I examined the role of local policy organizations, which represent overarching institutions, on this theoretical model. I presented my thesis statement and proposed research questions and hypotheses to be examined in the following chapters.

CHAPTER FOUR

METHODS

Chapter Introduction

To answer the research questions outlined in Chapter Three, I conducted a two-phase study involving qualitative and quantitative research. This chapter presents the methods for these phases, and is organized by four sections that correspond to each stage of research: the qualitative approach, quantitative approach, additional analyses, and data integration. The qualitative phase consisted of semi-structured interviews of riparian landowners (n=16) and local institutional actors (n=4). The quantitative phase was a mail-back survey sent to a sample of riparian landowners in the study watershed (n=175). This phase also involved a non-respondent telephone survey. Though some research questions can be addressed by only one method, a more thorough understanding required data integration, involving triangulation of qualitative and quantitative data. This research project follows a sequential mixed-method design (Tashakkori & Teddlie, 1998).

Qualitative Research

In this section, I describe the general rationale for the qualitative research and the purpose for interviews as a specific form of qualitative data. I describe the content of the interviews and outline the sampling process. I describe the data collection and analysis processes. I conclude with discussion on the data's reliability and validity.

<u>Rationale and purpose for interviews.</u> The purpose of the qualitative phase was to identify possible factors driving non-agricultural riparian buffer adoption. The

qualitative phase consisted of in-depth, semi-structured interviews with riparian landowners of private, residential or agricultural properties and with institutional actors representing public and private organizations involved in riparian conservation. I conducted interviews to gain a breadth of perspectives, opportunities, and constraints surrounding riparian BMPs and buffers within the study watershed. From this breadth I gained familiarity with the individuals and communities that make up the study population, as well as the watershed itself. I also conducted interviews to develop my research questions, and to populate the mail survey (described below). Such information grounded mail survey items with actual scenarios and response options that existed in the study region.

Qualitative research affords in-depth understanding of complex social situations and emerging areas of research (Patton, 2001). Qualitative investigation is inherently exploratory (Kirk & Miller, 1986). As discussed in Chapter 3, adoption-diffusion theory has not been applied to non-agricultural landowners, so preliminary qualitative exploration was necessary. Secondly, qualitative data illuminates processes and mechanisms that may not be detected using quantitative methods (Kvale & Brinkmann, 2009). Therefore, the qualitative phase complemented and informed the quantitative portions of my research.

<u>Interview Content</u>. Interview topics were based upon themes and research areas outlined in Chapters Two and Three, and included those identified in preliminary interviews and by previous research. To allow for previously unidentified themes to emerge, interviews were intentionally flexible to the interviewees' particular interests in riparian uses (See Appendix for interview guides). The qualitative phase received Cornell University Institutional Review Board (IRB) for Human Participants approval on October 29, 2008.

All interviews were conducted with an interview guide. Interview questions were tailored specific to participant types without forsaking the ability to compare across groups. Guides were constructed in accordance with McCracken (1988) and used a "funnel sequence" that began with broader questions and progressed to more topical questions (Tashakkori and Teddilie 1998). The questionnaire was organized with broad questions, followed by probing questions to cover sub-topics.

Interviews were organized into four participant categories—key informant, agricultural landowner, non-agricultural landowner, and institutional. Interview categories were created so that questions could be more relevant to landowners of varying land uses. Key informant interviews guided initial participant sampling, and gave a background to riparian conservation efforts in the region. Agricultural landowner interviews were designed to gather general information about land uses, management practices, and BMP knowledge or familiarity (see Appendix A for interview guide). Property management goals were asked, as well as thoughts on BMP outcomes and obstacles. The landowners who adopted BMPs were also asked questions concerning maintenance practices, expectations, and perceived BMP performance.

Non-agricultural landowner interviews were conducted following the conclusion of the agricultural landowner interviews. Non-agricultural interview guides were sequenced using the same basic design and concepts as farmer interviews, but with broad questions tailored to capture non-agricultural riparian land uses. For example, with non-agricultural interviews, questions concerning farm structure and retirement plans were replaced with questions regarding length of ownership and goals for riparian areas. Questions concerning the benefits and constraints of riparian BMP or buffer adoption remained the same. Because many non-agricultural landowners did not have BMPs already installed on their property, maintenance questions were not emphasized (see Appendix B for interview guide).

Interview guides for key institutional actors asked similar, general questions to allow for comparison across institutions, yet included probing questions specific to the interviewees' perspectives on riparian BMPs and buffers. The interview guide was organized to discuss the institution's mission, current project opportunities, and perceptions of BMP or buffer programs and natural resource quality (P.H. Gobster & L.M. Westphal, 2004) (see Appendix C for interview guide).

Sample Selection. Interview participants were purposefully sampled to include landowners with experiences and insights on riparian conservation (Patton, 2001). This strategy allowed for in-depth understanding of landowners grouped according to defining characteristics as identified in the adoption-diffusion literature: land size, land uses, and prior implementation of a riparian buffer. These characteristics were selection parameters based upon their potential to shape land management behaviors. Land size delineates if agriculture is possible on the property, while land use reflects biophysical characteristics of the property that may constrain some activities or promote others (e.g., cropping, forestry, open space) or promote others. Prior implementation of a riparian buffer or BMP was an important sampling characteristic in that landowner perspectives may change over the lifetime of a riparian project. The sample was selected for maximum heterogeneity across these landowner characteristics. Maximum heterogeneity sampling aims to identify diversity characteristics across a sample and describe the commonalities or uniqueness within the sample (Patton, 2001). I also attempted to select participants from different sub-watersheds and townships to reflect place-based differences. Interviews ceased when I attained a reasonable saturation of responses to interview questions (Patton, 2001).

In total, 22 interviews were conducted, two of which were used only for background information.

Procedure. I took a constructivist approach to qualitative data collection and interpretation, meaning that I built understanding of participants' experiences while taking into account the lenses through which they perceive the experience (Rubin & Rubin, 2005).

With the exception of key informant interviews, all potential participants were contacted via telephone to schedule in-person interviews at least one week prior to the scheduled interview time. All landowner interviews were conducted at the participants' homes and audio-recorded for transcription. Institutional representatives interviewed in-person with audio-recording.

Key-informant interviews. Key informants consisted of two staff members from the local watershed organization. These interviews gave insights to the adoption history of the region and individual landowners of the watershed. These interviews also provided background information on the type (including diary, crops, beef, horses, mixed-uses) and intensity (traditional, hobby, or some mix) of agriculture conducted in the region. Key informants directed me towards potential agricultural landowner participants based on their willingness to participate in prior conservation efforts. I identified additional farmer participants based on their type and size of agriculture.

Agricultural landowners. From this preliminary information, I selected potential participants for 30-60 minute semi-structured interviews. I recognized that sample selection was biased towards adopting landowners because they (1) exhibit stronger and more lasting relationships with conservation organizations, and (2) are generally more willing to participate in research on projects that took place than are those who refused participation. However, two non-adopting landowners agreed to participate, and were included in the agricultural interview sample. All participants were selected based on agriculture types, intensities, and parcel sizes, and length of residence. These interviews took place in November and December, 2008.

Non-Agricultural Landowners. The third interview stage of the qualitative phase involved semi-structured interviews of non-agricultural riparian landowners. As explained in Chapter Three, most of the adoption-diffusion research has focused upon farmers. Non-agricultural landowners were purposely interviewed after agricultural landowners to best compare the two groups along their reasons for adopting or not adopting riparian buffers. This timing reflects cumulative learning of agricultural adoption factors and their application to those insights on non-agricultural landowners.

Participants were once again recruited through local key informants, particularly Penn State University personnel, who were familiar with riparian residents in the watershed. I selected and interviewed non-agricultural riparian landowners based upon variety in parcel sizes and uses (e.g. small residential lots, retired farmland, forested parcels). To gain the greatest variety of perspectives, I also selected participants based on neighborhood population densities and land uses as I observed them in-person, on the landscape. Non-agricultural interviews were conducted between December 2008 and February 2009.

Institutional Actors. A fourth category of qualitative investigation consisted of four institutional actor interviews. These included representatives of a non-profit organization or local government agency that funded, implemented, or initiated riparian buffer projects. The literature review (Chapter Three) indicated that institutional actors and the organizations they represent are influential in agricultural landowner adoption behavior, and were therefore an important component of the adoption context. Non-agricultural adoption behavior had not previously been studied, so the relationship between non-agricultural landowner behavior and policy influences is not yet understood. Institutional actor participants were selected based on key informant interviews and landowner references that emerged during interviews. Institutional interviews were conducted between October 2008 and February 2009.

Data Analysis. Interview data were analyzed for general, descriptive themes. All audio-recorded interviews were transcribed using Express Scribe © software. Transcriptions were read for clarity and content twice in hardcopy, where general themes were summarized at the end of each interview. Transcriptions and interview field notes were then loaded into Atlas.ti, where they were coded. The coding scheme included codes developed deductively, based on the semi-structured interview guide topics, and inductively as new concepts and categories emerged during data review (Kvale & Brinkmann, 2009; Patton, 2001). These codes were then organized under broad categories. For example, the "outcomes" category included codes that indicated the type and location of riparian buffer outcomes such as perceived water quality improvement. The text units coded were phrases or sentences. Themes, or the relationships between general categories, were then identified. These themes were guided in part by theory and in partly by grounded concepts that originated in the interview data.

In an effort to validate the coding scheme and its interpretation, each transcript was reviewed at least three times. Field notes and transcription notes were also reviewed during data analysis. Patterns and themes that emerged from the coded transcripts were recorded throughout the coding process (Patton, 2002). Landowner typologies were then constructed based upon purposeful sampling parameters (e.g., land use, land size, prior riparian buffer adoption). I then used a constant comparative method (Silverman, 2000), which tests emerging hypotheses across cases or typologies. This method also integrated data across interview categories (i.e., agricultural, non-agricultural, institutional). The Atlas.ti software facilitated guided, deliberate comparison between transcripts. After comparing a provisional relationship across landowner typologies, illustrative examples of this relationship were selected from the interview data for presentation. These themes and examples were then summarized and organized for meaningful data presentation.

Quality Control in Qualitative Research: Ensuring Validity and Reliability. Reliability and validity are two components of objectivity, or the understanding of empirical reality (Kirk and Miller, 1986). Validity is the extent to which an observation identifies a fact, and if the result is properly labeled (Kirk and Miller, 1986; Kvale and Brinkmann, 2009). A measurement may have face validity, meaning that it appears to measure what is intended, but must also have instrumental and construct validity for it to actually be valid (Kirk and Miller, 1986). Instrumental validity involves similar observations across data collection methods, while construct validity is the appropriateness of applying a theory to decipher and label observations.

Validity was tested in three stages of the qualitative phase: instrument development, the interview, and data analysis. At the instrument development stage, the interview guide was examined for double-barreled or leading questions, a measure of face validity. Such questions would decrease validity, as respondents may be guided towards a particular response. During the interview I attempted to maintain question phrasing as it was written in the guides for face validity. At the data analysis stage, I kept construct validity in mind as I analyzed transcripts for emerging themes. Validity was also strengthened by use of field notes during data analysis, as they provide reference points for nuance and context observed during the interview that may not be captured in transcription.

Reliability is the consistency of observations (Kirk and Miller, 1986). It represents consistent measurement of phenomena across a sample or researcher consistency in interpretation. In particular, two forms of reliability were relevant to this research: diachronic, which observes reliability over time, and synchronic, which is internal consistency over the course of an interview (Kirk and Miller 1986). I thought of diachronic reliability as a methodical triangulation, where I compared participants' responses against other participants' statements during the course of the interview. Additionally, I took notes during the interview and recorded my post-interview impressions. These added reliability to my data analysis, as they consistently reflected fresh observations.

Synchronic reliability gauges whether consistent answers are conveyed over the course of an interview. If an interviewee gave different responses to similar questions, I asked clarification questions to determine the point of confusion. At the data analysis phase, I was highly conscious of reliability in terms of consistent interpretation of the coding scheme. I reviewed each transcript at least three times to ensure that 1) the coding scheme addressed my research questions and 2) the codes accurately represented participant statements. Here, reliability was coupled with validity, as extra time was spent on interpreting complex statements for consistent interpretation. As an additional check on reliability, I referred to field notes (Kirk and Miller 1986). This tied together my observations with my theory-based interpretations.

I hold reasonable confidence in the validity and reliability of my qualitative data and analysis. I learned much over the course of this qualitative phase, particularly regarding my own interview style and how to meaningfully interpret interview data. I believe that my interview skills improved over the research project, and that the qualitative data benefited from my awareness to asking valid and reliable questions.

Quantitative Phase

In this section, I present the rationale and purpose of the quantitative phase of my research. I outline and discuss the mail survey instrument design and content, sample selection, and implementation processes. I then discuss quality control in quantitative research. Following this, I calculate the mail survey response rate, and then discus the purpose and procedure involving the non-respondent telephone survey analysis.

<u>Mail Survey: Rationale and Purpose.</u> The quantitative phase of this thesis research consisted of a mail survey of riparian landowners in the Spring Creek watershed. I employed survey methodology in order to draw inferences across the study population using standard measures. Surveys are used to evaluate a population's a) demographic characteristics, attitudes, beliefs, and behaviors, b) their change over time, c) differences within the population, and d) causes of social behaviors (Fowler, 2002). A mail survey best addresses the primary research question: what factors drive private landowner adoption of riparian best management practices? This is a broad question that spans many types of landowners who I may not have time or access to interview. The mail survey let me reach landowners who may not have the availability, willingness, or approachability to participate in an interview. Mail surveys, as opposed to telephone or internet surveys, can reach a greater proportion of the survey population, as the mail survey does not rely upon the respondent to own or access those services (Dillman, 2002).

Considering the breadth of potential adoption factors, and the social heterogeneity of the study area, a mail survey was the most appropriate quantitative data collection tool. The survey enabled standardized measurement of attitudes, beliefs, and behaviors across many groups of people (e.g., socioeconomic status, land use, land size). Such standardized measurement led to statistical descriptions of the survey population, and from these descriptions, relative strengths of patterns and relationships could be determined (Fowler, 2002).

Questionnaire Design and Content. An introductory paragraph on the survey's inside cover and text of the survey mailings directed "the person in your household who most frequently makes decisions about your property" to complete the survey. The instruction paragraph was intended to be general as to entice landowners of all types and property sizes. This instruction was also gender-neutral, as to not assume that only men were knowledgeable enough to complete the questionnaire. The survey response was predominantly male (80%); however gender differences on key variables were not observed.

Survey content was organized into five sections: an introductory passage that reflected the study aims and provided instructions for survey completion; a section that collected information on current land use, management practices, knowledge and concern about water quality in the Spring Creek watershed; baseline knowledge of stream buffers; attitudes about stream buffers; and background information. This design moved from general, factual questions (e.g. length of residence, current management behaviors) to more topical ones (e.g., attitudes towards riparian buffers). This question ordering was intended to draw participants into completing the survey (Dillman, 2000). As the qualitative interview processes illuminated, water quality and riparian buffers are not salient topics for many landowners. Survey topic salience is a major predictor of response rates (Heberlein and Baumgartner,1978); therefore, I paid special attention not to focus on riparian buffers too abruptly in the survey sequencing. Questions directly related to riparian buffers may be sensitive to some landowners who oppose proposed local riparian policies (see Chapter Two); therefore, they were placed towards the end of the survey and completed after respondents are interested, or at least invested, in the survey (Fowler, 2002). Survey questions were closed-ended, with the only exception being "other" options of check all that apply questions. Closed-ended questions are the best format for collecting quantitative data, as they require minimal interpretation and re-coding upon return (Fowler, 2002) (See Appendix G for questionnaire). The survey instrument of the quantitative phase was approved by the Cornell University IRB on April 9, 2009.

Survey Sample Selection.

Survey Population (N). The sample population was determined based on the following criteria: (1) ownership of property adjacent to a stream, and (2) this property was in non-commercial, non-industrial, non-tax exempt uses. Properties that failed to meet both criteria were excluded from the study because these parcels have different, and often more formal decision-making structures and processes that are unable to measure in the survey, and fall outside the scope of this study.

Landowner eligibility was determined by combining county tax maps with 1:24,000 high resolution USGS National Hydrologic Database surface water hydrology maps (US Geologic Survey, 2010). Parcel information was obtained from the Centre County Planning Commission through the CEAP research team. These data were collected in 2007 and included geo-referenced, digitized property boundary information, with parcels categorized under county land use classifications. USGS hydrologic data was combined with the parcel layer in a Geographic Information System (GIS) by research team colleagues at Penn State. Overtop the hydro-landowner layers, a buffer analysis was used to create a 10 foot width around all surface water streams. Parcels and the corresponding landowners within this buffer were considered riparian landowners, and are shown in Figure 4.1. This ensured a comprehensive sample, or that the population intended to be surveyed (private riparian landowners) had the opportunity to receive a survey (Fowler 2002).

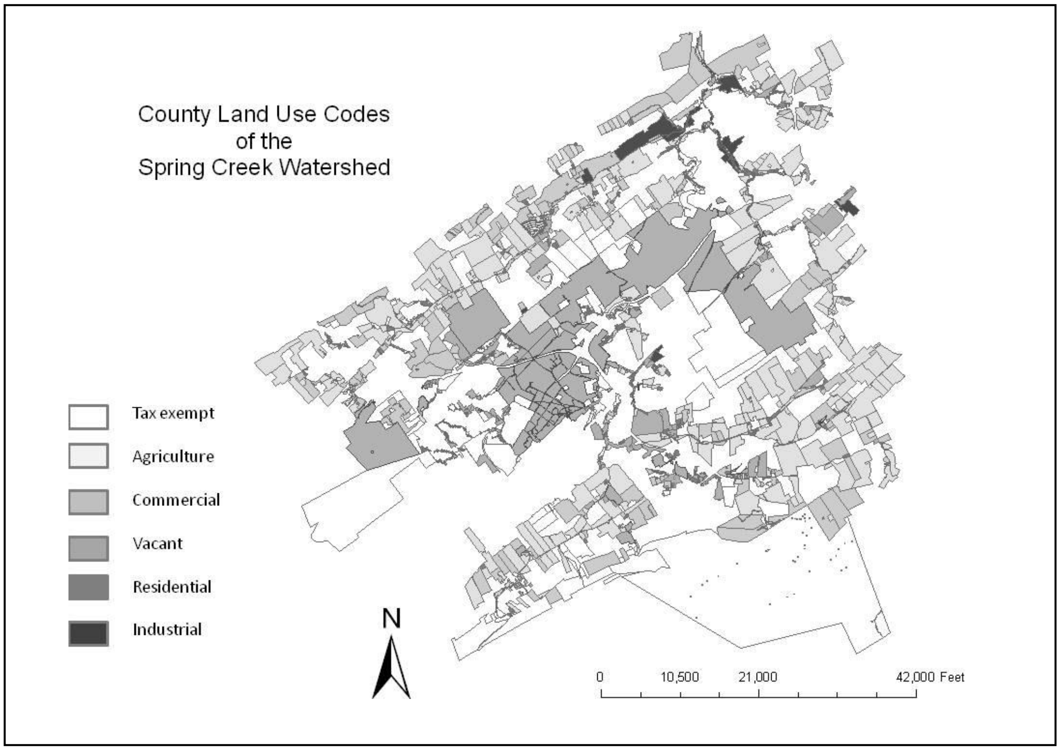

Figure 4.1. Riparian parcels classified according to Centre County land use codes.

Next, county land use classification codes were used to eliminate commercial and industrial properties from the sample. Tax-exemption status, which is included in the county land use codes, served as an indicator of institutional property (see Appendix D for code list). Therefore, all parcels with a tax exemption classification were also removed from the survey population. The remaining, eligible land use classification codes were grouped into three categories: agriculture, residential, or vacant (no buildings on the parcel).

The list of remaining eligible parcels was reviewed, and any ineligible parcels that were missed in earlier steps were removed by hand. Parcels titled under a family partnership or trust were included based upon the small number of remaining eligible landowners. The mailing addresses of these partnerships appeared to be the locations of actual landowner addresses, not law offices or distant locations that would have a low probability of reaching the landowner.

To control for an equal probability of selection, landowners of multiple eligible parcels were limited to one parcel (their largest) for the survey population sample selection. If two parcels were listed under the same name, but the mailing addresses were different for these parcels, then both parcels were left in the sample. This is to ensure that at least one of the surveys would be received if included in the sample. For example, if a landowner or married couple owned multiple parcels, but had only one name on one parcel and both names on a second, with the same addresses, then one of the parcels was removed. All landowners who met the survey population criteria were considered for the sample frame.

Sample frame (n). A sample frame is the list of eligible participants from which the sample will be drawn (Dillman, 2000). No magic formula exists to estimate the number of completed responses for a given sample frame size (n). In determining the sample size from the sample frame, it is desirable to minimize the sampling error, or the variation between a sample's true value and the population's true value (Fowler, 2002). The final survey frame equaled 706 landowners. I arrived at the sample size (n=500) with the estimation that the survey response rate would equal approximately 35%, or about 175 completed responses. At a minimum, this response rate would provide enough cases to conduct meaningful statistical tests. Therefore, the sampling probability was .71.

The rather high sampling probability begs the question, why not survey everyone? A number of cautions exist against surveying an entire population, or conducting a census (Fowler, 2002). First and foremost, a census would not allow statistical inferences to be made from survey responses. Other, secondary concerns were increased neighborhood awareness of the survey, therefore making it easier *not* to complete the survey if someone felt like they aren't part of a unique, contributing group. Additionally, I wanted to avoid public attention to the study, as a proposed riparian buffer ordinance had received media attention in the preceding months (see Chapter Two). However, the tradeoff between greater risk of public attention and a lower sampling error—the standard deviation of the sample estimates around a mean (Fowler, 2002)—was one I was willing to make in favor of reduced sampling error.

The sample frame was analyzed for parcel size distribution and comparative means of parcel sizes across sub-watersheds. The mean parcel size was 24.86 acres, with a standard deviation of 53.244, indicating a wide range of parcel sizes with a skewed distribution (see Appendix E for histogram). Parcel size was provided by the Center County parcel data in two forms, "CAMA_ACRES," the parcel area that appears on the property deed, and "MAP_ACRES," the parcel area calculated by the County's GIS. I used the "CAMA_ACRES" field throughout this study because it probably more similar to the acreage that landowners believe they own.

Once the sample frame size was determined, I explored the differences between simple randomized sampling and stratified sampling. Stratified samples have greater accuracy than simple random sampling when comparing groups that may vary (Weisberg, 1996). However, I also needed to account for potentially differing response rates among groups. Based upon the hypotheses that small parcel landowners would have lower salience regarding streams (i.e., be less aware of riparian conservation, or perceive that they don't influence riparian areas), I suspected that a smaller proportion of small parcel landowners than large parcel landowners would complete the mail survey. Within this consideration was the relationship between land size and land use: agricultural activities, at least conceptually, take place in areas with greater land availability (i.e., not in small acre residential lots).

I then compared the differences between a simple random sample and a stratified sample. To reflect the potential differences in response rates among land sizes, three conceptual groupings of land size ranges were created: less than three acres, three acres to less than 20 acres, and 20 or more acres. Then, I calculated the proportion of respondents desired in each land size group—this was my "target sample frame," if a stratified sample were to be drawn. I then took a simple random sample (SRS) from the survey frame, and analyzed its parcel size distribution (Table 4.1). The target sample frame and the actual sample frame had nearly equal parcel distributions, as measured by the proportion of the total sample. Based on this equal distribution across conceptual groupings, a stratified sample was deemed unnecessary, and a simple random sample was drawn.

Survey sample selection. As shown in Table 4.1, the target parcel size distribution was achieved without sample stratification. A random number generator was used to produce a random ordering of numbers 1-706, one for each survey population landowner. I then paired these random numbers with the final list of eligible landowners sorted in a Microsoft Excel © table alphabetically by last name. The landowner-random number list was then sorted by the random number order. Any landowners with a number less than 500 were included in the sample.

Table 4.1.
Desired and actual survey population distribution by parcel size. Parcel size distribution (measured in proportion, prop.) for the target sample and simple random sample (SRS) were equal, indicating that stratification was unnecessary.

Parcel size (acres)	Survey Pop'n (N=706)	Target sample frame: n, (prop.)	SRS (n=500)	SRS: n, (prop.)
< 1	229	180, (.514)	113	180, (.514)
1 - < 3	134		67	
3 - < 10	100	85, (.243)	50	85, (.243)
10 - < 20	71		35	
20 - < 40	49	85, (.243)	24	85, (.243)
40 +	123		61	

<u>Survey pre-test.</u> Survey reliability and validity were gauged at the pre-testing stage by five private riparian landowners residing outside the study watershed. Questions that were difficult for these landowners to interpret, or those that weren't accurately or consistently answered, were revised in future survey drafts. Members of the Department of Natural Resources Human Dimensions Research Unit (HDRU) also reviewed the survey for content, clarity, and conceptual accuracy. Lastly, Penn State faculty reviewed the survey for "hot button issues" I may not have been aware of. These pre-tests addressed face validity.

<u>Survey mailings.</u> Survey mailings were administered by the HDRU in accordance with the Dillman tailored-design method (Dillman 2000). Four mailings were made on the following days: April 23rd, 2009 (a letter providing background information on the study and one copy of the survey), April 30th, 2009 (a reminder letter); May 14th, 2009 (a reminder letter and second copy of the survey), and May 21st, 2009 (final reminder letter) (see Appendix F for survey correspondence).

Response Rate Calculation. Response rates are important to calculate so that the researcher has an idea of the percentage of the survey population represented within survey responses. There were four possible types of returned surveys: a full return (n=175), undeliverable (n=18), not useable (n=4), and “No Creek” (n=29), a group of responses that indicated streams weren’t present on a property. HDRU staff made determinations on whether or not returned surveys were useable in the study. The survey response rate was 39.0%. Survey response rate was calculated using the following formula:

Response Rate = [# Full Return / (Total n - # “No Creek” - # Undeliverable – # not useable)] * 100

Quality Control: Validity and Reliability of Quantitative Data. Reliability and validity are used very differently in qualitative research than in quantitative research. In qualitative research, validity and reliability are tools to analyze themes and linkages between concepts, where as in quantitative research, they are used to assign precise relationships to a phenomenon (Kvale & Brinkmann, 2009).

Throughout the survey implementation procedure, measures must be taken to ensure reliability and validity of the quantitative data. Survey questions are valid when they measure the phenomena they are intended to measure (Weisberg et al., 1996). Convergent validity is attained where questions on similar concepts derive answers of similar orientations. Another measure of validity is content validity, where there are many questions that measure different aspects of the same concept (Weisberg et al., 1996). For a survey to be reliable, it should contain questions that are consistently answered in the same way whenever they are asked. For example, a reliable survey that contains more than one question pertaining to the same phenomenon, and both of those questions derive the same results from one respondent (Weisberg et al., 1996).

Reliability and validity were also addressed at the questionnaire construction phase. The questionnaire contained multiple questions on the topics of buffer management behaviors, buffer information sources, and innovation, risk, and private property values. Questions that measured attitudes towards buffers were phrased both positively and negatively to ensure convergent validity. I also included many questions regarding certain aspects of riparian buffers and their potential benefits (e.g., habitat and water quality enhancement, surrounding buffer management behaviors).

Non-Respondent Survey

Rationale and Purpose. A non-response analysis determines the generalizability of survey findings to the survey population. Without relative information on behaviors, attitudes, and perceptions of those who did not complete the survey, it is difficult to consider the meaning of the collected survey information. The purpose of a non-respondent analysis is to compare survey respondents and the non-respondents. If there are differences between the two groups, there is systematic non-response error, which reduces generalizability of survey results to only the portion of the survey population that shares the characteristics of the responding group (Dillman, 2002).

In a situation with a high response rate, a non-response analysis may not be necessary. That is not the case with a response rate of 39%. There isn't an agreed upon standard for acceptable minimum response rates; however mail surveys are more likely to be biased towards those who are interested in the research topic (Fowler, 2002; Heberlein & Baumgartner, 1978). Therefore, I conducted a non-response telephone survey between June 30 and August 10, 2009. The non-respondent telephone survey described herein received IRB approval on June 26, 2009.

Procedure. Questions for the non-respondent telephone survey were adapted from the original mail survey. The telephone survey questions represented the essential topics to gauge non-respondent behavior, attitudes, and awareness of riparian buffers—the cornerstones of this study.

Questions were sequenced in the same relative order as in the mail survey, with the exception of the first question, "Do you have a stream on your property?" This question was included here because some survey respondents perceived they did not have a stream (n=29) and it was hypothesized that some sample frame error was present in the non-respondent population as well. Telephone respondents who indicated they did not have a stream were asked two additional questions regarding their concern and attitudes towards water quality.

A script was prepared to read to non-respondents. This script ensured that potential participants had information about the study prior to their decision to participate (see Appendix H for non-respondent script). Questions were written into the script with hopes to provide clarity and direction to the survey.

The non-response survey sample was determined by simple random selection. A random number generator produced a sequence of integers with the highest number equal to that of the number of non-respondents. This sequence was assigned to the sample of non-respondents sorted alphabetically. Phone numbers were obtained using online information databases, such as White Pages (The White Pages, 2009). Landowners were contacted in the order of their random number assignment. Using a variety of days and times, I called 33 landowners until they were either contacted or there were four unsuccessful attempts to reach them. Non-respondents were cold-called until one third of the call attempts ended in completed surveys (n=11). Because not all telephone participants completed each question, a sub-set of questions (6 attitudinal questions, one question regarding presence of water in a stream, and one question concerning how much they've heard about riparian buffers) were compared between mail survey respondents and telephone survey respondents. Mean responses were compared between the mail survey respondents and the telephone non-respondent surveys. Based on the small telephone survey sample size, no statistical tests were conducted.

Chesapeake Bay Foundation Mailing Analysis. On May 13, 2009, I learned through an institutional key informant interview that on or around February 24, 2009, the Chesapeake Bay Foundation (CBF) sent an informative post card mailing to CREP-eligible landowners in the Spring Creek watershed (and other regions in central Pennsylvania). The post card included basic information about CREP and noted that non-farmers could also be eligible for the program. This was potentially worrisome for the research in that it could distort our measurements of landowner awareness and knowledge of riparian buffers considering that outreach to landowners had commenced prior to my survey implementation. However, this provided an opportunity for a natural experiment to measure the impact of this and other outreach messages.

Upon request, CBF provided to the researcher a list of mailing recipients. This mailing list was compared to the survey population list. Of the 500 landowners sampled in my mail survey, 206 also received the CBF informative mailing. Of the 175 survey respondents, 80 received the CBF mailing. A CBF mailer variable was created for the survey data, and recipient landowners were coded "1" and non-recipient landowners were coded "0". The data were then analyzed for differences between landowners who received the CBF mailer and those that did not.

Quantitative Data Analysis. All survey data, the development gradient variable, and the CBF mailer variable were analyzed using the Statistical Package for Social Sciences (SPSS) 17.0. I analyzed the data for normality, and then calculated descriptive statistics. I then tested hypotheses and identified multivariate relationships.

Data Integration

Rationale. Data collected from mixed-methods research design can unveil insights otherwise obscured by use of only one method. Aggregation across can also lend validity by cross-method cancellation of biases or errors (Tashakkori & Teddlie, 1998).

Procedure. This research took a mixed-methods, QUAL-QUAN sequential design. To integrate data from qualitative and quantitative phases of research, I aimed to (a) identify common themes and patterns across data forms, and (b) discover contradictions within the data and their possible explanations.

I used the typology development approach to analyze and integrate my mixed data (Caracelli & Greene, 1993). This method organizes the first type of data, here qualitative interview data, into typologies and then applies the typology framework to the second type of data. I identified themes from the qualitative data and used these to 1) write survey questions, 2) organize survey questions for analysis, and 3) create quantitative groupings for landowner typology, parcel size, and stream flow quantitative variables. The landowner typology which is used in Chapters Five and Six led to integration of these data forms in my discussion, Chapter Seven.

Chapter Summary

In this chapter I presented the rationale, purpose, and methods for three phases of my research: qualitative, quantitative, and data integration. This chapter also included information on data reliability and validity for the qualitative and quantitative phases. I discussed sample selection for semi-structured interviews and mail survey participants. I provided details on survey response rate and discussed the purpose and methods for the non-respondent telephone survey.

CHAPTER FIVE

QUALITATIVE RESULTS

Chapter Summary

In this chapter, I present results from the qualitative research phase. These results represent stand-alone findings that were also used to inform the mail survey instrument (see Chapter Six). I provide general description of participating landowners and institutional actors. Then, I identify and support emerging themes, some of which follow my research hypotheses (Chapter Three) and some that emerge from the interview data. I identify eight themes concerning private landowners, followed by six themes that integrate institutional and private landowner perspectives.

Participant Characteristics

I conducted 20 semi-structured interviews including 16 riparian landowners and four institutional actors. Landowner participants were comprised of ten active farmers, six of which were hobby farmers and four were traditional farmers. Six non-farming riparian landowners were also interviewed as well (Table 5.1). Half of the 16 riparian landowners owned more than 50 acres, and four landowners had ten or fewer acres. Four interview participants were early adopters, having installed streambank fencing under the 1990's initiative (see Chapter Two). Two agricultural landowners and two non-farmers did not have riparian fencing or buffers. Most other agricultural landowners in this study had adopted riparian fencing, while two non-agricultural adopters had re-vegetated their streambanks. Re-vegetation generally included native tree and shrub plantings. Two non-farming landowners who owned retired farm

Table 5.1. Characteristics of private landowner participants and their riparian BMP.

Landowner	Land-owner Pseudonym	Land-owner Type	Parcel size (acres)	Adoption	How adopted
LO1	Clark Smith	non-farm	175	riparian buffer	conservation easement
LO 2	Fred and Lindsay Williams	non-farm	1	non-adopter	-
LO 3	Brian and Betty Reed	non-farm	2	non-adopter	-
LO 4	Tim and Megan Card	non-farm	2	riparian buffer	self-implemen-tation
LO 5	David and Sara Hunter	non-farm	197	riparian buffer; CREP	CREP agreement
LO 6	George and Cheryl Hoyer	hobby farm	116	riparian buffer; fencing	multiple organizations
LO 7	Dan and Jo Kelley	hobby farm	20	fencing	1990s initiative
LO 8	Wade and Jane Rider	hobby farm	197	riparian buffer; CREP	CREP agreement
LO 9	Bart and Amy Greene	hobby farm	15	riparian buffer; fencing	multiple organi-zations
LO 10	David Miller	hobby farm	27	non-adopter	-
LO 11	Larry and Lydia Martin	hobby farm	10	fencing	1990s initiative
LO 12	Charles and Abby Long	agricultural	152	fencing	1990s initiative
LO 13	Jim Ford	agricultural	92	non-adopter	-
LO 14	James Harris	agricultural	150	fencing	1990s initiative
LO 15	Steve and Sue Welch	agricultural	47	fencing	multiple organi-zations
LO 16	Mark Johnson	agricultural	313	fencing	1990s initiative

properties were enrolled in CREP. Three landowners collaborated with multiple organizations for their riparian project. One landowner created a riparian buffer under a conservation easement agreement, while another household implemented a buffer on its own.

I also interviewed four institutional actors representing the local watershed organization, the county soil and water conservation district, the municipal water authority, and Penn State Cooperative Extension (Table 5.2). All participating institutional actors were directly involved with riparian buffers in the Spring Creek watershed. All of the four participating institutions administer conservation programs in addition to buffer implementation.

Table 5.2. Institutional actor characteristics.

Institution No.	Institution represented	General activities	Riparian activities
INST 17	Local watershed organization	Riparian buffer implementation, environmental advocacy conservation easements	Installation, project coordination, education, include buffers in conservation easements
INST 18	County conservation district	Soil and water conservation on farms and impaired waterways	CREP and other installation, project coordination, education
INST 19	Penn State extension	Education and outreach for soil and water conservation	1990s streambank fencing initiative
INST 20	Municipal water authority	Water supply and service; property management of riparian and well areas	Landowner outreach and recruitment for project installation, funding, project maintenance

Emerging themes: Private landowners

<u>Land use determines information sources</u>. Agricultural landowners and hobby or non-farmers learned of riparian buffers through different diffusion pathways. Farmers typically learned of riparian buffers directly from within the agricultural

community (i.e., farming organization, fellow farmer) or from within their agricultural professional network or Extension. Many of the farmers interviewed implemented streambank fencing in an early-1990's livestock exclusion initiative led by Penn State extension in cooperation with Trout Unlimited. Riparian BMPs such as streambank fencing were not widely adopted prior to this initiative, yet one farmer reported familiarity before Penn State approached him: *"When I was reading about [riparian fencing] in the [farming] magazine, I thought, 'Oh, I don't want that,' but then after I thought about it for a while, I thought, 'Yeah, I guess it would be alright.'"* (LO 7) Another commercial farmer learned of riparian buffers through a professional group: *"I went to a young farmer's meeting one night. The lady was there talkin' about it and I said, I could use some ideas, and maybe some help."* (LO 13)

In contrast, hobby farmers learned about riparian fencing and stream buffers through social networks.

One of my soccer mom friends works for Soil Conservation… I'm on her mailing list for some reason. She's the person who notified people about the CREP program. She sent me an email--I'm on a big list serve probably about this email, for her and come to this meeting to learn about the CREP program or whatever. And a lot of times I get stuff from her that doesn't really apply to us because we're such a small-time farmer. But I saw this email from her, and I thought, 'She might know someone to help us to fix our [eroding] pond.' (LO 16)

On another hobby farm, the landowners learned of riparian buffers through personal observation and follow-up with a friend:

> While [my golf buddy] was the superintendent [at a local country club]—they were looking to do some stream rehabilitation thing. And when we bought this property, we called him up and said, 'Hey, where do we get the ball rolling with [our riparian buffer]. And he said, 'Well, the contact person is so-and-so at [the local watershed organization]'. (LO 9)

Here, landowners drew from a non-agricultural riparian project as evidence that they, too, could initiate a riparian restoration project on their small horse farm.

In general, residential landowners were not familiar with riparian buffers and attributed them to agricultural properties. These participants typically knew of riparian projects on agricultural properties, and often mentioned farmers by name who installed fencing or riparian vegetation. However, both residential landowners interviewed who did not have a riparian buffer were not aware that buffers were applicable to their residential property. Instead, they followed typical residential lawn care procedures:

> Brian: It's all in grass. We mow it down there. I've planted some trees down there over the years.
> Betty: Trees don't grow too well, because it's really too wet down there.
> Brian: Yeah, quite a few of them died.
> Betty: It's awful soggy down there. But there is, the way the ground is, there isn't too much you can do with it. If it’s' a swamp, I guess it will always be a swamp. (LO 3)

<u>Sources for reaching landowners shape attitudes</u>. Information sources may be informal, such as social acquaintances, or they may be directly from a professional source. Under the 1990’s streambank initiative, traditional farmers throughout the study area were approached by Penn State Extension personnel with information and incentives to install streambank fencing. One landowner perceived this initiative as an indication of future requirements:

> They put that fence all the way up [the stream reach]. You either had to, you went with them, or you’ll have to pay to put your own fence up. So, you might as well as go along with Penn State because you're already payin’ for it anyway. (LO 12)

This landowner perceived regulatory pressure for livestock exclusion, which effectively lowered the ownership she felt over the project. Without personal investment, the fencing remained something that Penn State did to her property, and something that she could complain about:

> The University didn't really let you clean along the stream. They wanted to come out and plant trees and all that. [The stream] was pretty. But look up there now. The neighbor and I were talking the other day…when you go out there just look down, and then the crick is coming into almost nothin', so it is. [Penn State] ought to think a little bit better. (LO 12)

Though this landowner expressed adoption pressure in terms of regulatory fear, this was not a popular perception. Another landowner who was directly approached to put a buffer on his property felt more of an indirect accountability—one in which he felt required to "do my part" (LO 11) even if it went against his preferences.

In contrast, landowners who learned of riparian buffers through informal sources often exhibited more pride, or more personal investment in their buffer projects:

> We want to be different, I guess. And we made that decision when we were going through this, because you always see these projects, and the weeds are up higher than those green tubes. The farmer or the landowner would just let it go wild. So we're not going to do that here. We kind of want to make a statement. (LO 9)

<u>Perceived maintenance burden varies by land use type</u>. Maintenance is a critical aspect of riparian buffer implementation. Without proper watering and weed suppression around new tree and vegetation plantings or maintaining new fences, the time, financial, and physical effort of riparian BMPs is worthless. Most agricultural landowners who participated in the early 1990's streambank fencing initiative were not confronted with new maintenance obligations. Rather, streambank fencing

increased existing fence maintenance duties: *"Instead of having two miles of fencing we have three and a half, so it's a lot more work."* (LO 6) Many farmers reported that they mowed under the streambank fencing—into the riparian vegetation targeted for growth—to prevent the fence from shorting-out or becoming entangled. One hobby farmer even reported fencing his goats *inside* the riparian area:

> Well, let me tell you, when 10 years was up [on the maintenance contract], I put some goats in there. And those goats cleaned up that stream bed to what it is now. They just ate those multiflora rose—they crawled up into the roses and ate 'em. And we got [the stream] back. (LO 11)

Here, the farmer was correcting for aesthetic and maintenance concerns. Despite common complaints of added labor, traditional famers did not see riparian buffer maintenance as something extraordinary or over-demanding: *"I just trim under the fence and at the crossings and that's pretty much it. Make sure that nothing gets broke, so, just normal maintenance that I do with the rest of the fencing."* (LO 14) In general, farmers were accustomed to riparian fence maintenance.

On the other hand, hobby and non-farmers adopters were surprised and frustrated about maintenance obligations. One couple who installed a buffer said, *"the most overwhelming thing that we face is the education--figuring out [what plants are] good, what's bad…And I can tell you, when we first started with this, there was never any talk about [the organization's] help with the maintenance, until just recently."* (LO 9) Many adopting landowners noted maintenance obligations weren't discussed until the buffer was nearly completed.

Multiple factors could influence why non-traditional farmers are overwhelmed with maintenance. Riparian buffer projects are typically implemented within one season for funding reasons or to simplify project administration. This requires landowners to abruptly change their land management regime. New demands on time and resources, at a large enough scale (absent experience), could leave adopting landowners bewildered and discouraged. In contrast, one residential couple gradually expanded their buffer year by year, so that their work extended across many seasons. Eventually, the couple reduced their overall property maintenance obligation with a smaller lawn and a healthy, established buffer: *"We've planted a lot—we've really worked hard to plant native trees and shrubs. And we could go even further than we have. But, it's a long term process."* (LO 4) This couple's successful buffer implementation suggests that the "all at once" model for installing riparian buffers may not hold across land use types, given that non-traditional farmers generally have less-experienced backgrounds in property maintenance.

<u>Intermittent streams are less recognized and appreciated than permanent streams</u>. Stream flow, or the presence of water passing through the stream, was frequently mentioned. When asked about the stream, landowners often recounted floods and the associated damage to buildings, property, and the streambank, and also told of weather patterns or drought that made the stream run dry. Event-related fluctuations such as flood and drought are often culturally and historically important, and inherently elevate stream salience with the landowner and community, even if temporarily. However, many landowners expressed genuine disappointment in prolonged decreases in stream flow: *"[The stream] appears to have dropped inside a sinkhole. So a stream that had run, in everybody's memory, consistently year round, just sort of disappeared within the last 10 years. So now it will run in the spring, and that's about it."* (LO 4) Lower stream flows, or change from a perennial to intermittent stream, seemed to diminish the stream's importance to some landowners:

> Well, the quality of the stream went down. I think that had to do with the major drought we had, and why the fish aren't back up yet.

> The streams are in good shape, even if they are low this time of year, there's still water running…Except it would be nice if we had more, our water back, the way we used to. (LO 11)

The same attitudinal differences exist between reaches with consistently high or consistently low flows. Many landowners, when asked if they were happy with their stream, responded about water quantity rather than quality: *"I think so…It runs year round. There's no problem with that. Now [a nearby stream] goes dry every now and then, which it was last summer. But this one runs year round."* (LO 3) Others with intermittent streams perceived they missed out on features associated with permanent streams: *"Everything goes downhill, and so you get more [wildlife and frogs] where the moisture is… I'd like them to flow a bit more up here. If there was anything that could be done, I'd prefer that they'd flow all year."* (LO 1)

Landowners believed that riparian buffers were pointless on intermittent streams:

> When my mom lived here, I think [the stream] ran all the time… Maybe once or twice a year, in the spring, when we get big-time hard rain, and things would still be frozen, there would be water that you could see running down the pasture into the stream. Most of the time that water would have been sinking into the ground. I don't think it was a problem carrying this manure into the stream." (LO 6)

The regional proposed riparian buffer ordinance calls for mandatory buffers on all new riparian development, including intermittent streams. A non-adopting landowner disagreed with the proposed riparian buffer ordinance on this count.

> At the [township] meeting that I went to, they [showed a map that included] streams here that kind of just quit. There is a stream that comes down off the side of Mt. Nittany on a parcel we used to own. You might go up there on a January or a February and it's raining and there's snow melting, and you might say, 'Ah, there's a stream!' But if you go up there, and you're quiet, most of the time, I can hear water running. But you can't see it, you know. (LO 4)

In fact, this landowner was observing interconnections between surface water and groundwater in the area's karst topography. Places with these hydrologic interconnections are more susceptible to water pollution in part because of the hydrology, and in part because landowners discount the importance of protecting intermittent streams. Landowners repeatedly devalued their streams because of intermittent flows. While intermittent streams are important hydrologically and ecologically, they are less important on the social landscape. This mismatch may have important implications for watershed management in headwater reaches. Intermittent streams contribute large amount of nitrogen, phosphorus, sediment, and discharge to surface waters. With landowners less aware, less concerned, and less willing to buffer ephemeral reaches, these areas may contribute a disproportionate amount of pollution.

<u>Perceived buffer improvements do not match the policy-based targets.</u> Adopters and non-adopters noted a variety of improvements associated with riparian buffers, whether these buffers were on their property, or more generally as a concept. The most frequently mentioned benefit was terrestrial or aquatic wildlife habitat. *"I liked the whole idea of the chain of wildlife and nature being as healthy as possible. I've always felt that way. So if you have a stream that's all full of mud, or erode, or if it doesn't have trees around it then it can't do that."* (LO 1) Some people specified improved fish habitat from their riparian buffer: *"Apparently, this area is great fishing. We don't have people come here and fish, but we send a lot down from what I understand…I'm glad to have the banks preserved, you know....that's', that's good to have that done."* (LO 8) This is not surprising given the area's history as a prime self-reproducing trout fishery.

Many landowners, particularly traditional famers, identified streambank stabilization as stand-alone improvement from riparian fencing. This is most likely because landowners saw the erosion mitigation aspect of stabilization rather than water quality improvements: *"Obviously the big benefit is to keep the livestock out of the stream, and not erode the bank."* (LO 7) However, preventing property damage through erosion was not enough for one farmer to install streambank fences: *"There are two streams that come down off the hill. And those aren't fenced off--they are part of the pasture. I can show you lots of soil erosion. If somebody wants to dig in their pocket book and help financing, I'll be [interested]. I got ideas."* (LO 13)

Water quality was also an important perceived improvement of riparian buffers. Landowners with all types of land uses and from many parcel sizes associated riparian buffers with water quality. As one non-farm landowner said of streambank fencing: *"It helps the whole stream, really, because if somebody muddies it up here and the cows get in it, the problem doesn't just stay there."* (LO 3)

Participants identified three scales where buffers could make improvements: their property (parcel-level), locally (their stream reach or the Spring Creek watershed), or the Chesapeake Bay. As discussed in Chapter Two, there are many policy-based programs that provide farmers financial incentives to improve water quality in the Chesapeake Bay. However, the vast majority of participants did not identify the Chesapeake Bay as connected to their buffer project. Rather, almost all participants expressed that local environmental quality was more important than the Chesapeake Bay or other far-downstream regions: *"I've certainly heard people from the Bay talk. But my mindset would be to make what's best for our immediate watershed because we're the headwaters. And if we don't take care if it right here, how can we possibly take care of it down there?"* (LO 5) One landowner, who buffered a first order stream on his property, spoke with great pride of his contribution to the region: *"This is considered the finest natural brown trout spawning stream in the state, if not the country. So that inspired Trout Unlimited to institute a stream* *rehabilitation program [here]…and apparently it has been very successful in its protection of the fish, and the spawning has increased."* (LO 8) This project may have met the goals of Trout Unlimited; however, the landowner's perception of success was also limited to the regional improvements, and did not extend farther downstream.

Parcel-level improvements were the most commonly mentioned reason for adoption, within which erosion mitigation and terrestrial wildlife habitat were the most popular. Even a non-adopting landowner who perceived his stream as "background and atmosphere" (LO 10) was concerned about erosion. Streambank stabilization and wildlife can be seen by the untrained eye, which may make these benefits more recognizable to landowners, where as non-point source water quality pollution is more conceptual observable, unless the contaminants are obvious. Two additional parcel-level buffer benefits were frequently expressed—a place for recreation and property enhancement:

> [My wife] always says "I want to see our kids down there fishing and playing." At the end of the day, this was mismanaged for how many years. And it feels good when you do the right thing, regardless of it s this or something else. There's also, I don't know if it adds any equity or value to the home by redoing that, but the kids are part of it, too. We can enjoy the stream. It's not just a stream that's choked with reed canary grass and algae. (LO 9)

Most landowners believed that buffer-related improvements extended downstream. *"I would think [our streambank fence has made a difference]. I would truly think so. I know what the banks look like before it was done and what they do now. The more you can keep the soil in place the better off you are. Everybody benefited from it."* (LO 14) There was a general sense from BMP or buffer adopters that their project extended beyond their property lines. For some, this was expressed by a sense of care specifically for the stream. For others, the stream was part of a larger, but still local entity: *"It's nice being in a little community where you know the neighbors…And the stream, I really do think is our common ground. I mean, we picnic [by the stream] all the time."* (LO 2) Many farmers expressed that they have corrected past behaviors, which suggests there is something socially rewarding in exhibiting behavioral change:

> "When I was a kid, the young cows were in the meadow, they'd just kinda have free roam, and they'd go down [in the stream] wherever they wanted to.…We all know better these days, we're aware of what we were doing wrong." (LO 13)

Many landowners described a stewardship ethic that influenced how they managed their property in general: *"We take this stewardship concept very seriously. Because it's not just about farming practices, it's about the buildings and the apple trees, and, everything. We were just only one step in all the people who are going to live here before us or after us."* (LO 6) Unfortunately for riparian areas, some landowners based what was right upon a traditional aesthetic of "shored up banks" and clean streambanks free of tall, "messy" vegetation. The few landowners who associated the Bay with their riparian projects tended to express environmental or stewardship values: "*As long as I have cattle, boy, I would [maintain my streambank fence]...I think we all benefit from it. The farmer benefits, and I think the neighbors and environmentalists, and the Chesapeake Bay, probably, it would help that, too…It is important to all of us, I figure.*" (LO 16) This farmer and landowners who expressed values were generally involved in national-level environmental or agricultural organizations, which were sources of conservation information, and came from all property types. The landowners who attributed their riparian conservation adoption to improving the Chesapeake Bay stood apart from landowners who expressed little knowledge about riparian buffers or the Chesapeake Bay. This is not to suggest that if landowners knew more about the Bay, they would necessarily be willing to adopt riparian buffers. Rather, this suggests that for landowners who live nearly 200 miles away and are not environmentally oriented, the Bay does not resonate as something more worthy of protection than their backyard.

Self-efficacy can motivate or deter riparian buffer implementation. As described in Chapter Three, self-efficacy is one's perceived ability to make a difference or contribution. Landowners experienced different levels of self-efficacy in relation to potential or perceived riparian buffer outcomes of various types and scales. The most frequently mentioned outcomes were enhanced wildlife habitat and water quality in their stream, downstream, and in the Chesapeake Bay. In general, landowners with more self-efficacy believed that riparian buffers on their property resulted in more types of improvements and that these improvements extended farther downstream.

Participants identified many factors that shape their self-efficacy in attaining buffer outcomes, one of which was their property size—the main determinant of buffer length and width. Landowners with small parcels commonly exhibited low self-efficacy, regardless of the type of improvement that could be made:

> You know, it is such a small space [by the stream]. It's such a wildlife center now, I mean, maybe more would come [with buffer adoption], but they're all welcome already. So I don't know that would change much. (LO 2)

It is no surprise that small landholders perceive they make less of an improvement. This perception exists in the policy realm, where managers assess riparian buffer success in terms of the number of acres protected rather than riparian areas' biophysical characteristics (e.g., hydrology, biodiversity, location), which influence riparian BMPs' actual effectiveness.

Hobby and traditional farmers also attributed animal intensity as another dimension of self-efficacy. Traditional farmers spoke openly about the in-stream improvements that resulted from livestock exclusion: *"Well, they're not standing in the creek the whole time. They're not working the edges of the crick bed down all the time. Now there's grass starting."* (LO 15) Hobby farmers perceived less self-efficacy in water quality outcomes (and thus less of a reason to adopt riparian BMPs) because they have fewer animals in larger pastures: *"With four horses that don't go down there too much, well, I doubt that there are many [improvements from our fencing]. Especially when you think about all the cattle that are in it other places in the area."* (LO 7)

<u>Riparian conservation is seen as collective</u>. Most buffer adopters recognized that their efforts were diminished if no one around them buffered their streams: *"I think [riparian buffer programs are making a difference], but I think that everybody has to get involved in it. You can't jump over one place and not the next."* (LO 15) This participant expressed a sense of collectivity, that her riparian buffer could make more of a difference if nearby landowners also participated.

Adjacent riparian management behavior is therefore linked to self-efficacy. Landowners freely reported their observations of neighbors' stream mis-management, which included faulty septic systems, excessive pet duck manure, unchecked invasive plants, or widespread streambank erosion. As with animal intensity, landowners were well-aware of how they compared to their adjacent riparian managers. However, participants pointed to their neighbors as reasons for why they want to care for the stream: *"Our neighbors are my biggest concern. It's like I own the stream now. It's my stream and it really irritates me whenever somebody upstream from me isn't taking care of it… I'm like that little old lady who gets on the phone and tattle-tales on* *everybody."* (LO 9) In contrast, a non-farming landowner pointed to adjacent land uses as a reason not to bother with a buffer on their property:

> When I think about [riparian land use] around here, it's different [than on a farm]. And I think, if you go down the road here, to the quarry, the creek goes right through the quarry. And it's like, dirt. Shale and, I mean there's some nice areas that they have, but you walk through some of it, and say, 'Come on!' But they just...you know. And this is Happy Valley--it's pretty environmentally sensitive. (LO 2)

When considering adjacent land use behaviors, this landowner sees a minimal contribution to water quality improvement from his residential property compared to downstream degradation.

Landscape change reduces self-efficacy. The Spring Creek watershed is made up of heterogeneous land uses with diverse property management objectives (see Chapter Two). Many participants commented on landscape changes, particularly concerning residential development. As one traditional farmer noted, he hasn't discussed his stream or fencing with his neighbors, *"because we don't have many farm neighbors around here anymore. We're getting pretty urban."* (LO 16) For one farmer, urbanization was a long-term reason not to invest in conservation programs, or riparian fencing:

> I thought about [enrolling in a conservation program] a while ago. But, you know, suburbia comes out and the kids got this big pile of land that they can't sell for houses and they're locked into agriculture. About the only thing you can do is put a school on it, or sell it to somebody for houses. (LO 13)

An adopting landowner also saw development as an obstacle: *"I think eventually I would like [the stream] to be full of the fish...I don't know if that'll happen [because] we still have an awful lot of runoff coming into it with the [upstream] developments."*

(LO 14) Throughout the interview, this farmer expressed concern for the environment and the well-being of his farm. He frequently observed development's effects on the stream:

> The water was muddy, yellow. And this man stopped by and said he was checking on the run-off and he wanted to see if I was doing anything here. And I said, 'Ya know, you have to really watch yourself and how you say that! If it comes from upstream, it can't be muddy from here.' I think it was a matter of quite a few different places because they were putting in a new water line or sewer line in [the upstream community] and I think it was that development's responsibility. I mean once the water would go down and after the rain it was yellow, with sediment on the stream edges. (LO 14)

In general, traditional farmers felt threatened by residential development, and saw this development as counter-productive to the soil and water conservation efforts implemented on their farm. This holds many consequences for farming in the watershed, as well as riparian buffer adoption on agricultural properties.

Non-farming landowners had very different attitudes on how their riparian buffer related to residential development. One landowner, who had an easement on his property, believed that his riparian conservation would benefit the area as it becomes more developed:

> The population keeps going up—especially around here. [My property] can't be subdivided for now, that's it. If it could be, the whole valley will fill up with houses eventually, and then this place up here would be developed. And from this standpoint, I think we'll have a positive impact. (LO 1)

Another landowner, with a CREP buffer on a retired farm, noted that his riparian conservation created an opportunity for heightened public awareness at a time of increasing development:

> As far as I know, its' the only farm between [nearby communities] that is publically accessible. Everyone else is some immigrant—I call them immigrants coming in and buying up farms so that they can come in and keep other people away. So we are very happy that this is an open farm, open stream, open woods. If there were people really interested, they would provide opportunities for young people and for conservationists to study and do some projects on the stream. (LO 8)

Regional residential development could be a major obstacle for riparian conservation on agricultural properties. Alternatively, non-farming landowners think their buffers are preserving the environment and increasing awareness of water resources conservation in the face of residential development.

Emerging themes: Integrating institutional and landowner perspectives

In this section, I consider institutional and landowner perspectives in the context of one another to develop a greater understanding of how policy players interact with landowners and how these interactions shape riparian buffer adoption.

<u>Organizations with an agricultural focus generally disregarded hobby and non-farm landowners as potential buffer adopters.</u> Institutional actors discounted potential water quality outcomes derived from riparian buffer implementation on non-traditional agricultural properties. In the case of the 1990's buffer initiative, the project leader focused on agricultural landowners to meet the project goal: " to reduce sediment loading." (INST 19) While non-agricultural activities can certainly contribute to sediment loads, this project implemented *"…fencing, whenever [landowners] would allow us--we'd keep animals off the bank. Whenever there was a fairly high density of animals, there would be no vegetation…Pretty much on all farms, the stream bisected the pasture, so the animals had to get across."* (INST 19) The municipal water authority's more recent riparian conservation initiative has also targeted farms for water quality improvements: *"This local farmer, who put corn on this field for many,*

many years, was convinced about a year ago to convert it to wheat and he had it planted in grasses and mowed just once a year." (INST 20)

Some non-farming organizations were willing to install riparian buffers on non-agricultural properties. The local watershed organization performed buffer installations on three of the hobby farms represented here, and also worked with a local museum to restore the riparian corridor on museum grounds. Similarly, the local branch of Trout Unlimited was active in funding and overseeing riparian buffer projects on all types of privately-owned properties. Many of the traditional farmers who participated in the 1990's fencing initiative correctly associated Trout Unlimited with the project, though often farmers were unclear about how the project came about:

> I guess as my wife and I were talking—at the time there was enough money in our budget to do [the fencing]—and then with Trout's Unlimited, we got talking with them and then somehow or another there was money set aside so we had [the fencing] done. (LO 14)

<u>Institutions more frequently interact with non-agricultural landowners to control development rather than conserve riparian areas</u>. All institutional actors commented on the rate of land use change from agriculture to residential development. The local watershed organization and the municipal water authority attempt to control development using similar tools: conservation easements or outright land acquisition. The watershed organization appeared experienced in working with non-agricultural landowners in conservation easements, while the water authority tended to target former agricultural properties that were vulnerable to development and near their groundwater wells: *"Obviously if the highway had been there, there would be some potential for development. This is prime land, as you can tell. And with utilities available, the next phase was down towards [the stream]. I think our [land*

acquisition] may block most if not all of that effort to develop that land." (INST 21) While this does not pertain directly to riparian buffers, it is a reflection of the land use changes underway in the watershed.

Institutions haven't yet adapted to working with a variety of landowners. In a heterogeneous landscape, in a financial climate of continuously limited funds, organizations will be unable to achieve their conservation goals unless they collaborate with other organizations and, more importantly, riparian landowners, who may not fit the profile of past participants. In more than one instance, landowners reported that institutional representatives were unwilling to tailor riparian and non-riparian BMPs for their goals or properties. For example, one hobby farmer reported tension in their collaboration with the local conservation district for fencing and re-vegetation:

> Amy: I guess we had some issues with—it was difficult because we lost our main person who we were working with right before we started this project.
> Bart: So we had been working with somebody for well over a year, and then a new person came on board--
> Amy:--and it was like staring all over again.
> Bart: They had a different outlook on the project all together.
> Amy: He was more used to going onto huge cattle farms and saw our horse farm as a kinda less deserving of the funds, I guess. (LO 9)

Greater institutional adaptability will enhance partnerships with landowners, and help both parties achieve long-term project goals.

Funding sources shape project outcomes and landowner-institutional interactions. As seen in the last section, traditional farmers and hobby farmers face different sets of constraints in implementing riparian buffer projects. While hobby farmers learn of riparian BMPs from informal, often unprofessional sources, traditional farmers are readily aware of riparian conservation programs, such as CREP or Pennsylvania's Growing Greener grants. However, traditional farmers may be taking part in riparian restoration for the monetary or infrastructure incentives, not for the water quality improvements. For example, the county conservation district makes it difficult for farmers to enroll in Growing Greener without installing riparian buffers: *"We made a stipulation that in our ranking sheet, if people were willing to put a buffer in, they got more points. So that was a way that we got more buffers on the ground. That we would say that if you are going to do some other kind of ag project, you need to put a 35 foot buffer… If people want the money, they'll do it."* (INST 19)

CREP and Growing Greener grants are competitive, supply-driven programs that, based on abundant interest from riparian farmers, can select who participates. However, under point systems such as the one described here, landowners who install buffers as part of a package may be less inclined to maintain their riparian plantings. This is a problem for the long-term success of the project and for water quality outcomes.

Nonetheless, agricultural organizations can only offer landowners grants that meet the objectives of their funders. As previously noted (Chapter Two), Growing Greener is not entirely an agricultural program; however, most of the grants awarded to the conservation district are intended for farm-related water quality BMPs. Requirements such as this may prevent local organizations from best-serving local landowners on a heterogeneous landscape. Institutional resistance to hobby farm projects, as Bart and Amy mentioned above, may reflect the limited availability of policy-based incentives are available to non-traditional farmers rather than organizational disapproval for small-farm riparian BMPs.

Groups that work with non-farmers and agricultural landowners, such as the local watershed organization, have already sponsored restoration projects on hobby farms and institutional properties, such as one at a local museum. Hobby and non-farmers frequently identified the watershed organization by name without confusion: *"We had people from, like six organizations here… Many of them came out [to our farm] several times, and [the watershed group project leader] kind of lead up this charge."* (LO 6). Even a non-adopting, residential couple were aware of the group's riparian restoration efforts:

> Betty: There's an organization here that works on [riparian buffers].
> Bob: ClearWater.
> Betty: Especially with [a nearby stream], down where that, that starts with a spring about a mile below here—I know they've done things on that stream up through here. (LO 3)

In contrast, many traditional farmers did not identify the local watershed organization by name. The only situations in which farmers did specify the watershed organization was with complaints about streambank vegetation:

> Steve: We planted some trees, but they didn't amount to much.
> Sue: They all died. Yeah, some of the things they did were really stupid.
> Steve: [The local organization] got involved in that end of it--and it was the conservation district that did the fencing--or am I getting that confused?
> Sue: It was the conservation district, and they brought [the watershed organization] in on the tree part of it. We weren't really thrilled about the trees in...cuz it's just one more thing to mow around and one more problem to have. We knew the trees wouldn't last if the water got high and came through again. I mean, it's going to wipe them right out. (LO 15)

Except for streambank fencing projects from the 1990's initiative, most riparian projects were collaborations among many organizations, each with monies for different project components (i.e., fences, trees or shrubs, watering systems).

Landowners often failed to precisely recall the names of non-local institutions, or exactly how their riparian projects were funded:

> There's all those programs like CREP. And [project sponsors] are like 'This one will pay 15%, but you have to do this, and this one will pay this much if you do that.' We still don't have any idea of who did what or how it all fits together, but [a conservation district representative] was very instrumental in helping organizing everything, and apply for the grants or however they do all that…Everything hinged on something else that hinged on something else. (LO 6)

Additionally, landowners were frequently confused as to how different components of a buffer project came together:

> Wade: The fellow who was really pushing [to install a riparian buffer], along with Trout Unlimited, was with the County--not with the County, but he's a local man and was with the Pennsylvania Fish and Boat Commission--
> Jane:--what about the trees?
> Wade: Trees? They came from the CREP program.
> Jane: Yeah. How long are you responsible for keeping those?... I don't know. We had so many agencies involved. (LO 8)

Such confusion may hold implications for buffer maintenance and technical support, especially if landowners don't know where to turn when questions arise.

Over time, riparian buffer installations on hobby and non-farm properties have increased. It is also likely that these projects increasingly combine funding and expertise from multiple organizations. As this pattern of collaboration and diversification progresses over time, there may be increased opportunities and awareness of riparian buffers by non-traditional farmers.

<u>Organizations and landowners believe that peer-peer observation encourages adoption</u>. Institutional actors believed that peer-peer observation reinforced property management norms: *"[One of my colleagues] thinks people do what they see. And that's kind of what we hope would happen, is if people see a buffer, and see how good*

it is, they they'll do the same thing. But right now I know in one watershed, people are just cutting lawns, right up to the edge. So then the next person does it and the next person does it--that's kind of a problem." (INST 19) It is important to note that lawn mowing patterns and "neat" riparian vegetation are well-established aesthetic and behavioral norms. They may not need as much reinforcement as an innovative conservation practice, like riparian buffers.

Some institutional actors believed that peer-peer observation could also educate or maybe even inspire other landowners to take on buffers: *"I was interested in [putting a buffer on that farm] particularly because it is so visible and everyone drives past there. I was hoping that it would help enlist people upstream."* (INST 21) In fact, landowners do take notice of each others' land use practices, but whether or not this changes behavior is questionable. A non-adopting, traditional farmer reported a recent observation with some amazement:

> Someone [on a recently purchased property] put up this cute barn, and then there appeared these guys with this high tensile fence and they start putting up the perimeter fence, and then they put up some inside fences. I saw them happen, and they're just tickled pink. They probably got more horses there per ground than what a farmer is allowed to have more animal units per acre. I'm sure. Now, I don't know how they get away with it....Because he has money, probably. (LO 13)

This farmer did not observe the new rotational grazing system and desire for one of his own. However, his comments are evidence that neighbors are attune to how they compare to each other's property management behaviors.

<u>Landowners want to set an example</u>. At least one landowner from each land use category prided themselves as being a leader in riparian conservation. This self-perception was frequently conveyed in terms of their adoption timing: *"I think it was the first farm in the whole country that had the agricultural easement on the fields and*

the [buffer] on the stream. I don't know if there have been any more [projects like ours] since then or not." (LO 8)

Landowners also articulated their sense of leadership in terms of changing their neighbors' behaviors:

> Another benefit [from our buffer is] that, being an academic I guess I think about this, that potentially it is educational. That other people look at it and say, 'What the heck is he doing?' But, it does open some people's eyes. (LO 4)
>
> ***
>
> We want to model the way and show [others] what good looks like. Because there's been a lot of dialogue with [a neighboring property] but they've never pulled the trigger. So if [a partner organization] can go in there, you know, loaded for bear, and say, listen, this is what the positive effects were, and this is what we can do for you. (LO 9)

These participants were non-farmers and hobby farmers, respectively, who also expressed frustration with adjacent landowners' riparian management. Though their outreach was indirect, these adopting landowners wanted adjacent landowners and neighborhood members to learn from their buffers:

> Even the neighbor where the stream goes through, the neighbor that wasn't very happy with [our buffer]. Even there, I think that there's been a change in the amount of vegetation that's been around the stream-side. Instead of mowing right down to it, and weed whacking right down to the stream, I see a little bit of, not really much of a buffer, but...(LO 4)

The perceived educational benefit is further evidence that landowners aspired for, if not expected, collective participation in stream buffers.

Landowners' goal to evoke change by example assumes that peer-peer observation takes place within a neighborhood. Adopters specified that they wanted their neighbors to take notice of their riparian buffer adoption, but these adopters did not specify the landowner group(s) (i.e., agricultural, hobby farm, non-farm) they hoped to influence. In a mixed land use neighborhood, who is a peer is less clear than it is in a suburban development or agricultural landscape. One can speculate that there must be some similarity, or similar self-categorization, among landowners who observe riparian projects and think that those riparian behaviors apply to them. The effectiveness of peer-peer observation and behavioral change on a heterogeneous landscape, such as the Spring Creek watershed, is questionable.

Chapter Summary

Agricultural landowners belong to well-established information networks supported by agricultural institutions. Farmers reported knowing more about riparian buffers and adopted them earlier than hobby and non-farming landowners. Generally, farmers were contacted by institutional representatives to implement streambank fencing on their properties. Alternatively, hobby farmers and non-agricultural landowners tend to initiate their own projects, even in the face of less knowledge about programmatic support and less formal understanding of buffers. This scenario of restricted opportunities for non-traditional farmers is shaped by funding sources, such as federal and state grants that distributed or awarded to local institutions for water quality conservation on agricultural properties. On one hand, these local institutions need financial support to sustain their activities; however, the agricultural specifications attached to grants limit the rate at which local organizations can adapt to land use changes, such as residential development.

Many landowners and institutional actors hope that neighboring property owners will learn from their riparian buffer projects. However, this goal may depend on the type of properties where projects are installed. If landowners do not identify themselves with adopting landowners and their properties, observers may believe that this practice does not apply to them. The same idea is currently seen in reverse: non-adopting, residential landowners generally do not believe that their riparian management influences the stream. As land use changes, there will be more fine-scale land use heterogeneity, leading to a scenario in which landowners of many different land use typologies will live in the vicinity of one another. In this situation, peer-peer observation may not be an effective dissemination mechanism, even though this is a prevailing hope of landowners and organization representatives.

Adopting landowners reported different types and scales of improvements resulting from their buffer project. This variation is related to landowner self-efficacy, or one’s perceived ability to effect change. Varying levels of perceived efficacy is determined by many factors including stream flow, parcel size, current land uses, and nearby or downstream land uses. In this vein, landowners see riparian conservation as collective, meaning that their perceived efficacy is increased with additional participants; however, perceived efficacy decreases with outcomes’ distance downstream.

Lastly, riparian landowners of intermittent streams generally had lower appreciation for their streams. This attitude has many implications for water quality and riparian conservation on private properties in headwater regions, such as the Spring Creek watershed.

CHAPTER SIX

QUANTITATIVE RESULTS

Chapter Summary

In this chapter, I provide results from a mail survey of riparian landowners in the Spring Creek watershed. I first present results from the non-respondent analysis. I then describe survey respondents—their characteristics, attitudes, beliefs, and how these landowners are involved in their communities or with organizations—as well as the characteristics of their properties and the surrounding landscape. I use a factor analysis to identify relevant items for the following composite variables: outcome expectations, adoption willingness, buffer constraints, environmental attitudes, and innovation attitudes. I then make bivariate comparisons across three key variables: landowner type, stream flow, and parcel size. Lastly, I create three multivariate models that predict 1) the amount of information heard about riparian buffers, 2) landowner willingness to adopt riparian buffers, and 3) changes in adoption willingness under a composite set of scenarios.

Non-respondent Analysis

The adjusted mail survey response rate was 39.0% (see Chapter Four). As this response rate is not very high, I conducted a non-response telephone survey to detect differences between respondents and non-respondents. Non-respondents were generally similar to the mail survey respondents on key questions, with non-respondents exhibiting somewhat lower mean adoption willingness (Table 6.1). The main difference between the groups is their concern for water quality in the Spring

Creek watershed, where non-respondents were less concerned about water quality than were respondents. Non-respondents were also less likely to have heard about riparian buffers.   This implies that survey respondents are more aware and receptive to riparian buffers than the watershed as a whole. I also compared survey respondents (n=175) and non-respondents (n=302) for differences in property characteristics with a two-tailed paired samples t-test. Respondents and non- respondents did not significantly differ on parcel size or stream length (Table 6.2).

Table 6.1. Comparison of mail survey and non-respondent telephone survey responses.

Question	Mail survey mean	Non-respondent mean
How regularly does your stream have water in it (Scale: 1= always; 2 = Most of the time; 3 = Sometimes; 4 = Rarely)	1.84	1.70
How concerned are you about water quality in the Spring Creek Watershed? (Scale: 1= not at all; 2 = slightly; 3 = somewhat; 4 = very)	3.55	2.27
How much have you heard or read about buffers? (Scale 1 = nothing whatsoever; 5 = a great deal)	2.88	2.33
How much of the stream on your land has a buffer? (Scale: 1 = None of the stream; 2 = less than half; 3 = about half; 4 = more than half; 5 = all of the stream)	3.55	3.57
How willing are you to increase the amount of your property under a stream buffer? (Scale: 1 = not at all willing; 2 = not very willing; 3 = somewhat willing; 4 = willing; 5 = very willing)	2.99	2.29
I have a moral obligation to maintain water quality. (Scale: 5-point Likert with 1=strongly disagree)	4.35	4.09
I don’t want others to decide what is on my property. (Scale:5-point Likert with 1=strongly disagree)	4.23	3.64
I am the kind of person who is willing to take a few more risks than others. (Scale: 5-point Likert with 1=strongly disagree)	3.79	3.27

Descriptive Analyses

Respondent Characteristics. Respondents were on average 63 years old (std. dev. = 13.3 years), were generally long-time residents of Centre County (mean = 41 years, std. dev. = 21.9), and had owned their property for many years (mean = 27 years, std. dev = 17.3). Eighty percent of respondents were male. Respondents were highly educated (Table 6.3), with 41% having at least some graduate education. The political views of respondents were normally distributed on a scale from 1, or "very conservative" (15%) to 5, or "very liberal" (13%), with 35% responding in the center of the scale (Table 6.4).

Table 6.2. Differences in property characteristics between survey respondents and non-respondents.

	Respondents		Non-respondents		
Property characteristic	Mean	Std. dev.	Mean	Std. dev.	p-value
Parcel size (acres)	22.84	49.8	24.94	52.27	.714
Stream length (km)	.61	.86	.58	.89	.745

Landowner Typologies. I defined an agricultural landowner as having livestock / farm animals or harvested crops / hay on their property. Within the agricultural landowner group, I then defined "hobby farmers" (15%, n=23) as owning less than or equal to 10 acres or having less than 25% pasture and 25% fields. Landowners that had more than 10 acres and had pasture or fields that made up more than 25% of their property were categorized as "traditional farmers" (17%, n=26). All remaining respondents were categorized as non-farmers (69%, n=109).

Table 6.3. Respondents' education (n=169)

Level of education	% Respondents
graduate high school or less	21%
attended some college	15%
bachelor's or associate degree	23%
some graduate study	11%
graduate degree	30%

Response by township and sub-watershed. Local policies vary across townships (see Chapter Two) and biophysical conditions are not uniform across the Spring Creek sub-watersheds (Carline & M. C. Walsh, 2007). Responses were received from each of the six sub-watersheds, with the highest percent response located in the Spring Creek sub-watershed (30%) (Figure 6.1). As described in Chapter Two, the Big Hollow sub-watershed does not have surface waters. Harris Township contributed the highest percentage of survey respondents (22%), while the Bellefonte Borough represented the fewest (1%). Benner Township and Bellefonte Borough were under-represented, where as Harris, Potter, and College Townships had higher proportional responses (Figure 6.2).

Table 6.4. Respondents' political views (n=168)

Political views	% Respondents
1 "very conservative"	16%
2	19%
3	35%
4	17%
5 "very liberal"	13%

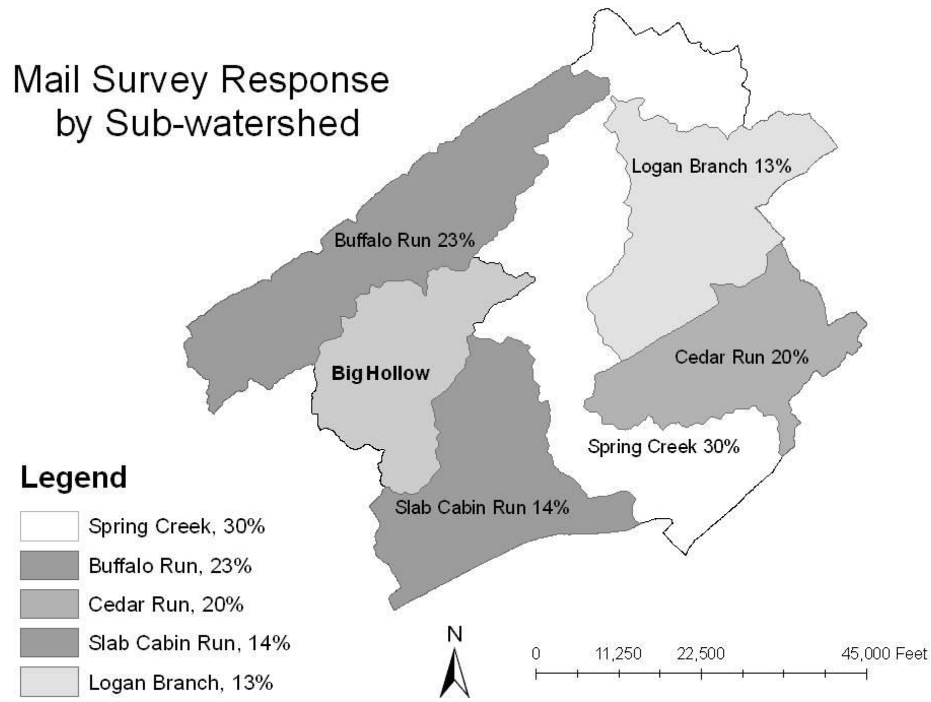

Figure 6.1. Mail survey response rate per sub-watershed in the Spring Creek watershed.

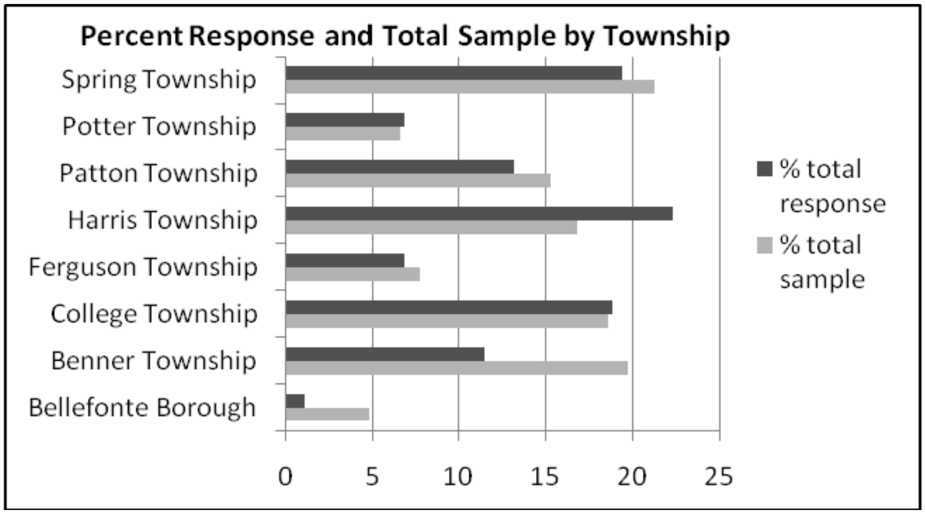

Figure 6.2. Percent survey sample and response by township.

Parcel Characteristics. The distribution of respondents' parcel sizes was skewed towards small parcel landowners (mean size = 22.8 acres, median = 3.0 acres, std. deviation = 49.1). The largest group of survey respondents (33%) own less than one acre, while the remaining parcel size groups were distributed relatively evenly across these categories (Table 6.5), which are based upon conceptual potential for agricultural land use activities based on size.

Table 6.5. Respondents' parcel size

Acre groups	n	%
< 1 acre	57	33%
1 - < 4 acres	42	24%
4 - < 13 acres	34	19%
13+	42	24%

Under the Centre County zoning classification a majority of landowners owned residential properties (58%, n=101), with agriculture (25%, n=44) and vacant properties (17%, n=30) (i.e., land without buildings) also present.

Stream characteristics. Fifty-two percent of respondents reported that their stream "always" had water in it, while 22% indicated water was present "most of the time." Sixteen and ten percent of survey respondents "sometimes" and "rarely" had water in their stream, respectively. A majority of respondents (57%) indicated that the stream on their property was between 100ft and one-quarter mile long, with 23% owning ¼ mile or more (Table 6.6).

Table 6.6 Stream length on Respondents' parcels

Length of stream on parcel	% Respondents
less than 25 ft	3%
25ft to less than 50	4%
50ft to less than 100	14%
100 ft to less than 1/4 mile	57%
1/4 mile to less than 1/2 mile	18%
more than 1/2 mile	5%

Water quality assessment and knowledge. Landowners were asked to rate the water quality in the stream next to or on their property, in the Spring Creek watershed, and in the Chesapeake Bay (Table 6.7). Respondents had a mean response of "very good" water quality in their stream (mean = 2.56) and in the Spring Creek watershed (mean = 2.73), and a "fair" rating for water quality in the Chesapeake Bay (mean = 3.90).

Table 6.7. Respondents' water quality ratings in three locations by percent and (n).

Water quality rated in…	Excellent	Very Good	Good	Fair	Poor	Mean	Std. Dev.	Don't Know
Stream	20% (34)	19% (32)	25% (41)	11% (19)	6% (10)	2.56[a]	1.22	17% (31)
Spring Creek watershed	4% (6)	27% (45)	28% (47)	13% (21)	2% (4)	2.73[a]	0.91	26% (44)
Chesapeake Bay	1% (1)	6% (9)	13% (22)	24% (40)	26% (43)	3.90[b]	0.98	30% (50)

Scale: 1= excellent, 5= poor.
[a,b] indicate significantly different groups

Respondents' knowledge about water quality decreased with distance downstream (Table 6.8). Respondents perceived that they are "somewhat knowledgeable" about water quality in their stream (mean = 2.46), the watershed (mean = 2.31), and the Chesapeake Bay (mean = 2.07). The most popular information sources about riparian buffers were environmental organizations (16%)[2] and the local media (11%) (Table 6.9). Thirty-eight percent of respondents had not heard anything about buffers prior to this survey. These variables do not differ across the six sub-watersheds, suggesting it is appropriate to look at the Spring Creek watershed as a single system.

[2] One source of riparian conservation information known by the research team was the Chesapeake Bay Foundation informative mailing (see Chapter Four). About half (46%) of survey respondents received this mailing two months prior to the first survey mailing. In an independent samples t-test, there were no significant differences between mailing recipients non-recipients in their self-assessment of how well-informed respondents felt or how much respondents have heard about riparian buffers (p=.369). Therefore, we do not see this mailing as introducing a new source of bias.

Table 6.8. Respondent knowledge of water quality in three locations by percent and (n).

Knowledge of water quality in…	Not at all	Somewhat	Moderately	Very	Mean	Std. Dev.
Stream	23% (38)	32% (53)	23% (38)	23% (39)	2.46	1.08
Spring Creek watershed	24% (41)	34% (57)	28% (48)	14% (23)	2.31	0.99
Chesapeake Bay	31% (53)	37% (63)	24% (41)	7% (12)	2.07	0.92

Scale: 1= not at all knowledgeable, 4 = very knowledgeable.

Stream importance and concern. A majority of respondents noted that their stream was very important to them (70%, n=118). Respondents also indicated that they were in between "somewhat" and "very" concerned about water quality in their stream (mean = 3.33), the Spring Creek watershed (mean = 3.55), and the Chesapeake Bay (3.48), with no significant differences among these levels of concern (Table 6.10). While respondents ranked water quality in the Chesapeake Bay lower than more proximate waters, their concern for the Bay did not correspond to the worse water quality ratings. This suggests a lack of emotional investment in Bay water quality.

Table 6.9. Where did you first learn of stream buffers?

From…	% Respondents
An environmental organization	16%
Local Media	11%
Local soil conservation district	8%
Penn State Extension	7%
A friend	5%
Municipality	5%
A co-worker	2%
A family member	2%
Other	6%
No Prior Information	38 %

Table 6.10. Respondent concern about water quality in three locations by percent and (n).

Concern of water quality in…	Not at all	Slightly	Somewhat	Very	Mean	Std. Dev.
Stream	9% (15)	5% (9)	30% (49)	56% (94)	3.33	0.93
Spring Creek watershed	2% (3)	5% (9)	29% (49)	64% (107)	3.55	0.68
Chesapeake Bay	4% (7)	5% (9)	29% (48)	62% (104)	3.48	0.78

Scale: 1= not at all concerned, 4 = very concerned.

Respondents' Behaviors. The mail survey measured two forms of stream management behaviors—informal, on-the-ground behaviors like mowing patterns and formal enrollment in buffer programs (e.g. Conservation Reserve Enhancement Program (CREP)). Fifty-nine percent of respondents (n=100) cut grass, shrubs, or trees within 30 feet of their stream. Within this group, fifteen percent mow their lawns to the edge of the stream, and 21% mow within 3ft of the stream (Table 6.11). In general, crop harvest took place farther from the stream, with only one landowner indicating that he or she generally harvested crops within 5ft of the stream (Table 6.12).

Riparian landowners who have livestock on their property (n=30) were asked if they had riparian BMPs to prevent livestock in the stream. Sixteen had streambank fences and 10 had fenced stream crossings. Nine respondents indicated that they water livestock in the stream, while 11 respondents noted they have an alternative watering system.

Table 6.11 Respondents' distance from stream edge to mowed lawn

How close to the edge of the stream do you mow your lawn?	% Respondents
To edge of stream	15%
Within 3 ft of stream	21%
within 3-10 feet of the stream	15%
within 10-30 ft of the stream	7%
I do not mow near stream	42%

<u>Conservation program participation</u>. Only 15% (n= 27) of respondents were enrolled in formal conservation programs. Of the nine landowners enrolled in CREP, five were agricultural landowners, one was a hobby farmer, and three were non-agricultural landowners. About half (58%) of respondents participating in riparian conservation programs were required to have a stream buffer under the program. Only two landowners were enrolled in the Conservation Reserve Program (CRP), both of which were traditional agricultural landowners.

Table 6.12 Distance of crop harvest from stream

How close to the edge of the stream do you harvest crops?	% Respondents
Within 5 ft of the stream	2%
Within 6-15 ft of the stream	24%
Within 15-30 ft of the stream	24%
More than 30 ft of the stream	50%

<u>Community engagement</u>. I asked a series of questions to measure community engagement in the Spring Creek watershed. Two-thirds of respondents indicated that they interact with neighborhood members daily or weekly (Table 6.13). A majority (59%) of respondents responded that they were close friends with one-quarter of the

people in their neighborhood, while 26% of respondents indicated they were not close friends with anyone in their neighborhood.

Table 6.13 Respondents' community engagement.

	Daily	Weekly	Monthly	Less than Monthly	Never
How often do you interact with people in your neighborhood?	26%	41%	8%	20%	5%
	0	1/4	1/2	3/4	Almost all
How many are close friends in your neighborhood?	26%	53%	9%	7%	6%

Another aspect of community participation is an individual's involvement in local issues.   Forty-one percent of respondents indicated they had signed a petition about a local issue in the last two years, and 49% attended a public meeting sponsored by a government agency during that time (Table 6.14). Fewer respondents were involved in the local media, as 26% indicated they had written a letter to a public official or newspaper. Overall, respondents were very active.

Table 6.14 Respondents' involvement with local government or media.

In the last two years, have you…	n	Mean	Std. Dev.
Signed a petition about a local issue?	170	.41	.494
Attended a formal public meeting sponsored by a government agency?	171	.49	.501
Written a letter to a public official or newspaper?	171	.27	.445

Scale: 0=No; 1=Yes

Riparian Recreation. The most popular form of recreation was wildlife or bird watching (70%), while 27% of respondents indicated that they often went walking, hiking, or relaxing on their stream-side property (Table 6.15). Only six percent of respondents indicated that they often fished on their property, while 55% of respondents sometimes or often went fishing elsewhere.

To consolidate recreation variables for further analysis, I conducted a maximum likelihood factor analysis with varimax rotation and Kaiser Normalization. Two distinct factors emerged: recreation on landowners' properties, and recreation elsewhere; however, the fishing measures did not load on either of these factors, and were not included (Table 6.15). Both scales underwent a reliability analysis[3] (parcel recreation scale alpha = .750, recreation elsewhere scale = .768), followed by a means substitution. Fishing on property and fishing elsewhere remained dichotomous variables.

Table 6.15. Location of respondents' recreation near streams and (loading) on respective parcel recreation and recreation elsewhere factors in a maximum likelihood factor analysis⌂.

Recreation Activity	My property	Elsewhere
Fishing	29% (--)	55% (--)
Wildlife or bird watching	70% (.558)	57% (.731)
Swimming or wading	31% (.431)	40% (.647)
Walking, hiking, or relaxing	63% (.990)	69% (.670)
Canoeing or boating	-- (--)$^{\infty}$	48% (.587)

⌂ Eigen value = 1.248; Cumulative total variance explained = 63.2%

$^{\infty}$ This variable was removed from the study[4]

[3] Reliability analysis examines the correlation among multiple survey items to determine how related they are to one another. Higher alpha values represent more similar items and a greater reliability that the average of these items represents an average of the responses.
[4] I removed the variable "canoeing or boating on your property" because most streams in the study watershed are too small for boating.

Institutional Membership. Another hypothesized factor in riparian buffer adoption was membership to an organization associated with riparian buffer implementation. Most respondents indicated they were familiar with organizations listed in the survey, but most respondents were not members (Table 6.16). The highest organization memberships were for a sportsman's group (26%) and fraternal organization (24%). Of the organizations listed, the most common organization that respondents were familiar with, but not members of, was a local chapter of Trout Unlimited or Ducks Unlimited.

Table 6.16. Respondents' level of membership in local and national organizations

Organization	% Member
A sportsman's group	26%
A fraternal organization	24%
ClearWater Conservancy	20%
national environmental organization	14%
national farming organization	10%
A local landowner's association	10%
local chapter of Trout Unlimited or Ducks Unlimited	9%
A watershed association	7%

Respondent Attitudes and Beliefs.

Willingness to adopt buffers. Thirty-eight percent of respondents were either willing or very willing to increase riparian buffer on their property (Table 6.17). Landowners were asked how their willingness would change based on 14 conditions (Table 6.18). The condition "if a buffer reduced streambank erosion" prompted the greatest increase in willingness (40% much more willing). These incentives were combined into a composite variable that represented respondents' willingness change (alpha = .949).

Table 6.17 Respondents' willingness to increase riparian buffers on their property

	% Respondents
not at all willing	21%
not very willing	15%
somewhat willing	26%
willing	21%
very willing	17%

Attitudes towards the environment, innovation, and private property. Environmental, innovation, and private property attitudes were assessed using a 5-point Likert scale. Seventy percent of respondents indicated that protecting the environment is important to them, with 69% responding that they would be upset if their activities harmed the stream (Table 6.19). Environmental attitude measures were combined (alpha = .797; mean = 4.57, std. dev. = .584).

Respondents exhibited generally pro-innovation attitudes, with 54% of respondents strongly agreeing with the statement, "I'm always looking for ways to improve my property." This and the statement "I am the kind of person who is willing to take a few more risks than others" were averaged to produce the innovation attitudes composite scale (alpha =.588; mean = 4.07, std. dev. = .810).

Beliefs about riparian buffers. Respondents were asked a series of Likert-type questions that measured their beliefs about riparian buffers. The first set of questions gauged landowner agreement with potential improvements that could result from a riparian buffer on their property (Table 6.20). Landowners most frequently agreed that riparian buffers on their property would improve wildlife habitat (70%) and water quality downstream (64%). Respondents were least likely to agree that buffers improved their access to buffer program payments (12% agree) or that buffers increased property values (23% agree). Twenty percent of landowners disagreed with the notion that a riparian buffer on their property would improve local drinking water. A factor analysis (Varimax rotation with Kaiser Normalization) revealed that these items belong to a single factor (Eigen Value = 8.391, 70.0% total variance explained); therefore, all items were included in the outcome expectation scale (alpha = .957; mean = 3.45, std. dev. = 1.105).

A final set of questions measured beliefs towards buffer adoption constraints. In general, respondents did not frequently recognize riparian buffer constraints, suggesting that these may not be a broad cause for non-adoption. For example, the constraint item most frequently agreed upon was, "a buffer doesn't make sense for the size of my property," by 31% of respondents. The next-highest item of agreement was "a buffer would take up too much land," with only 25% respondents agreeing.

Landowner beliefs towards riparian buffer constraints were analyzed using a maximum likelihood factor analysis with varimax rotation and Kaiser Normalization (total variance explained = 60.2%, Eigen value = 3.612). One factor emerged, which underwent a reliability analysis (alpha =.866) (Table 6.21). This buffer constraints scale then underwent a log transformation for normality and a means substitution.

Table 6.18 Respondents' change in willingness to adopt riparian buffers

	Would you be more willing if…	Mean	Std. Dev.	More and much more willing	No change
Scale: Willingness Change Alpha = .949	A good friend installed a stream buffer	2.01	1.361	19%	58%
	Someone in your neighborhood installed a buffer	2.15	1.384	19%	50%
	Most of your neighbors installed stream buffers	2.45	1.528	30%	43%
	You were given guidance how to build a buffer	2.66	1.615	35%	40%
	You received a one-time payment for your buffer installation	2.71	1.548	36%	34%
	You had assistance with buffer maintenance	2.86	1.576	41%	32%
	You received you received yearly payments for your buffer costs	3.01	1.686	49%	34%
	Volunteers planted the buffer	3.01	1.626	47%	31%
	The trees and shrubs were free	3.10	1.656	51%	31%
	A buffer made water runoff from your property cleaner	3.25	1.587	51%	25%
	Your buffer included wildflowers	3.27	1.612	55%	25%
	Invasive or noxious weeds were removed for you	3.32	1.602	57%	26%
	You had a say in designing your buffer	3.40	1.555	56%	20%
	A buffer reduced streambank erosion	3.43	1.630	58%	24%

Scale: 1= no change; 5 = much more willing

Table 6.19. Respondents' private property attitudes, environmental attitudes, and innovation attitudes.

		n	Mean	Std. Dev.	% Agree
Single item: Private Property Attitudes	I don't want others to decide what is on my property	170	4.23	1.06	73%
Scale: Environmental Attitudes alpha = .797 mean = 4.57 std. dev. = .584	I have a moral obligation to maintain water quality	167	4.35	.95	82%
	I want to conserve the stream for future generations	167	4.60	.71	86%
	I would be upset if my activities harmed my stream	166	4.63	.73	89%
	Protecting the environment is important to me	167	4.66	.65	89%
Scale: Innovation Attitudes alpha =.588 mean = 4.07, std. dev. = .810	I am the kind of person who is willing to take a few more risks than others	166	3.79	1.04	58%
	I'm always looking for ways to improve my property	168	4.35	.94	84%

Scale: 1= strongly disagree; 5 = strongly agree

Table 6.20 A stream buffer on my property would improve:

		n	Mean	Std. Dev.	% Agree	Factor loading
Scale: Outcome Expectation Alpha = .957 Cumulative total variance explained = 69.9% Eigen Value = 8.391	wildlife habitat	159	3.89	1.278	70%	.753
	Water quality downstream	161	3.73	1.230	64%	.956
	Water quality in the Chesapeake Bay	160	3.66	1.213	60%	.920
	Water quality in my stream	159	3.64	1.289	58%	.933
	character of my property	158	3.63	1.279	59%	.817
	Water quality in local groundwater	159	3.57	1.250	54%	.939
	children's exposure to nature	150	3.47	1.334	62%	.781
	fish habitat	159	3.43	1.520	56%	.761
	flood protection downstream	157	3.39	1.366	51%	.733
	local drinking water	159	3.35	1.312	46%	.856
	property values	159	3.31	1.308	23%	.679
	access to buffer program payments	143	2.89	1.169	12%	.556

Likert-scale: 1= strongly disagree; 5 = strongly agree

Table 6.21 A stream buffer would:

	Scale Items	n	Mean	Std. Dev.	% Agree	Factor loading
Scale: Buffer constraints	doesn't make sense for the size of my property	152	2.78	1.460	31%	.720
Alpha = .866 Cumulative total variance explained = 60.2% Eigen Value = 3.612	would take up too much land	153	2.76	1.313	25%	.788
	takes too much time to maintain	149	2.69	1.173	14%	.650
	plants look messy	148	2.44	1.168	18%	.741
	doesn't fit appearance of neighborhood	149	2.30	1.245	14%	.778
	would bother my neighbors	148	2.08	1.128	8%	.654

Scale: 1= strongly disagree; 5 = strongly agree

Hypothesis Testing

In this section I first explore the bivariate relationships between three variables—landowner type, stream flow, and parcel size—and respondent attitudes, community engagement (i.e. neighborhood interaction and friendship), water quality perceptions, and adoption willingness. Then, I report results from three multivariate models: amount heard about riparian buffers, landowner willingness to adopt riparian buffers, and change in adoption willingness.

<u>Effect of stream flow</u>. A one-way ANOVA yielded many significant differences across stream flow groups (always, most of the time, sometimes, and rarely) (Table 6.22). For space considerations only significantly different variables are shown. In general, respondents with more regular stream flow exhibit greater concern for the stream and water quality (mean regular flow = 3.65; mean rare flow = 2.06; p=.000) (Table 6.22a). Compared to landowners with intermittent streams, respondents with more regular flow also perceive that they know more about water

quality in their streams (mean regular flow = 2.81; mean rare flow = 1.63; p=.000) (Table 6.22a). Riparian landowners adjacent to regularly flowing streams generally have more positive attitudes about riparian buffers.

Perceived knowledge of water quality, concern for water quality, and stream importance differed between landowners who always had water in their stream and those who rarely had water in their stream (Table 6.22a). Differences among these stream flow groups were also found for all items that measured expected outcomes from buffer installation (Table 6.22b). Stream flow groups significantly differed for nine of the 14 items that measured change in willingness to adopt buffers (Table 6.22c). In terms of attitudes towards buffers, the “always” and “most of the time” stream flow groups significantly differed from landowners with rare stream flow for three items, and overall differences were found for a fourth item. Of 11 items that measured beliefs towards buffer constraints, four exhibited significant differences among stream flow groups (Table 6.22d). Respondents who always (p=.015) and most of the time (p=.035) had water present in their stream were significantly more likely than landowners who sometimes or rarely had water in their stream to agree with the statement, “I want to conserve the stream for future generations” (Table 6.22d). This implies that conservation attitudes specific to the stream are tied to the regularity of stream flow.

Table 6.22a. Differences among perceived water quality and attitudes based on stream flow.

Item	"My stream has water in it…"[∞] Always	Most of the time	Sometimes	Rarely	p-value
How would you rate water quality in your stream? (Scale: 1=Excellent; 5=Poor)	2.28[a]	2.71[a,b]	2.71[a,b]	3.64[b]	.003
How concerned are you about water quality in your stream? (Scale: 1=Not at all; 4=Very)	3.65[a]	3.50[a,c]	2.96[b,c]	2.06[b]	.000
How concerned are you about water quality in the Spring Creek watershed? (Scale: 1=Not at all; 4=Very)	3.63	3.58	3.59	3.06	.011
How knowledgeable do you feel about water quality in your stream? (Scale: 1=Not at all; 4=Very)	2.81[a]	2.24[a,b]	2.19[b]	1.63[b]	.000
How important is your stream to you? (Scale: 1=not at all important; 5=very important)	4.76[a]	4.69[a]	3.70[b]	2.60[b]	.000

[∞] Response categories "Always", "Most of the time", "Sometimes", and "Rarely" represent regularity of stream flow.
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Table 6.22b. Differences among stream flow groups for outcome expectation items.

Item	"A stream buffer on my property improves or would improve…"[∞] Always	Most of the time	Sometimes	Rarely	p-value
Fish habitat	4.15[a]	3.47[a]	2.16[b]	2.00[b]	.000
Wildlife habitat	4.18[a]	4.06[a]	4.00[a]	2.19[b]	.000
Property values	3.57	3.32	3.28	2.44	.014
Flood protection downstream	3.60	3.68	3.08	2.50	.008
My children's exposure to nature	3.69	3.71	3.19	2.56	.007
The character of my property	3.91	3.50	3.63	2.75	.006
My access to buffer program payments	3.07[a]	3.29[a]	2.48[a,b]	2.06[b]	.001
Water quality in my stream	4.01[a]	3.85[a,c]	3.13[b,c]	2.38[b]	.000
Water quality in local groundwater	3.79[a]	3.85[a]	3.24[a,b]	2.63[b]	.000
Water quality downstream	4.00[a]	3.88[a]	3.50[a,b]	2.63[b]	.000
Water quality in the Chesapeake Bay	3.89[a]	3.91	3.20[b]	2.75	.000
Local drinking water	3.49[a]	3.20[a]	2.75[a,b]	3.67[b]	.015

[∞] Response categories "Always", "Most of the time", "Sometimes", and "Rarely" represent regularity of stream flow.
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Table 6.22c. Differences among respondents' change in willingness based on stream flow.

	How would the following change your willingness to increase stream buffers on your property? ∞				
Item	Always	Most of the time	Sometimes	Rarely	p-value
You were given guidance how to build a buffer	2.84[a,b]	3.16[a]	2.09[a,b]	1.75[b]	.007
Volunteers planted the buffer	3.31[a,c]	3.64[a]	2.32[a,c]	1.60[b,c]	.000
You had assistance with buffer maintenance	2.97[b,c]	3.61[b]	2.36[a,c]	1.73[a,c]	.000
Invasive or noxious weeds were removed for you	3.51[a,b]	3.85[a]	2.81[a,b]	2.29[b]	.005
Your buffer included wildflowers	3.45	3.72	2.68	2.67	.036
You had a say in designing your buffer	3.60[a]	3.94[a]	2.52[b]	2.87[a,b]	.002
A buffer reduced streambank erosion on your property	3.27	3.75	2.76	2.80	.040
A buffer made water runoff from your property cleaner	3.49	3.61	2.64	2.60	.026
A good friend installed a stream buffer	2.01[a]	2.61[a]	1.55[b]	1.60[b]	.018

∞ Response categories "Always", "Most of the time", "Sometimes", and "Rarely" represent regularity of stream flow.
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Table 6.22d. Differences among landowners' beliefs towards buffer constraints and one general attitude item based on stream flow.

Item	A buffer on my property…[∞] Always	Most of the time	Sometimes	Rarely	p-value
Doesn't fit the appearance of my neighborhood	2.05[a]	2.06[a]	2.77[a,b]	3.27[b]	.001
Has plants that look messy	2.26	2.30	2.82	3.00	.047
Would bother my neighbors	1.88[a]	1.76[a]	2.55[a,b]	3.07[a]	.000
Doesn't make sense for the size of my property	2.44[a]	2.59[a]	3.25[a,b]	4.13[b]	.000
I want to conserve the stream for future generations	4.79[a]	4.70[a]	4.37[a,b]	3.94[b]	.000

[∞]Response categories "Always", "Most of the time", "Sometimes", and "Rarely" represent regularity of stream flow.
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Differences between parcel sizes. I analyzed landowner perceptions and attitudes for differences across four parcel size categories. For all analyses with significant post-hoc test differences, respondents in the smallest acreage category (less than one acre) were significantly less in favor of riparian buffers than those in the largest acreage category (13 or more acres) (Table 6.23a, 6.23b, 6.23c).

Respondents owning less than one acre rated water quality significantly higher than landowners with four to less than 13 acres, and more than landowners with 13 or more acres (p=.000) (Table 6.23a). This corresponds with the earlier finding that non-farmers rate water quality significantly higher than traditional farmers. There were significant differences among parcel size groups in terms of how much respondents have heard or read about riparian buffers (p=.025); yet there were no significantly different multiple comparisons found with the Dunnett T3 test.

Seven items measuring perceived buffer improvements and the outcome expectation scale were significantly different among property size groups (Table 6.23b). Respondents owning smaller properties believed that a buffer on their property would be less effective in improving water quality than respondents with larger parcels. There were no significant differences among parcel sizes and landowner willingness to adopt riparian buffers.

Table 6.23a ANOVA differences between landowner responses grouped by parcel size.

	Parcel size groups				
Item	<1 acre (n=57)	1 - <4 acres (n=42)	4 - < 13 acres (n=34)	13+ (n=42)	p-value
∞How would you rate water quality in your stream?	3.16^{a}	$2.53^{a,b}$	2.28^{b}	1.94^{b}	.000
Ω How much had you heard or read about buffers?	1.46	1.47	1.26	1.52	.025

∞Scale: 1=Excellent; 5=Poor
Ω Scale: 1=nothing whatsoever; 5=A great deal
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Three significant differences exist in terms of parcel size and landowner attitudes about riparian buffers. Respondents with one to less than four acres agreed with the statement, "buffers take too much time to maintain" significantly less frequently than landowners with over 20 acres (p = .008). Landowners with less than one acre agreed more strongly than those owning land between one and four acres that a riparian buffer would bother their neighbors (p = .026).

Table 6.23b ANOVA differences between landowner responses grouped by parcel size.

$^{\infty}$A stream buffer on my property improves or would improve…	<1 acre (n=57)	1 - < 4 acres (n=42)	4 - < 13 acres (n=34)	13+ acres (n=42)	p-value
Wildlife habitat	3.34^{a}	$4.03^{a,b}$	4.17^{b}	4.23^{b}	.003
My children's exposure to nature	3.04^{a}	4.92^{b}	$3.44^{a,b}$	$3.56^{a,b}$	.022
Water quality in my stream	3.19^{a}	$3.89^{a,b}$	$3.59^{a,b}$	4.03^{b}	.009
Water quality in local groundwater	3.21^{a}	$3.76^{a,b}$	$3.45^{a,b}$	3.93^{b}	.032
Water quality downstream	3.32^{a}	$4.00^{a,b}$	3.73^{b}	$4.00^{a,b}$	.021
Water quality in the Chesapeake Bay	3.28^{a}	$3.^{79a,b}$	$3.59^{a,b}$	4.08^{b}	.015
Local drinking water	2.98^{a}	$3.57^{a,b}$	$3.10^{a,b}$	3.80^{b}	.011
Outcome expectation (scale)	3.10	3.74	3.33	3.69	.034

$^{\infty}$Scale: 1=strongly disagree, 2=somewhat disagree, 3=neutral, 4=somewhat agree, 5=strongly agree.
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Table 6.23c. ANOVA differences between landowner responses grouped by parcel size.

∞A buffer on my property…	<1 acre (n=57)	1 - < 4 acres (n=42)	4- < 13 acres (n=34)	13+ acres (n=42)	p-value
Takes too much time to maintain	2.88[a,b]	2.26[a]	2.44[a,b]	3.09[b]	.008
Would bother my neighbors	2.46[a]	1.76[b]	2.07[a,b]	1.91[a,b]	.026
Would require me to grant public access	3.00	2.42	2.26	2.19	.026

∞Scale: 1=strongly disagree, 2=somewhat disagree, 3=neutral, 4=somewhat agree, 5=strongly agree.
Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Differences between landowner typologies. I conducted an ANOVA sorted by landowner typology (traditional farmers, hobby farmers, and non-agricultural landowners). Significant differences were found for only six variables across the range of conceptual areas, signaling that there are far more similarities among landowners with different land uses than previously hypothesized.

Traditional farmers perceive they know significantly more about water quality in the stream on their property than do hobby farmers (p = .050) (Table 6.24). Non-farmers rate water quality of the stream on their property significantly higher than traditional farmers (p = .001). Traditional farmers report that they have heard or read more about riparian buffers than non-farmers (p = .036). Concerning attitudes towards buffers, traditional farmers more strongly agree than non-farmers (p = .046) that buffers take too much time to maintain. There were no significant differences in overall willingness to increase buffer size among respondents; however, hobby-farmers were significantly more willing to increase the size of their riparian buffer than non-farming respondents if a good friend adopted a buffer (p = .029).

Table 6.24. ANOVA differences between landowner types across conceptual areas.

	Landowner Type			
Item	Traditional Farmers	Hobby Farmers	Non-Farmers	p-value
How knowledgeable do you feel about water quality in your stream? (Scale: 1=Not at all; 4=Very)	2.96 [a]	2.25 [b]	2.40 [a,b]	.030
How would you rate water quality in your stream? (Scale: 1=Excellent; 5=Poor)	2.19 [a]	3.00 [a,b]	3.47 [b]	.002
How much had you heard or read about buffers? (Scale: 1=nothing whatsoever; 5=A great deal)	3.56 [a]	3.04 [a,b]	2.70 [b]	.023
I don't want others to decide what is done on my property. (Scale: 1=strongly disagree; 5=strongly agree)	4.73 [a]	4.18 [a,b]	4.13 [b]	.021
A buffer on my property would take too much time to maintain. (Scale: 1=strongly disagree; 5=strongly agree)	3.33 [a]	2.69 [a,b]	2.56 [b]	.031
I would be more willing to install a buffer if a good friend installed a buffer. (Scale: 1=strongly disagree; 5=strongly agree)	4.33 [a,b]	4.50 [a]	3.80 [b]	.034

Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Traditional farmers are significantly more likely to agree with pro-private property rights statements than non-farmers (p = .012); however, differences between landowner types do not exist for environmental and innovation attitudes. Differences among landowner types were not found for sociodemographic characteristics (age, length of residence, length of ownership, primary residence, education, political views, gender) or for community engagement variables. Overall, there are more similarities than differences across the range of landowner types.

I also tested for differences among landowners regarding the amount of information heard about riparian buffers (Table 6.25). Traditional farmers have heard significantly more than non-farmers (p = .036). Hobby farmers did not significantly differ from either of the other groups.

Table 6.25 ANOVA differences between landowner types for amount heard about riparian buffers.

	Landowner Type			
Item	Traditional Farmers	Hobby Farmers	Non-Farmers	p-value
How much have you heard or read about riparian buffers? (Scale: 1=nothing whatsoever; 5=a great deal)	3.56 [a]	3.04	2.70[b]	.023

Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Differences between original willingness and change in willingness. I conducted a one-way ANOVA of the change in willingness scale (ranging from "no change" = 1 to "much more willing" = 5) between original wiliness groups (i.e. not at all willing = 1; very willing = 5) (Table 6.26). Mean across original willingness groups represent respondents' average change in willingness across 14 tested conditions (see Table 6.18). Respondents in the "very willing" and "willing" categories had the highest mean change willingness (means = 3.33 and 3.34, respectively). This indicates that respondents with initially high willingness also exhibited the greatest increase in willingness. In contrast, the "not at all willing" group had the lowest willingness change mean (mean = 1.92). In other words, landowners who were already very interested in riparian buffers became more willing to adopt them in response to various incentives.

Two significantly different willingness categories emerged from the Dunnett's T3 post-hoc comparison. Respondents of the "not at all willing" and "not very willing" categories were significantly different from the "somewhat willing" "willing" and "very willing" groups (p=.000). This means that landowners who are already willing to adopt riparian buffers increase their willingness to adopt in response to the 14 conditions. As landowners' change in willingness differs across groups of baseline willingness, I included the baseline willingness variable in the change of willingness model (below).

Table 6.26. ANOVA of change in willingness among willingness groups.

	Not at all willing	Not very willing	Somewhat willing	Willing	Very willing	p-value
Change in willingness (scale)	1.92[a]	2.30[a]	3.26[a]	3.33[b]	3.34[b]	.000

Different superscripts indicate significantly distinct groups (p =< .05) identified by Dunnett's T3 post-hoc multiple comparisons.

Factors Contributing to Riparian Buffer Information

I created an OLS regression model to predict the amount of information landowners have heard about riparian buffers. The dependent variable question asked landowners "Until now, how much had you heard or read about riparian buffers?" on a five-point scale with 1 anchored with the statement "nothing whatsoever" and 5 with "a great deal." This question was positioned in the survey after a three sentence definition and description of riparian buffers.

The regression model consisted of three blocks: 1) landowner type, 2) water quality knowledge, and 3) environmental attitudes. The first block consisted of two dummy variables, non-farmer and hobby farmer, with traditional farmers as the reference group. This block's adjusted R-square was .039, meaning that it contributed to 4% of the total variance (Table 6.27). The second block of variables concerning water quality perceptions added an additional 26.5% explained variance, which brought the adjusted R-square to .304. The third block raised the adjusted R-square to .313, with an additional 9% variance explained by environmental attitudes.

Table 6.27. OLS regression model predicting amount heard about riparian buffers

Block	Item	Beta	S.E.	Sig.
1 Adj. R-square = .039	Non-Farmers	-.714	.280	.012
	Hobby Farmers	-.399	.356	.264
2 Adj. R-square = .265	Knowledge – water quality In stream	.202	.161	.209
	Knowledge – water quality in Spring Creek watershed	.333	.217	.127
	Knowledge – water quality in Chesapeake Bay	.341	.151	.026
3 Adj. R-square = .009	Environmental attitudes (scale)	.273	.166	.102
Model R-square =.313	Constant	.171	.814	.834

Factors Contributing to Landowner Adoption Willingness: Multi-Variate Analysis

Willingness to Adopt: A Binary Logistic Regression Model. A binary logistic regression was conducted to predict riparian landowners' willingness to adopt riparian buffers. The dependent variable, landowner willingness, was originally measured on a five-point Likert scale from "not at all willing" to "very willing." This scale was then recoded into a dichotomous dependent variable: the willing group consisted of "very willing" and "willing landowners" (n=60; code = 1) and the low-willingness group (n=115; code = 0) comprised of “somewhat willing”, “not very willing”, and “not at all willing” categories. The “somewhat willing” category was grouped with the low-willingness categories to assure the most likely adopters were included in the same willingness group. The dependent variable was then entered into the regression model with five blocks of independent variables. The blocks included: 1) landowner characteristics; 2) social groups; 3) knowledge and buffer attitudes, 4) neighborhood friends; and 5) parcel size (Table 6.28). The model’s sample size was n=138, with n=36 missing cases (20.6%).

The first block of variables are commonly tested in adoption-diffusion studies, and are included here to as a comparison of their importance between agricultural and non-agricultural contexts as well as to control for sociodemographic characteristics in the model. This block contained measures of education, age, a composite scale of environmental attitudes, composite scale of innovation attitudes, and one variable measuring private property attitudes. The first block correctly predicted 56.6% of willing landowners and 89.5% of less-willing landowners (69.0% total) (Table 6.28). This explained for 33.9% of variance (Nagelkerke R-square = .339).

Table 6.28. Binary logistic model descriptive statistics predicting willingness to adopt riparian buffers.

	% Correctly Predicted		
Block	Very willing	Low willingness	Nagelkerke R^2
1 – landowner characteristics	56.6%	89.5%	.339
2 – social groups	52.8%	87.2%	.352
3 – knowledge and buffer attitudes	66.0%	89.5%	.479
4 – neighborhood friends	67.9%	89.5%	.514
5 – parcel size	69.8%	90.7%	.551

The second block consisted of three variables that measured presence in a social group: non-farmers, hobby farmers, and fishermen who fish on their property. With Blocks 1 and 2, the model correctly predicted 52.8% of willing landowners and 87.2% of non-willing landowners (70.0% total). This block brought the Nagelkerke R-square to .352, with 35.2% total variance explained.

The third block included three variables: perceived knowledge about in-stream water quality, knowledge about water quality in the Chesapeake Bay, and a composite variable of beliefs towards buffer constraints (log transformed). The knowledge questions were measured on a four-point scale ranging from "not at all knowledgeable" to "very knowledgeable". The buffer constraints composite variable was computed under factor analysis. Blocks 1, 2, and 3 combined for 47.9% total variance explained, or a 12.7% increase with Block 3. This block correctly predicted 89.5% of low willingness landowners and 66.0% of very willing landowners.

The fourth block considered one variable: the proportion of close friends in a neighborhood, referred to as "neighborhood friends." This variable represents one element of social desirability in that friendships may increase importance of surrounding features (including streams). Block 4 accounted for 3.5% of the variation in the model, which brought the total variation explained to 51.4% (Nagelkerke R-square = .514). With all four blocks combined, the model's prediction of willing (69.8%) and less-willing (90.7%) landowners was increased to 80.3% overall.

The fifth and final block also consisted of one variable: parcel size group. There are five parcel size groups ranging from less than one acre to thirteen or more acres. The marginal variation explained in this block was 3.7%, with the total variation explained increasing to 55.1% (Nagelkerke R-square = .551). The model (Blocks 1, 2, 3, 4, and 5) correctly predicted 69.8% of willing landowners and 90.7% of less-willing landowners correctly, with an average 80.3% correctly predicted.

Of the 13 variables included in the final model, six significantly predicted willingness to adopt riparian buffers ($p < .05$), and one variable, innovation attitudes, was marginally significant ($p < .10$) (Table 6.29). Landowners with more positive innovation attitudes were twice as likely to adopt a buffer at every unit increase on the five-point Likert scale (odds ratio = 1.935; $p = .051$). Private property attitudes were negatively related to landowner willingness ($p = .004$), as hypothesized. Controlling for all other variables, every unit increase on a Likert scale in agreement with pro-property rights corresponds with a 56.6% lower chance that landowners are willing to adopt riparian buffers. Surprisingly, the environmental attitudes variable was not a significant predictor of buffer adoption willingness, which contrasts the adoption-diffusion literature.

Non-farmers were 89.9% less willing to adopt riparian buffers than traditional farmers, (odds ratio = .101; $p = .019$). Hobby farmers did not significantly differ from traditional farmers in adoption willingness, when other variables were controlled. Hobby farmers and traditional farmers are classified in this study under the same metric: presence of animals or cropping on the property, which makes them more similar than hobby farmers and non-farmers. There are many differences between hobby and traditional farmers, such as profitability goals, the presence of off-farm income, and social networks in which information is shared. These factors are not represented in this model, yet are likely drivers in landowner conservation behavior.

Perceived knowledge of water quality in their stream is positively related to are adoption willingness ($p = .035$), as with every increase in perceived knowledge (e.g., from “not at all knowledgeable” to “somewhat knowledgeable”), landowners are nearly twice as likely to adopt a riparian buffer as they were before. Landowners who agreed with buffer constraints were 90.8% less willing to adopt riparian buffers than landowners one unit lower than them on the buffer constraints scale (odds ratio = .092; p = .002).

Having more close neighborhood friends encourages landowner adoption willingness to adopt (p = .013, odds ratio = 1.974). Landowners with smaller properties are 50.3% less likely to be willing to adopt riparian buffers than landowners in the next-highest property size group (odds ratio = .497; p = .019). For example, landowners with 1 acre are significantly less willing to adopt riparian buffers than landowners with 3 acres.

Table 6.29. Binary logistic regression model predicting landowner willingness to adopt riparian buffers. High willingness = 1; low willingness = 0.

Block	Item	Beta	S.E.	Wald	Sig.	Odds Ratio
1	Environmental attitudes (scale)	.809	.576	1.975	.160	2.246
	Innovation attitudes (scale)	.660	.338	3.813	.051	1.935
	Age	.026	.020	1.742	.187	1.026
	Education	.183	.168	1.186	.276	1.200
	Private Property attitudes	-.836	.291	8.256	.004	.434
2	Non-farmers	-2.293	.974	5.543	.019	.101
	Hobby farmers	-1.065	.933	1.301	.254	.345
	Fish on property (y/n)	.205	.594	.119	.730	1.227
3	Buffer constraints (scale)	-2.386	.754	10.018	.002	.092
	In-stream water quality knowledge	.619	.293	4.456	.035	1.858
	Chesapeake Bay water quality knowledge	-.031	.317	.010	.922	1.032
4	Neighborhood friends	.680	.275	6.112	.013	1.974
5	Parcel size	-.699	.298	5.497	.019	.497
	Constant	-3.468	3.966	.733	.379	.031
	Model R-square	.551				

Increase in Willingness to Adopt: A Linear Regression Model. I created a linear regression model to predict landowners' change in adoption willingness. The dependent variable, willingness change, is a scale representing respondents' average response to a set of conditions. The scale ranges from "no change" to "much more willing", and underwent means substitution. Independent variables were tested for this model based on hypothesized relationships with the independent variable (see Chapter Four); however, very few hypothesized variables or significant predictors of adoption willingness were found significant in the linear model.

Three blocks were entered into the final model: 1) baseline willingness and outcome expectation; 2) underlying attitudes; and 3) social involvement (Table 6.30). The first block consisted of two variables: the baseline adoption willingness item, "How willing are you to increase the amount of your property under a buffer?" and the outcome expectation scale. As noted above, the change in willingness variable exhibited significant differences across the baseline willingness categories, making it fit for inclusion in this regression analysis. This block's adjusted R-square of .310. The second block consisted of two attitudinal variables that were significant predictors in the logistic model: innovation attitudes, and private property rights attitudes. This block decreased the R-square to .304; however, these variables were retained in the final model as I believe they are important control variables.

Block 3 consisted of four social involvement variables: neighborhood friends; three dichotomous variables: membership in a national environmental organization, membership in a sportsman's organization, and membership in a national farming organization (Table 6.30). This model accounted for 5.9% of the variation, with the final model's adjusted R-square = .363

Of the eight variables entered in the final model, four were significant predictors of change in willingness ($p < .05$). Landowners with higher original

Table 6.30. Linear regression model predicting landowners' change in adoption willingness.

Block	Item	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	Sig.
1	How willing are you to increase the amount of your property under a buffer?	.350	.070	.426	.000
	Outcome expectation	.303	.089	.270	.001
2	Innovation attitudes (scale)	-.101	.098	-.072	.302
	Private property rights attitudes	.037	.081	.034	.647
3	Member - national environmental group (y/n)	-.650	.239	-.195	.007
	Member - national farming group (y/n)	.411	.246	.118	.097
	Member - sportsmen's group (y/n)	-.258	.178	-.100	.149
	Neighborhood friends	.179	.071	.168	.013
	Constant	.088	.904		.923
	Model	R-square = .363			

adoption willingness are more likely to increase their adoption willingness than less-willing landowners, even when attitudinal variables are controlled (p = .000). Additionally, landowners with increased adoption willingness exhibit stronger, more positive outcome expectations (p = .001).

Neighborhood friendships (p = .013) encourage increased adoption willingness. Surprisingly, membership in a national environmental organization discourages adoption willingness (p = .007).

CHAPTER SEVEN

DISCUSSION

Chapter Introduction

In this chapter I summarize my qualitative and quantitative results and relate them to past research in the adoption-diffusion tradition. I evaluate the adoption-diffusion model's performance in the Spring Creek watershed, which is composed of diverse sets of landowners with heterogeneous land use. I then examine findings that suggest a need to depart from the traditional adoption-diffusion model, and consider how these departures are influence the particular context—an urbanizing watershed. I propose that efficacy theory, in combination with adoption-diffusion theory, should be used to consider water quality conservation behaviors. I argue that efficacy provides additional theoretical power for analyzing how downstream water quality outcomes influence landowner adoption behavior. To a similar end, social identity theory is proposed as a compliment to diffusion theory to explain the pattern of riparian buffer awareness among landowners. I discuss how this pattern is influenced by policy-based conservation programs, and then make policy recommendations given rapid urbanization. I then examine the potential effectiveness of residential riparian buffers, and encourage further research in this area.

Summary of Results

<u>The adoption-diffusion model in a heterogeneous landscape?</u> The adoption-diffusion model has been applied to conservation practices since the mid 1980's, but very few studies have considered the model in regions undergoing rapid land use

change. Most adoption-diffusion studies of conservation practices have emphasized farmer behavior. The Spring Creek watershed is rapidly urbanizing from predominantly agricultural to intermixed residential, hobby farm, and traditional farm land uses. Therefore, the watershed was an ideal location to test how well the adoption-diffusion model holds on a transitioning landscape.

The binary logistic regression model of landowner willingness to adopt (Chapter Six) support the adoption-diffusion model in two dimensions: 1) landowner innovation and private property rights attitudes are significant factors of adoption when all other factors are controlled; and 2) attitudes towards the specific innovation, here "buffer constraints" also shape adoption willingness. The mixed-landowner model reaffirms the importance of broad, underlying attitudes, suggesting some transferability of the agricultural-based adoption diffusion model. The importance of these attitudes also underscores the influence of long-standing social structures, such as organizations and family, which encourage and reconfirm certain attitudes within member individuals. Central Pennsylvania is commonly known for more conservative attitude orientations, particularly regarding private property rights.   It is therefore likely that local social organizations and family perpetuate the importance of private property rights. While underlying attitudes are difficult for practitioners to change through policy-based incentives, these attitudes may be used as indicators to target potential riparian buffer adopters.

My model of riparian buffer adoption also demonstrated that landowner perceptions of buffer characteristics, such as size and aesthetics, and that these characteristics potentially constrain buffer adoption. This upholds the adoption-diffusion model in that the nature of the innovation, or its characteristics and fit within ongoing management practices and properties, is directly related to landowner willingness.

Landowners with more property were more willing to adopt riparian buffers than landowners of smaller properties, net other factors. Riparian buffers are a unique innovation in that they transform space through altering landcover. Physical space is necessary for riparian buffer installation, particularly if buffers are to meet policy-prescribed dimensions. That parcel size is a prominent factor of riparian buffer adoption is reflective of farm structure—an important adoption factor identified in previous adoption research on conservation and commercial innovations (Rogers, 1995). While farm size generally means greater profitability, parcel size in a heterogeneous landscape does not. For example, a household may own 40 acres with forest and have a lower socioeconomic standing than a Penn State professor who owns two acres and a large, new home. Therefore, parcel size in a mixed land use setting is not an indicator of property structure or land capital as farm size represents on an agricultural landscape. Rather, the parcel size factor signals different environmental contexts (i.e., landscape characteristics and ownership structure).

Some factors that commonly predict adoption willingness did not explain adoption in my analyses. Education and age, two key variables in most adoption studies, did not influence riparian buffer adoption, accounting for other factors.

Environmental attitudes. Net of other factors, environmental attitudes did not influence adoption willingness or change adoption willingness. This finding is rather surprising given the prevalence and prominence of environmental attitudes as key predictors in past adoption-diffusion of conservation practices (Prokopy et al., 2008). My overall findings suggest that landowner willingness is based more so on how riparian buffers mesh with their property rather an affinity for the environment.

Knowledge of riparian buffers. Information about potential innovations is a prominent factor in many adoption-diffusion studies; however, previous amount of information did not influence landowners' adoption willingness, and was not included in the OLS model.

To further explore why information exposure was not a factor of adoption, I used another OLS model predicting how much landowners have heard about riparian buffers. This model identified one positive factor, perceived knowledge of Chesapeake Bay water quality, and one negative factor, non-farming landowners. These findings point to policy-based outreach initiatives as prominent information sources about riparian buffers. These initiatives encourage agricultural landowners to implement BMPs to improve Chesapeake Bay water quality, yet they have created a spatial disconnect between what motivates buffer adoption (local water quality knowledge) and the promoted riparian buffer outcomes (Chesapeake Bay water quality).

Departures from the adoption-diffusion model. My findings suggest many departures from the traditional adoption-diffusion model. Some are related to fundamentals within adoption-diffusion theory itself, while others relate to the theory's application to an urbanizing context.

Landowner typologies. One landowner type, non-farmers, was a key, negative factor of riparian landowner adoption, compared to traditional farmers. Most adoption diffusion studies of conservation practices have not created landowner typologies based on the presence, absence, or intensity of agricultural activities. This is a departure from the adoption-diffusion model that I believe is best supported by social identity theory, discussed below.

Although much of my analysis and discussion is framed in terms of differences among discrete landowner typologies (non-farmers, hobby farmers, and traditional farmers), I realize that these typologies are not rigid and that individuals may change typologies over time, particularly as their social identities transition in relation to surrounding land uses. For example, three landowners enrolled in CREP were categorized as non-farmers in my land use classification scheme. While this suggests that riparian conservation programs may be available to non-traditional farmers, it is possible that these properties are retired farms.

Change in adoption willingness. As examined under the OLS regression, changes in adoption willingness are not related to parcel size, land use, or other common adoption-diffusion factors. Rather, landowners with higher initial adoption willingness are also more likely to increase their willingness, and those with initial low willingness are not likely to change their willingness, when controlled for environmental, innovation, and private property rights attitudes.

This finding suggests that there is a core group of landowners that strongly believe in riparian buffer adoption and that their enthusiasm will intensify in response to various incentives. These landowners are likely motivated to adopt riparian buffers out of a pro-buffer attitudinal orientation. More generally, landowners increase their adoption willingness when they have more positive outcome expectancies from a riparian buffer on their property. This means that as landowners believe that their buffer can enhance water quality locally and in the Chesapeake Bay, they are more willing to exhibit greater adoption willingness.

The relationship between initial willingness and willingness change also indicates that a group of very unwilling landowners will continue to oppose buffers regardless of incentives. This leads to a broader scenario in which landowners are polarized in strong opposition to, or in favor of, riparian buffers. In turn, watershed managers may wish to target landowners with less-strong pro-buffer attitudes for riparian restoration. This programmatic attention to a less zealous participant could expand landowners' notions of the types of people who support riparian buffers. Therefore, the pool of landowners with more neutral buffer attitudes may perceive that riparian buffers are not a demonstration of extreme environmental attitudes, but something that is applicable for more moderate landowners.

Neighborhood friendships. Both adoption willingness models identified neighborhood friendships as positive predictors of riparian conservation. Neighborhood friendships represent one dimension of social cohesion—sense of community, which is built over time. Sense of community contributes to a place-based identity in which natural and social features enhance social cohesion. Social cohesion is typically not found as a factor of adoption—possibly because it is rarely considered within adoption-diffusion framework. That neighborhood friendships encourage or discourage landowner willingness speaks to social desirability surrounding riparian buffer projects. Riparian buffers can be highly visible on the landscape, as they typically involve taller permanent vegetation, protected tree plantings, and in some eyes, "messy" vegetative growth (though I note that riparian aesthetics were not any more of an adoption obstacle than perceived size constraints). These changes to property appearance are readily observable to friends and neighbors, who may support riparian conservation. On the other hand, neighborhood social norms may emphasize traditional property maintenance, such as well trimmed lawns and visible streams. Either way, landowners with more neighborhood friendships may be influenced by members of their social groups regarding buffer adoption. With more members observing riparian buffer conservation, the more social rewards or acknowledgements landowners will receive for their conservation behaviors. Therefore, riparian buffers could be "contagious" within a tightly-knit neighborhood.

The effects of neighborhood friendships could easily work against riparian buffer adoption as well. In the factor analysis of change in willingness items, those that measured social desirability (e.g., a good friend installed a buffer, a neighbor installed a buffer) did not emerge as influential items. This suggests that social desirability is not a prominent factor of adoption; however, when the notion of "neighbor" and "friend" are combined, willingness is encouraged. Therefore, intra-neighborhood strong-ties, or close friendships, are more influential than weak-ties, or neighbor interactions, in shaping property management behaviors. If social norms dictate "tidy" riparian areas, then neighborhood strong-ties are a barrier to adoption.

Neighborhood friendships and social cohesion develop over time. We would therefore expect landowners with a high proportion of close friends to have lived in the same neighborhood with the same neighbors for a substantial amount of time. In a transitioning landscape, homeowners may be long-term residents, yet an influx of residents under urbanization could introduce more weak ties to a neighborhood. Under this approach, conservation behaviors and attitudes could suffer in transitioning areas with lower social cohesion and social desirability for pro-environmental behaviors. However, continuing this scenario in time, incoming residents introduce new ideas, conservation practices, and social norms in an area that perhaps resisted environmental behaviors. As long-time residents observe and gain trust in the new, more innovative members of their neighborhood, environmental behaviors could proliferate. Future research should examine temporal aspects of adoption-diffusion, social cohesion, and landscape change to further our understanding of intra-neighborhood social processes.

Outcome expectations. The "willingness change" OLS model identified outcome expectations as a positive factor of adoption, when other variables were controlled. Landowners' outcome expectations are a component of efficacy, and represent the extent to which an individual believes he or she can evoke a specific outcome. I measured outcome expectations of riparian buffer adoption with the question "How much do you agree or disagree that a stream buffer on your property improves or would improve the following?" Again, outcome expectations are typically not considered in adoption-diffusion research, yet it enhanced the predictive power of adoption willingness change. I discuss the importance of this variable and concept below.

Limitations to the adoption-diffusion approach in transitioning landscapes. There are three basic limitations to the adoption-diffusion theory: adoption and non-adoption are not mutually exclusive, de-adoption is unaddressed in the conservation practice literature, and maintenance of adoption behaviors is absent. Additionally, adoption-diffusion theory fails to account for landscape-level factors that influence individuals' adoption behavior.

Adoption is not dichotomous. Rather, I propose that we consider adoption of conservation practices as a gradient of adoption to non-adoption across which a landowner may vary over space and time. Landowners commonly adopt certain aspects of a riparian buffer, such as streambank fencing, but do not include other pieces of adoption, such as tree planting, in their project. Riparian buffers are rarely uniform across individual properties, as they frequently vary over width and vegetation content. These real-life behaviors present difficulty for adoption models based on dichotomous dependent variables.

Maintenance of a conservation practice over time is also not included in the standard adoption-diffusion model. In my analysis, maintenance was one component of the buffer constraints factor, a negative predictor of adoption willingness. Buffer maintenance, particularly livestock exclusion, may lead to rather immediate water quality improvements; however, lack of maintenance could present a major obstacle for long-term riparian conservation success. Buffer maintenance can change over the life of an innovation based upon social factors (adopters' age, health, finances) and attitudes towards the buffer. Results from the semi-structured interviews showed that landowners who were initially enthusiastic about riparian fencing projects became dissatisfied by the loss of visual access to their stream, changing vegetation within the buffer region, and the amount of work required for fence maintenance. Agricultural landowners are readily familiar with maintenance demands—fences required upkeep before they were put near streams. However, non-traditional farmers, including many hobby farmers, expressed surprise at the amount of maintenance required for riparian buffer survival. As local programs collaborate more frequently with non-agricultural landowners, they should include maintenance guidelines upon project initiation so that landowners have a reasonable expectation of their future commitments.

Different from the adoption-non-adoption gradient is the de-adoption of a practice. My qualitative findings identified two farmers who either removed their streambank fencing altogether or fenced livestock within the riparian area rather than outside as intended. De-adoption of innovations has been considered for certain technological or health behavior practices, but the conservation practice literature is largely silent on this behavior. My survey instrument did not address de-adoption, as riparian buffers are a new practice for many non-farming residents and it is likely too early on the adoption timeline to measure de-adoption.

Adoption diffusion does not consider neighborhood or landscape-level factors that shape adoption behavior. The adoption-diffusion analysis presented here is non-spatial in that the locations of potential or actual adopters were considered. Future adoption-diffusion analyses, particularly in heterogeneous landscapes, should consider the spatial relationship among adopters, non-adopters, and potential adopters. In doing so, social and landscape influences on adoption may be more readily identified. Additionally, spatial data is more suitable for using in a watershed disproportionality framework.

Neighborhood structure is another important consideration for future adoption-diffusion analyses in transitioning landscapes. Social behaviors, such as disseminating information, installing a riparian buffer, or having neighborhood friendships, are all likely influenced by the rate and proximity of urbanization. As neighborhoods urbanize, they will likely change the social connectivity among residents, which as we learned here plays an important role in riparian buffer adoption. Another element of neighborhood structure that is more readily observable is parcel size. With urbanization, there will be more, smaller parcels, thus changing the potential opportunities and constraints for adoption of particular land practices.

As seen in my qualitative results, landowners are aware of landscape change. With potential for continued urbanization, landowners may feel less desire or place less importance on investing in a new conservation project. Broader forces such as land use and social change are not measured in the adoption-diffusion model, but play an important role in the decision to adopt riparian buffers.

Hypothesis performance. Looking back on my research hypothesis (Chapter Four), certain landowner characteristics (H1) failed to predict buffer adoption (education, age, environmental attitudes) and others were successful predictors (traditional farmers, positive innovation attitudes, and private property rights emphasis). Landowner awareness (H2) was not a factor of riparian buffer adoption willingness in the logistic regression analysis, but I suspect that this is tied to policy-based focus on agricultural landowners for buffer outreach. Knowledge about in-stream water quality was a positive factor of buffer adoption willingness, but knowledge about water quality in the watershed and the Chesapeake Bay were not significant predictors. As discussed further below, landowners' social identity (H3) was influential in terms of how landowners heard of riparian buffer opportunities and practices. Self-efficacy (H4) was also associated with positive adoption willingness, as seen in the interviews. Outcome expectations, or how landowners perceive a buffer shaping various improvements, were positively related to adoption willingness change, rather than baseline adoption willingness, as hypothesized.

Concerning my willingness change hypotheses, landowners were neither more willing to adopt buffers based on pro-innovation attitudes, pro-environmental attitudes, nor amount heard about riparian buffers. Property "fit" with riparian buffer implementation was best described by the buffer constraints factor (a composite of six items). Buffer constraints did not predict willingness change, as hypothesized, but instead was a factor of initial willingness.

Efficacy informs the adoption-diffusion model

In this section, I discuss how the notion of efficacy supports the adoption-diffusion model in the context of water quality BMPs. Self-efficacy is an individual's perception of his or her ability to carry out a certain behavior. This is represented by the question *"Do buffers work for me?"* (Figure 7.1; see discussion below regarding means-ends beliefs, or *"Do buffers work?"*). I first discuss my self-efficacy findings from the qualitative interviews. Then, I consider landowners' outcome expectations, or their answers to the question *"What will result from my buffer?"* as measured in the quantitative phase. I explore how outcome expectations are supported by outcome values, or as landowners would ask, *"Do I care?"* about buffer outcomes. I then discuss combining collective efficacy with adoption theory as an area for future research, including methodological considerations.

Figure 7.1. The relationship of self-efficacy to outcome expectations and outcome values as determinants of adoption (adapted from Kirsch, 1995).

Efficacy may contribute explanatory power to the adoption-diffusion approach. Landowners readily expressed notions of self-efficacy during the qualitative interviews, particularly in terms of the size of their riparian property, existing land uses within the riparian zone, and their perception of water quality and wildlife abundance in the surrounding area. In general, farmers who fenced out livestock from riparian areas expressed stronger self-efficacy notions than hobby farmers with fewer animals. This pattern points to landowners' perceived impacts on streams as an indicator of their self-efficacy for water quality improvements. Again, traditional farmers may express a strong sense of self-efficacy because they are more aware of riparian conservation than non-traditional farmers.

Outcome expectations are the perception that a behavior will produce a certain outcome. The outcome expectations scale, which represents landowners' perceptions that buffers on their property will attain various water quality and environmental outcomes, improved the prediction power of the adoption-diffusion model as demonstrated in the "willingness change" OLS analysis. According to efficacy theory, individuals must value the outcomes they expect from a behavioral change before they make this change. While my results found outcome expectations as a factor of willingness change, outcome values as represented by variables such as water quality concerns, stream importance, or environmental attitudes, were predictors of riparian buffer adoption. If efficacy theory holds, and positive outcome expectations still imply that these outcomes are valued, then landowners probably have complex value orientations that underlie their conservation behaviors.

These value orientations may not be based on environmental outcomes. Neighborhood friendships encourage both initial adoption willingness and change in willingness. This, in combination with the comparatively weak influence of environmental values, strongly suggests that the outcomes landowners most value may be social responses to their riparian conservation behaviors. In other words, in-stream water quality improvements encourage landowner willingness, but the outcomes most valued are those deemed socially desirable by their neighborhood friends. Again, if social norms dictate that riparian buffers are unacceptable, outcome expectancies may work in opposition to adoption.

I contend that outcome expectations should be considered in future conservation practice adoption research as it accounts for individuals' perceived contribution to a specific outcome. This is in line with the goal of conservation practices, which target environmental improvements. Outcome expectations represent a dimension of how potential adopters rationalize the purpose of their adoption.

Collective efficacy. Collective efficacy is another conceptual tool that may be used to explain individual conservation behavior. In general, collective efficacy represents a perception of a collective's ability to perform a certain behavior (Zaccaro et al., 1995). If collective efficacy was integrated with adoption-diffusion theory, then the concept should be operationalized as the individual's sense of a collective's ability to perform a certain behavior to the extent that an outcome or sets of outcomes are realized. The collective may be a social group, like a neighbor or a type of land use, to which the individual belongs.

During interviews, landowners expressed notions of collective efficacy towards their areas' abilities to implement riparian buffers in order to improve downstream water quality at the Chesapeake Bay watershed scale. Often landowners described the collective at the stream scale, using examples of downstream or upstream neighbors' behaviors. Collective efficacy is a likely factor of conservation adoption that was not quantified in my mail survey.

Collective efficacy may inform adoption-diffusion theory in that it measures the extra-parcel, social factors that shape an individual or household's adoption decision. Like formal conservation incentives and programs, adoption research has focused too much on individual characteristics and has not incorporated sociopolitical factors that guide adoption. Programs based on voluntary, parcel-by-parcel incentives will continue to be ineffective in promoting collective efficacy among landowners without stepping back and taking a targeted, landscape scale approach to water resources conservation.

Unfortunately, this research cannot offer specific incentives that would bolster landowner willingness for riparian buffers. This is because the suite of incentives tested on the mail survey, which ranged from monetary payments to social incentives (e.g., your neighbor has a buffer), aggregated into one factor with a high reliability score (alpha = .949). This alpha score represents high correlation among survey respondents, meaning that there is little differentiation between the types of responses for each willingness change item. While this is convenient from an analysis perspective, I am unable to specify the types of incentives or conditions that landowners would most prefer, or would most likely increase their buffer adoption willingness.

Similarly, I am unable to differentiate the types of riparian buffer outcomes landowners most expect from buffers on their property. The outcome expectations scale included five measures of water quality improvements and seven other improvements that were social (perceived property values) and biophysical (fish habitat). Again, all outcome expectation items loaded onto one factor with high reliability (alpha = .957). This means that landowners believed that a buffer on their property could improve wildlife habitat just as well as it could improve local groundwater. This suggests that landowners are more reflective about their capacity to attain these outcomes (self-efficacy) than the buffer's ability to effect change (means-ends beliefs).

Methodological Implications

My choice of methods influenced my research findings. From the quantitative analysis I gained access to landowners who otherwise may not have participated in an intensive, qualitative study. The mail survey allowed me to identify and quantitatively asses the relative impacts of adoption factors. This general understanding of the watershed-wide drivers of adoption enable me to make theoretical comparisons and expansions on the adoption-diffusion model as well as make policy and watershed management recommendations (see below).

The quantitative analysis precluded me from understanding certain mechanisms relevant to the diffusion of riparian buffer information; however, the semi-structured interviews uncovered diffusion patterns, such as the formality and strength of relationships between individuals sharing information. Information such as this that builds over the course of an interview is not readily captured in a close-ended survey. One concept readily mentioned during interviews was that of collective efficacy. This is a difficult concept to measure quantitatively, primarily because collective efficacy may be defined as a representation of a collective's sense of efficacy or an individual's perception of a collective's efficacy of which the individual is a member. If a researcher takes on the latter definition, then collective efficacy may be measured with survey instruments or other methods that focus on the individual. Collective efficacy perceptions from an individual's perspective may be useful in explaining water quality behaviors, and is an area ripe for methodological and theoretical exploration.

Social identity influences exposure to riparian buffers

Social identity theory, which explains individuals' identity formation from inter-group comparisons, is an important compliment to adoption-diffusion theory as it is applied to the transitioning landscape. This approach accounts for landscape heterogeneity—the diversity of land uses and land management styles across the watershed. Landowners of commercial farms will more likely construct social identities similar to those of other farmers than they would suburban professors. Social identity theory includes how landowners self-categorize over time, and how their social identities may change over time as the landscape urbanizes.

Non-farmers and hobby farmers identify themselves differently from traditional farmers. The social identification as "not a big-time" or "not a for real" farmer was common for most hobby farmers, and some retired farmers who still owned their farm properties. These identities shaped how landowners viewed riparian buffer implementation programs. Compared to their nearby traditional farmers, hobby farmers often thought that their farms were not competitive for programmatic support. The prevailing non-farmer perception is that riparian buffer programs "are for farmers to keep their cows out of streams" and that the programs did not apply to non-farmers. These non-farm landowners did not view riparian buffers as appropriate for their land uses because they didn't identify their purposes with the typical farm-focused conservation policies. This is a major barrier for riparian buffer adoption, and holds watershed management implications (discussed below).

Social identity theory also informs the diffusion of riparian buffer information. One result from the semi-structured interviews was that agricultural landowners learned about riparian buffers through formal contact with conservation professionals, where as non-farmers and hobby farmers learned about buffers through informal social relationships or through their formal education. Landowners seek information from different sources depending upon their social identities. For example, hobby farmers did not mention the county conservation district as their initial buffer information source; however, many traditional farmers specified more agriculture-focused organizations as their primary project contacts.

The type of information sources (formal vs. informal) may also encourage or discourage the social desirability of riparian buffers. As seen in the interviews, landowners who were approached by an organization for buffer implementation often expressed notions of "doing their part" for water quality, but they did not exhibit as much pride and sense of leadership as landowners who sought buffer information. In learning of riparian buffers from social contacts, landowners may also be guided by social pressures that are attached to this information.

My qualitative findings illuminate the potential interaction between social identity and self-efficacy based upon land use. Landowners self-categorize using land use characteristics, particularly agricultural activities or intensities (e.g., "We're not a big time farmer"). Traditional famers, in general, have stronger self-efficacy notions than non-farmers, meaning that farmers believe that their riparian buffers make a positive difference in stream quality. Perhaps through education and experience, it is apparent that farmers have crafted a social identity of high efficacy. In other words, farmers and non-farmers understand that agriculture can harm water quality, but that their BMPs such as riparian buffers can lessen those impacts. This is a social identity of high efficacy. Such and identity likely encourages adoption within the social group (i.e., among other farmers); however, it may hinder buffer adoption for non-farming landowners. Non-farmers may believe that, compared to farmers with high self-efficacy, their self-efficacy is too low to be worthwhile or attain environmental outcomes.

Urbanization may change the social identities of inhabiting landowners as these identities relate to riparian conservation practices. Landowners in transitioning neighborhoods will likely be exposed to new property management behaviors. These potential shifts in land use and specific practices may change, or lessen the importance of, certain features by which landowners form their social identities and self-efficacy notions. In turn, there are changes to the defining characteristics used in self-categorization processes. Similarly, with different land use and conservation practices implemented by many types of landowners, not just farmers, there may be an expansion in the types of behaviors seen as logistically and socially appropriate. Therefore, under urbanization and diversification of land use practices, property management norms may change or relax as the normative behaviors of the earlier neighborhood become few and far between. With lesser prevalence, such norms may weaken in their influence on specific practices, or possibly even broader social identities.

Policy results and implications

Local policies and organizations must recognize changing land use patterns and modify their programmatic support to reflect the land use composition. This will require organizations to diversify their program content and outreach strategies to best suit a range of riparian landowner attitudes, preferences, and project objectives.

Three of the four local organizations interviewed worked primarily with agricultural landowners in riparian conservation. County soil and water conservation districts work predominantly with agricultural landowners, as they have since the early 1930s. In the Spring Creek watershed, the State College Borough Water Authority (SCBWA) works directly with riparian farmers to reduce nutrient contamination. The SCBWA recently held forums, much like focus groups organized by neighborhood, to educate farmers on riparian buffer opportunities and nutrient management BMPs (e.g. conservation tillage). The SCBWA also connected farmers with organizations like the conservation district for riparian buffer implementation. On the other hand, Clear Water Conservancy coordinated or contributed to a number of riparian buffer projects on both agricultural and non-agricultural properties.

Local organizations carry out regional institutional mandates for water quality conservation. Until very recently, the Chesapeake Bay Program has focused primarily on agricultural sources of nitrogen, phosphorus, and sediment pollution. My research found that this policy-driven focus on farmer outreach is reflected among landowners' comparative knowledge of riparian buffers. Non-farmers are less aware of riparian buffers than traditional farmers. Additionally, those who are aware of riparian buffers perceive to know more about Chesapeake Bay water quality. Perceived knowledge about water quality in their stream or in the Spring Creek watershed did not predict the amount landowners heard about buffers.

These findings represent spatial and land use discrepancies between the factors that motivate buffer adoption and how riparian buffers are encouraged across the landscape. Policies that emphasize Chesapeake Bay-related riparian buffer outcomes do not motivate adoption. While landowners who receive this information may know more about the Bay's perilous condition, they do not change their property management behaviors accordingly. This lack of action may not be out of apathy, but because landowners are not aware of potential mitigating behaviors. Traditional farmers are probably significantly more willing to adopt riparian buffers than non-farmers because they have been the focus of policy-based outreach for twenty years. Farmers know more about the potential outcomes of riparian buffers and have a stronger sense of efficacy than non-farmers.

Local organizations are key players in riparian buffer implementation, yet most continue to tailor their programmatic and technical support to farmers, even in the face of urbanization and agricultural land conversion. Given current urbanization rates, the prevalence of farmers will decrease in the Spring Creek watershed over the next twenty-five years. Given predictions of continued urbanization, where should organizations focus their attention for riparian conservation?

Landowners with smaller parcels are more willing to adopt buffers than large-parcel landowners, yet non-agricultural landowners are significantly less willing to adopt riparian buffers than agricultural landowners. Figure 7.2 depicts relative riparian buffer adoption willingness among four landowner ideal types: small non-farmer, small farm, large non-farm, and large farmer. Larger circles represent the proportion of riparian land owned by that ideal type.

In the current situation (a), large farmers are the most willing to adopt riparian buffers, while non-farmers with larger properties are the least willing. A moderate portion of the total potential willingness (dark gray) is left "unclaimed" by any of the landowner ideal types, suggesting that there is a bottleneck in the current system. Under persistent urbanization, riparian landownership will transition to non-farmers who own smaller parcels (i.e., smaller riparian segments). If the policy framework remains at the status quo and the total potential willingness is unchanged (b), non-farmer adoption willingness will likely remain at the current level, but the number of small, non-farmers will increase, thereby decreasing the proportion of non-farm riparian buffers. Large farmers, though decreasing in riparian ownership, will continue to receive a disproportionate amount of incentives and policy-based support. At some point, maximum adoption rates will be attained.

Policy frameworks can adapt to meet conservation needs. Under a policy adaptation scenario that also considers projected population increases and total willingness change does not change (c), small farms and small non-farmers, would gain more policy-based incentives and information accompanied by population increases. Large non-farms will decrease in riparian acres owned, but have a greater proportionate willingness to adopt buffers because of new outreach initiatives. As in the status quo scenario, large farms will likely reach maximum adoption willingness by the time of policy adaptation, as farmers' exposure to riparian conservation practices is already widespread. There is no foreseeable reason why large farms would decrease adoption willingness if other landowners became more willing, unless resources were dramatically re-distributed away from agricultural conservation.

Implications for watershed management

The adapted policy framework recommended above translates into a tailored, local approach for watershed management. These local-level watershed managers are still positioned within the multi-scale institutional framework that serve as a backbone for regional watershed partnerships, yet with more autonomy to make decisions, set priorities, and initiate projects that are relevant to their watershed's landscape. Grant programs that link upper-level watershed policy with local programming may change grant allocations from project-based to land use based, thereby including watershed-level context into project implementation and addressing water quality degradation from multiple sources, not exclusively agriculture.

Watershed managers and conservation program practitioners that operate in heterogeneous landscapes must be equipped with a variety of water quality innovations, practices, and approaches within their jurisdictions. This could require practitioners to approach projects on different land uses with more specificity, rather than following a general approach to collaborating with private landowners. Further research should consider how different landowner groups respond to information and communication styles from various types of conservation organizations.

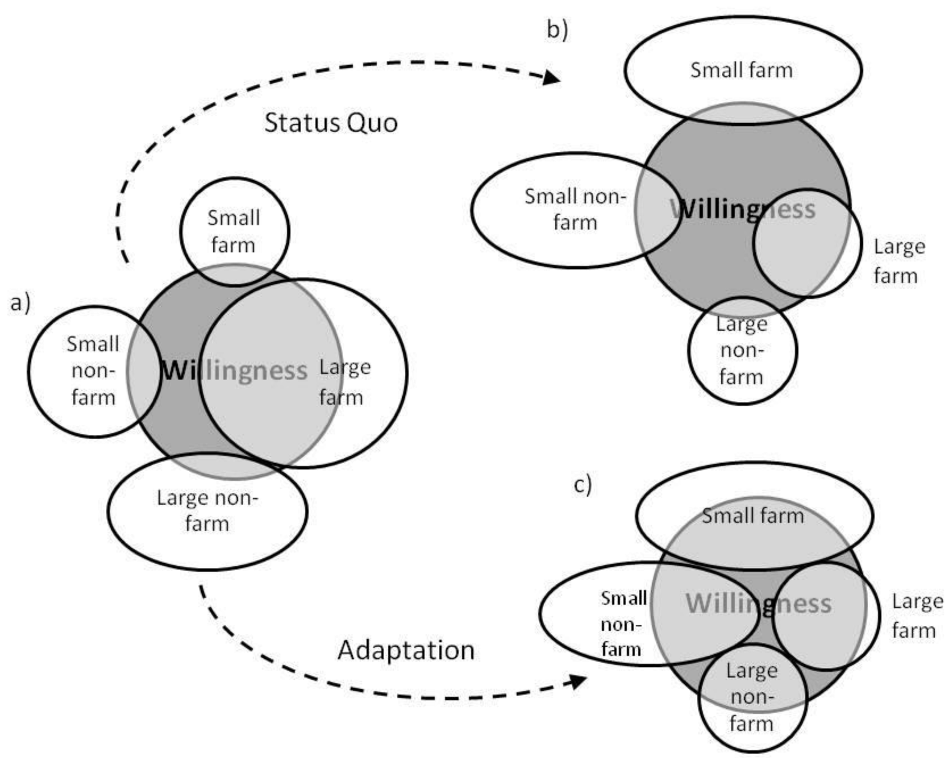

Figure 7.2. The proportion of total adoption willingness based on four ideal types (small non-farms, large non-farms, large farms, and small farms) represented by proportion of riparian land ownership (circle size) for the: a) current policy framework, b) status quo policy framework with urbanization, and c) adapted policy framework to reflect urbanizing land use patterns.

Watershed management in transitioning landscapes may require conservation organizations to reshape their own communication strategies and organizational scope. It is foreseeable in an urbanizing watershed that conservation districts will expand their efforts to work with non-agricultural landowners towards conservation. This is more complicated than rewriting a mission statement. Organizational direction is molded over time and is challenged by institutional inertia that may hinder practical and ideological shifts. Additional research on bottom-up vs. top-down mechanisms of organizational adaptation will inform our understanding of local policy processes, constraints, and opportunities within an institutional framework. This may encourage organizational specialization tailored to different conservation initiatives or practices.

ClearWater Conservancy, the local watershed organization, may be the best positioned among local conservation organizations to adapt their programs and outreach to reflect the changing landscape and to work more closely with non-agricultural landowners. Landowners' willingness to adopt does not differ among ClearWater Conservancy members and non-members, suggesting that the organization may have a wide array of attitudes among their riparian landowner members. Twenty-percent of survey respondents were ClearWater Conservancy members, and 62% of these respondents were non-agricultural landowners. This implies that the organization is balanced both in terms of landowner membership, and ClearWater's experience in working with farmers and non-farmers. If ClearWater works with engaged, willing non-farmers for riparian conservation, these non-agricultural projects may catalyze similar restoration efforts in their neighborhoods. Of course, landowners in areas that resist riparian buffers are unlikely to prompt a restoration movement.

Buffer constraints may take a more parcel-based, logistical form as well. While many perceived constraints are based on extra-parcel social or biophysical surroundings (e.g., how well buffer appearance meshes with the neighborhood, and if the buffer would bother their neighbors), parcel-based considerations (e.g., their current land uses, the proportion of area a buffer would occupy, vegetation appearance) are influential. For many landowners, physical space is a practical obstacle that restricts their sense of self-efficacy, a precursor to adoption. Property size limitations are particularly relevant to non-farming landowners.

Considering the constraints to residential buffer adoption, it is reasonable to ask if buffers would even work on small properties. This is the means-ends component of the outcome expectation relationship (Figure 7.1). A means-ends belief is the notion that a successful behavior will produce a specific outcome, independent of one's ability to conduct that behavior. In other words, do buffers on small properties actually have results? Based on numerous biophysical studies and state and federal reports (including extensive literature from Chesapeake Bay Program), riparian buffers have numerous benefits, few of which occur with narrow widths[5] (except for stream cooling). Buffers on small properties may not make logistical sense to landowners or to scientists given that the width and length of a limited buffer would preclude most of the benefits associated with wider buffers (e.g., terrestrial habitat, flood control, nutrient removal). In this sense, perhaps buffer implementation on small properties would best be achieved if there were adjacent landowners interested in implementation, as to create a trans-parcel buffer. The practicality of this option sounds less realistic than implementing individual, small buffers; yet given the neighborhood effects observed in my research, trans-boundary buffers may be a more viable, practical option that it appears on its face.

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[5] Much of the riparian buffer literature identifies uncertainties in buffer nutrient removal effectiveness based upon buffer width; however, studies have shown that narrow forested riparian buffers (i.e. less than 65ft wide) can reduce sediment inputs (Lee et al., 2000).

Perhaps a better way to approach the means-ends question is to consider what riparian buffers prevent rather than what they produce. Riparian areas, particularly those along intermittent streams, are sources of nutrients and sediment (Walter et al. 2009). While buffering riparian areas enhances filtration from upland pollution sources, they also dissociate the riparian region from contributing these pollutants. Therefore, one result of riparian buffers is the dissociation of a pollution-generating activity from the riparian area. This dissociation applies to small, residential properties, where there is potential for many destructive (i.e., vegetation mowing) or polluting behaviors (i.e. fertilization) to take place within the riparian corridor.

Though a single, small riparian buffer may not enhance or prevent many water quality outcomes, these buffers may work towards social outcomes, which are furthered by buffer "contagiousness" in strongly tied communities. In this scenario, there may be minimal environmental reasons to buffer streams on small properties other than the buffer has potential to lead to more substantial outcomes as adoption permeates throughout the neighborhood. In this vein, buffer water quality outcomes would be realized if measured at a larger scale.

The better question is, what do riparian buffers work for? As discussed in Chapter Two, riparian buffers have many potential outcomes such as sediment and nutrient filtration and associated local and regional water quality. If positioned in hydrologically sensitive areas (Easton et al., 2008), riparian buffers are even more effective in reducing nutrient contamination. While most of our knowledge on riparian buffer and BMP effectiveness is based in agricultural systems, non-agricultural systems undoubtedly have anthropogenic sources of nutrients and sediments for riparian buffers to remove.

Many residential riparian landowners are concerned about streambank erosion (Armstrong, unpublished data), which in some situations can cause substantial reductions in property size. Stream channel erosion is a major source of sediment pollution (Trimble, 1997). Riparian buffers stabilize streambank erosion, with variations on effectiveness based on the type of vegetation (Lyons et al., 2000; Simon & Collison, 2002) and the location of protective vegetation along the length of a river (Abernethy & Rutherfurd, 1998).

Residential riparian buffers also improve terrestrial and aquatic wildlife habitat. Recent ecological studies have identified the importance of the habitat matrix, or the small patches of habitat that enhance biodiversity within preserved, more natural habitats (Prugh et al., 2008). While the ideal riparian corridor may not be constructed in residential areas, interspersed riparian buffers may improve overall biological integrity for a region. Biotic outcomes may be more difficult to measure from small riparian buffers, but interconnected buffers can improve migration habitat.

From a policy standpoint, riparian buffers are popular indicators of Chesapeake Bay restoration efforts. Buffer goals are articulated in terms of the number of acres or miles restored, and are thought of as benchmarks towards large-scale restoration plans. It is easier to document the total area of riparian buffer restoration than the total nutrients removed from this buffer, so watershed organizations, in accordance with CBP protocols, speak of their buffer restoration efforts in terms of miles or acres of buffers, regardless of location, quality of function, or maintenance.

As buffers are implemented to attain biophysical and programmatic goals, they may also have local or community-based impacts. Riparian buffers are tangible fixtures on the landscape. People planted them, and the purposes for which buffers were installed are remembered by volunteers, landowners, and observers. If nothing else, riparian buffers have the image that they are improving the local environment and improving the communities in which buffer initiatives occur (Armstrong, unpublished data). In turn, this image may further watershed planning efforts or curb future degradation of water resources.

The effective targeting of farmers for riparian buffers has, and will continue to have, two major consequences for the diffusion of riparian buffers. First, the concept of riparian buffers may become, if not already, known as something for farmers that are not applicable for non-farming properties. Here, social identities may make buffer adoption available to farmers and preclude non-farmer implementation. The prevalence of riparian buffers and farmer-based outreach could actually be an obstacle that landowners of different social identities must overcome. Secondly, the ag-focused outreach efforts have left a large percentage of non-farming riparian landowners unaware of their negative influence to surface water quality. With the notion that buffers are meant for farmers, non-ag landowners are left wondering what they can do to lessen water quality impacts.

Watershed managers need to adapt their communication strategies to match how non-farming landowners learn about property management practices. First, residential landowners need to be made aware of their potential impacts to water quality and possible ways to mitigate these impacts. Under the current BMP communication strategy, this outreach is minimal, or having minimal influence. While structural constraints to buffer adoption, such as buffers size for small properties, may be difficult to overcome, other perceived barriers such as parcel and neighborhood aesthetic preferences may be more malleable, and therefore overcome with knowledge about adjacent in-stream water quality.

Additionally, water quality BMPs, including riparian buffers, should be adapted to ameliorate the potential constraints on residential properties. Buffers and other water quality BMPs (e.g., targeted fertilizer application) may not conform to non-farming land uses with limited space and more intense human occupation of near-stream areas. Therefore, watershed managers and organizations that promote water quality BMPs must be flexible in working with non-farming landowners to accommodate myriad interests, goals, and land use contexts. The preferences and perceptions of residential riparian buffers are poorly understood, and are ideal for future research.

APPENDIX

Appendix A. Interview guide: Agricultural landowners

Greeting and thank you. Discuss and sign informed consent form.

Q1: To start things off, tell me about your farm.

Probes:

- Farm type, # animals/acres, is most income derived from farm?
- History and Goals: how long owned, changes in operation and land uses over time, idea of how long they'll be in business, do you have plans for the farm when you retire?

Q2: Let's talk about your stream. Is it important to you and what sort of shape do you think it is in?

Probes:

- How do you use it (on and off farm)? What about family/friends?
- Are you happy with the quality of the stream/streamside area?
- What was the stream like in the past? How has it changed over time?
- What would you like it to be?

Q3: How did your BMP come to be/how did you get involved? (don't ask for non-adopters)

Probes:

- Who approached you? What were the terms of their plan? What sorts of incentives were you offered? Did these seem fair to you? What would you have preferred?
- What were you thinking about during this process? What hesitations did you have?
- Why did you adopt? Why didn't you adopt other parts?
- Have your neighbors done this? What was their experience? Were they at all influential in your decision to adopt?

Q4. What do you think are the benefits of BMPs? The costs?

Probes:

- Who do you think receives the benefits? Are these benefits personally important to you?
- When did you realize/learn of these benefits? Pre/post adoption?
- Off your property? Bay?

Q5. Could you tell me about how you've maintained the BMP? What have you had to do to keep it going?

Probes:

- What were your expectations for maintenance when you adopted? Have these changed?
- How frequently do you maintain your BMP? What do you think about that?
- Do you feel well-supported if something goes wrong?

What sort of scenario could you imagine that would cause you to stop maintaining your BMP?

Q6. To sum up, all in all, are you happy that you've done what you've done? Do you regret the implementation? Why?

Probes:

- If you had to do it all over again, what, if anything, would you do differently?
- Do you think the program is making a difference? What kinds of impacts is it having?

Appendix B. Interview guide: Non-agricultural landowner

Background: Thank you for agreeing to be part of this interview. Consent form. In case you aren't familiar with the terminology, "riparian" refers to land next to a stream. I'd like to hear your thoughts on this topic.

Q1: Could you tell me about the land you own? How long? What did previous owners do?

Probes:

- How has your use of the land changed over time?
- Do you participate in any conservation programs? Why/why not?

Q2: What about the stream? Is your stream important to you?

Probes:

- How has your use of the stream changed over time?
- Do other people use the stream?
- Are you happy with the current state of your stream?
- What would you like it to be?

- How concerned are you about water quality in your stream?
- What are the causes for WQ problems?

Q3: What do you do with your land next to the stream?

Probes:

- What are your reasons for doing this?
- What do you want your riparian land to look like?
- What do you envision as possible for your riparian area?
- What are the barriers? (not just time)
- Scenario question: if someone said it is important for you not to mow to the edge of the stream, what would you say?
- Would you consider stop mowing?

Q4: There are many streams in the area. Could you tell me how other people do with their streams?

Probes:

- Why do you think they do this?
- What do you like about it? What do you dislike about it?
- If not, why not?
- Does it matter to you what your neighbors do?
- Do you do anything different than your neighbors?

Q5: What kind of benefits do you see to riparian management?

Probes:

- What are the types of benefits? (water quality, wildlife, recreation)
- Who gets these benefits? (local, regional, Chesapeake Bay?)
- What are the costs? What do those mean to you?

Q6: Do you think what you do on your property makes a difference? What kinds of impacts is it having?

Appendix C. Interview guide: Institutional Actors

Background info on project and consent form.

Q1: I've been told by a few private landowners that the your organization is active in riparian BMP projects? What do you and your organization do in riparian areas?

- How long have these programs been going on? How long have you worked here? On riparian projects?

Q2: What types of landowners does your organization work with on riparian projects? (aka what characteristics do they use to determine eligibility?)

-How does the process unfold?

-How do you decide who has projects done on their property?

-Do you ever turn people away?

-Why don't you work with other types of riparian landowners ? (thinking small farm/rural-non ag, forested, etc.)

-How many projects are going on at any given time? Any currently?

Q3: How do you convince landowners to participate? What incentives do you provide? What are the typical concerns they express? How do you address their concerns? What is your general approach to working with private landowners?

Q4: What organizations do you partner with?

- How does this coordination start?
- How are collaborative projects organized?
- Is there a leader on the project? How is leadership decided?
- How does this change depending on what organization you're working with?

Q5: An important part of what I'm researching is riparian BMP maintenance. What does your organization do about project maintenance?

- When during the adoption/implementation process is it discussed with the landowner?
- Are landowners aware of the maintenance effort when they take on the project?
- How well are BMPs maintained?
- Is there a "check-up" on how landowners are maintaining (i.e. a form of enforcement?)

Q7: What are the benefits of riparian BMPs? (where/who/when) What are the costs?

- Is there enough improvement of (stated benefit) to warrant more riparian BMP projects?

Q8: If there was something that you could change about the process of riparian BMP implementation, what would it be?
Q9: Is there something that I'm missing or that you'd like to add?

Appendix D. Centre County land use zoning codes

Table D.1 Center County property types with zoning code (bolded). Codes with a preceding (*) indicate that code was included in the survey population.

Center County Property Types	Center County Property Types, cont.
*A – Agricultural w/ House – 10+ Acres *AC – Agricultural w/ some commercial function *AM – Agricultural w/ some mineral quarry *AO – Agricultural w/ buildings only – 10+ Acres *AS – Agricultural Seasonal w/ 10 or more Acres *AT – Agricultural w/ trailer AX – Agricultural Exempt C – Commercial – General CA – Commercial – Apartments (4+) CB – Commercial – Bank CC – Commercial – Combination CG – Commercial – Service Station CH – Commercial – Hard Surface CL – Commercial – Vacant Land CM – Commercial – Motel or Hotel CO – Commercial – Office CP – Commercial – Camper Park CR – Commercial Restaurant CS – Commercial – Store CT – Commercial – Trailer (4+) CU – Public Utility CW – Commercial Warehouse CX – Commercial – Exempt CY – Commercial – Golf Course	I – Industrial *L1 – Vacant Lot – Less than 1 acre *L2 – Vacant Lot – 1 to 4.99 acres *L3 – Vacant Lot – 5 to 9.99 Acres LX – Vacant Lot – Exempt *R – Residential – Under 10 Acres w/ house *RA – Residential Apartment (1-3 Apts) *RC – Residential – W/ Some commercial function *RO – Residential – Under 10 Acres outbuilding only *RS – Seasonal – Occupied less than 50% of year *RT – Residential – trailer w/ less than 10 Acres RX – Residential – Exempt *V – Vacant Land – 10 + Acres *VM – Vacant Land w/ minerals VX – Vacant Land – Exempt

Appendix E. Histogram of parcel sizes

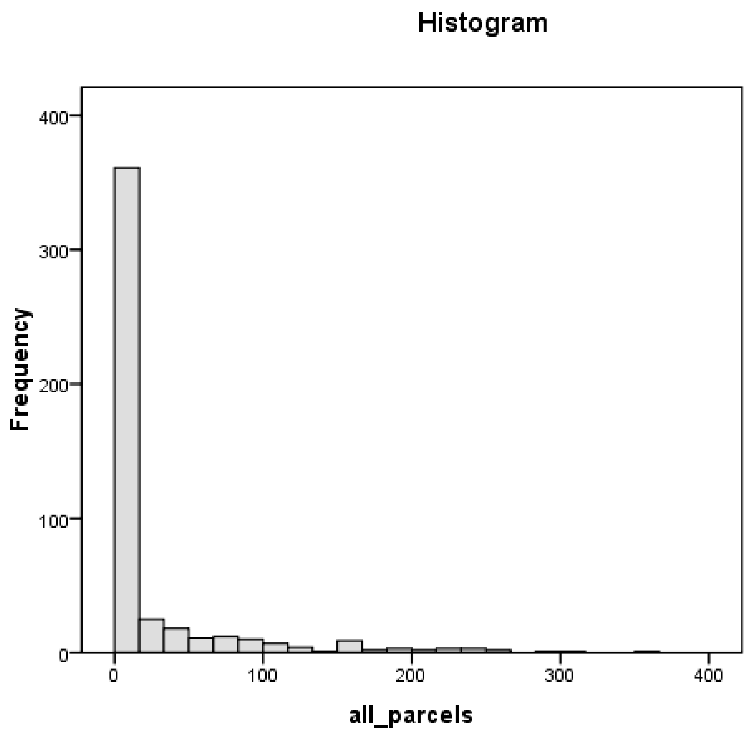

Figure E.1. Histogram of parcel sizes within the sample frame.

Appendix F. Mail survey correspondence to survey sample

April 23, 2009

Dear Centre County Landowner:

We invite you to participate in a survey conducted in a joint effort between the Penn State Cooperative Wetlands Center and the Department of Natural Resources at Cornell University to learn about landowners' attitudes and experiences of stream management in the Spring Creek watershed. You were chosen to participate in this survey because you own property on a stream in the Spring Creek watershed. Information from this study will help us better understand and assist landowners' management decisions about their stream.

Please have the person in your household who most frequently makes decisions about your property complete the enclosed questionnaire as soon as possible, seal it with the enclosed white removable sticker, and drop it in the nearest mailbox (no envelope is needed). The return postage has been provided. Your participation in the survey is completely voluntary, but your response is very important to us. We would like to hear from everyone who receives this questionnaire, not just those with strong opinions. Because we contact only a sample of stream landowners, the information you provide will represent many other people in your area. Your identity will be kept confidential and the information you give us will never be associated with your name.

The questionnaire has an identification number for the purpose of crossing your name off our master list when you respond, so that we will not send you additional reminder notices. Your name will not become part of the database of survey results. The Cornell University Institutional Review Board for Human Participants (IRB) has approved the methods used in this study (#0908000565) on April 9, 2009. You may contact IRB at 607-255-5138 or irbhp@cornell.edu. If you have any questions or concerns about the survey, please contact Andrea Armstrong at 607-255-8337 or ala23@cornell.edu, Richard Stedman at 607-255-9729, or James Shortle at 814-865-7657.

Thanks for your help!

Sincerely,

Andrea Armstrong	Richard Stedman	James Shortle
Master's Student	Professor	Professor
Cornell University	Cornell University	Penn State University

April 30, 2009

Dear Centre County Landowner:

Last week we mailed you a questionnaire asking you about landowners' attitudes and ideas of stream management in the Spring Creek watershed. If you have already completed and returned the questionnaire, please accept our sincere thanks for your help. If the questionnaire has not yet been completed, we would appreciate it if the person in your household who is most aware of stream management takes a few minutes now to fill out the questionnaire. Your prompt response will keep us from bothering you with additional reminder letters.

Even if you do not have strong opinions about stream management, we'd still like to know about your interests and concerns. Please fill out the questionnaire as soon as possible, seal it with the enclosed white removable sticker, and drop it in the nearest mailbox. Postage has been provided.

Thanks again for your help.

Sincerely,

Andrea Armstrong	Richard Stedman	James Shortle
Master's Student	Professor	Professor
Cornell University	Cornell University	Penn State University

May 14, 2009

Dear Centre County Landowner:

About three weeks ago we wrote to you seeking information about your experiences with stream management. If you have already completed and returned the questionnaire, thank you. If you have not yet done so, please ask the person in your household who most frequently makes decisions about your property to take the time to complete it today.

Cornell University is conducting this study to learn more about landowner attitudes and experiences of stream management in the Spring Creek watershed. Information from this study will help us better understand and assist landowner management decisions about their stream.

Let us assure you that your participation in this study is voluntary, but your response is important. Your identity will be kept confidential and the information you give us will never be associated with your name. In case our earlier mailing did not reach you, or in the event that your questionnaire has been misplaced, we have enclosed a replacement questionnaire. Return postage has been provided. After completing the questionnaire, simply seal it with the enclosed white removable sticker, and drop it in the mailbox. If you have any questions or concerns about this survey, please contact Andrea Armstrong at 607-255-8337 or ala23@cornell.edu, Richard Stedman at 607-255-9729, or James Shortle at 814-865-7657.

Thank you for your time and effort.

Sincerely,

Andrea Armstrong	Richard Stedman	James Shortle
Master's Student	Professor	Professor
Cornell University	Cornell University	Penn State University

May 21, 2009

Dear Centre County Landowner:

We are writing to you once more to encourage you to participate in the survey of stream landowners' interests and experiences with stream management in the Spring Creek watershed. Even if you do not have strong opinions, we are hopeful to hear from you. Your identity will be kept confidential and the information you give us will never be associated with your name.

Although we have received many completed questionnaires, we have not heard from you. Our past research tells us that those who do not return their questionnaire right away often have quite different opinions from those who do. For the survey results to reflect accurately all the stream-side landowners in this area, we need to hear from you and others who have not yet responded. Please have the person in your household who most frequently makes decisions about your property complete the questionnaire, seal it with the white removable sticker provided, and drop it in any mailbox. Postage has been provided.

Thank you for your time and effort.

Sincerely,

Andrea Armstrong	Richard Stedman	James Shortle
Master's Student	Professor	Professor
Cornell University	Cornell University	Penn State University

Appendix G. Mail survey questionnaire

A SURVEY OF LANDOWNER ATTITUDES TOWARDS STREAMS ON THEIR PROPERTY

PENNSTATE

Cooperative Wetlands Center

Cornell University
Human Dimensions Research Unit

Landowner Attitudes Towards Streams on Their Property

Thank you for being part of our survey. It is conducted by a team of researchers at Cornell and Penn State Universities. Our goal is to learn more about your thoughts of stream-side land uses on your property. You were randomly chosen to participate from Centre County property tax rolls.

To reflect the views of all local residents, it is important that we hear from everyone who receives this questionnaire, not just those with strong opinions.

Please have the person in your household who most frequently makes decisions about your property complete the enclosed questionnaire as soon as possible. Postage has been provided.

Your identity will be kept confidential and the information you give us will never be associated with your name.

Thank you!

If you own more than one piece of land that has a stream, please consider ONLY the largest stream while answering the questions below. If you have many streams on one piece of property, please respond with the largest of these streams in mind.

1. How long have you owned property at the location of your stream?
_______ Years *(Please write how many years.)*

2. Is the location at which you received this questionnaire your primary residence? *(Please check one.)*

□ Yes □ No

3. About how long is the stream on your property? *(Please check one.)*

□ Less than 25 ft □ 100 ft less than ¼ mile
□ 25 ft to less than 50 ft □ ¼ mile to less than ½ mile
□ 50 ft to less than 100 ft □ More than ½ mile

4. How regularly does the stream on your property have water in it? *(Please circle one.)*

Always	Most of the time	Sometimes	Rarely

5. About what percent of your property (aside from buildings or pavement) is covered by the following land uses? *For example, if your property is all lawn, write 100% next to "Lawn" below.*

_____% Lawn
_____% Woods
_____% Pasture
_____% Fields for crops or hay
_____% Garden
_____% Other:___________

6. Do you cut grass, shrubs, or trees near the edge of your stream? *(Please check one.)*

□ Yes □ No → (Skip to Question 9)

7. In general, how close to the edge of the stream do you mow your lawn? (*Please circle one.)*

To the edge of the stream	Within 3 feet of the stream	Within 3-10 feet of the stream	Within 10-30ft of the stream

8. Do you harvest farm crops on your property?

□ Yes □ No → (Skip to Question 10)

9. In general, how close to the edge of the stream do you harvest crops? (*Please circle one.)*

Within 5 ft of the stream	Within 6-15 feet of the stream	Within 15-30 ft of the stream	More than 30ft away from the stream

10. Do you have livestock / farm animals on your property?
(Please check one.)

□ Yes □ No → (Please skip to Question 13)

11. What livestock / farm animals do you have on your property? *(Please list the number of each you have below.)*

____ Dairy cattle
____ Beef cattle
____ Sheep/Goats
____ Swine
____ Horses
____ Poultry
____ Other *(Please describe)* ______________________

12. Do you have any of the following on your property? (*Please check all that apply.)*

□ Streambank fences
□ Water livestock in the stream
□ Fenced stream crossings
□ Alternative watering system

13. How often have you used the stream on <u>your property</u> AND a stream <u>elsewhere</u> for recreation in the last 12 months? *(Please check TWO boxes for each row.)*

Stream on your property				Stream elsewhere		
Never	Some-times	Often	← Uses →	Never	Some-times	Often
□	□	□	Fishing	□	□	□
□	□	□	Wildlife or bird watching	□	□	□
□	□	□	Swimming or wading	□	□	□
□	□	□	Walking, hiking, or relaxing	□	□	□
□	□	□	Canoeing or boating	□	□	□

14. How would you rate the water quality for each of the following places? *(Please check one for each row.)*

	Excellent	Very good	Good	Fair	Poor	Don't know
In your stream?	□	□	□	□	□	□
In the Spring Creek watershed?	□	□	□	□	□	□
In the Chesapeake Bay?	□	□	□	□	□	□

15. How concerned are you about water quality for each of the following places? *(Please check one per line.)*

	Not at all	Slightly	Somewhat	Very
In your stream?	□	□	□	□
In the Spring Creek watershed?	□	□	□	□
In the Chesapeake Bay?	□	□	□	□

16. In general, how knowledgeable do you feel about water quality for each of the following places? *(Please check one per line.)*

	Not at all Knowledgeable	Somewhat knowledgeable	Moderately Knowledgeable	Very Knowledgeable
In your stream?	□	□	□	□
In the Spring Creek watershed?	□	□	□	□
In the Chesapeake Bay?	□	□	□	□

17. In what conservation programs, if any, is your stream-side property enrolled? (*Please check all that apply.)*

□ Conservation Reserve Enhancement Program (CREP)
□ Conservation Reserve Program (CRP)
□ A conservation easement
□ Other *(please describe)*: ________________________
□ My property is not enrolled in any conservation program → (Please skip to Question 19)

18. Do you have a stream buffer requirement under this program?

□ Yes □ No

19. Please answer the questions in the far left column, then follow the arrow to the second question for each row.

Are these next to your stream? *Circle Yes or No.*	Did you put them in? *Circle Yes or No.*	Do you want them? *Circle Yes or No.*
Tall grass Yes → No →	Yes No	 Yes No
Trees or shrubs Yes → No →	Yes No	 Yes No
Bank stabilizing structures (e.g., large stones) Yes → No →	Yes No	 Yes No

20. How important is your stream to you? *(Please circle one number.)*

Not at all Important	1	2	3	4	5	Very Important

Stream Buffers

Stream buffers are borders of permanent vegetation alongside a stream. These buffers may have been planted, or may have grown on their own. Some buffers have fences to keep animals out. A buffer may follow the length of your stream, or it may only be in certain areas on your stream.

21. Before reading this description, how well-informed did you feel about stream buffers? *For example, if you feel very well-informed, circle "5". (Please circle one number.)*

Not at all informed	1	2	3	4	5	Very well-informed

22. Until now, how much had you heard or read about buffers? If you circle "1" below, please skip to Question 25. *(Circle a number.)*

Nothing Whatsoever	1	2	3	4	5	A great deal

23. We'd like to know more about where you heard of stream buffers.

Information Sources	Step 1: Where did you first learn of stream buffers? *(Check one.)*	Step 2: Rank your top three sources by marking a 1, 2, or 3 in that row
An environmental organization	□	
Penn State Extension (e.g., technical manual, contact with an agent)	□	
Local soil conservation district	□	
A family member	□	
A friend	□	
Local media (e.g., newspaper, TV, radio)	□	
A co-worker	□	
Other:	□	

24. How much of the stream on your land has a buffer? *(Circle one.)*

None of the stream	Less than half	About half	More than half	All of the stream

Attitudes about stream buffers

25. How much do you agree or disagree that a stream buffer on your property improves or would improve the following? *(Please check one per line.)*

A stream buffer on my property improves or would improve…	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
fish habitat in my stream	☐	☐	☐	☐	☐
wildlife habitat near my stream	☐	☐	☐	☐	☐
my property values	☐	☐	☐	☐	☐
flood protection for communities downstream	☐	☐	☐	☐	☐
my children's exposure to nature	☐	☐	☐	☐	☐
the character of my property	☐	☐	☐	☐	☐
my access to buffer program payments	☐	☐	☐	☐	☐

26. How much do you agree or disagree that a stream buffer on your property would improve water quality? *(Please check one per line.)*

A stream buffer on my property improves or would improve water quality…	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
in my stream	☐	☐	☐	☐	☐
in local groundwater	☐	☐	☐	☐	☐
downstream	☐	☐	☐	☐	☐
in the Chesapeake Bay	☐	☐	☐	☐	☐
local drinking water	☐	☐	☐	☐	☐

27. How willing are you to increase the amount of your property under a stream buffer? *(Please circle one.)*

Not at all willing	Not Very willing	Somewhat willing	Willing	Very willing

28. How would the following change your willingness to increase stream buffers on your property? *(Please check one per line.)*

If ….	Much more willing	More willing	Somewhat more willing	Slightly more willing	No change
you received <u>yearly</u> payments for your buffer costs	□	□	□	□	□
you received a <u>one-time</u> payment for your buffer installation	□	□	□	□	□
you were given guidance how to build a buffer	□	□	□	□	□
the trees and shrubs were free	□	□	□	□	□
volunteers planted the buffer	□	□	□	□	□
you had assistance with buffer maintenance	□	□	□	□	□
invasive or noxious weeds were removed for you	□	□	□	□	□
your buffer included wildflowers	□	□	□	□	□
you had a say in designing your buffer	□	□	□	□	□
someone in your neighborhood installed a buffer	□	□	□	□	□
a buffer reduced streambank erosion on your property	□	□	□	□	□
a buffer made water runoff from your property cleaner	□	□	□	□	□
most of your neighbors installed stream buffers	□	□	□	□	□
a good friend installed a stream buffer	□	□	□	□	□

29. How much do you agree or disagree with the following statements about stream buffers? *(Please check one per line.)*

A buffer on my property…	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
would take up too much land	□	□	□	□	□
doesn't fit the appearance of my neighborhood	□	□	□	□	□
takes too much time to maintain	□	□	□	□	□
has plants that look messy	□	□	□	□	□
would bother my neighbors	□	□	□	□	□
benefits others more than it benefits me	□	□	□	□	□
would require me to grant public access	□	□	□	□	□
limits my access to the stream	□	□	□	□	□
doesn't make sense for the size of my property	□	□	□	□	□
fits with how I use my land	□	□	□	□	□
doesn't comply with local regulations	□	□	□	□	□

Background Information

30. How long have you lived in Centre County? _____ Years

31. How often do you interact with people in your neighborhood? *(Circle one.)*

Daily	Weekly	Monthly	Less than monthly	Never

32. Of all the people in your neighborhood, how many are close friends? *(Circle one.)*

0	1/4	1/2	3/4	Almost all

33. Please check the box that best describes whether or not you agree or disagree with the following statements. *(Check one per line.)*

	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
I am always looking for ways to improve my property	□	□	□	□	□
I am the kind of person who is willing to take a few more risks than others	□	□	□	□	□
I am reluctant about adopting new ways of doing things until I see them working for people around me	□	□	□	□	□
I have a moral obligation to maintain water quality	□	□	□	□	□
I would be upset if my activities harmed my stream	□	□	□	□	□
I don't want others to decide what is on my property	□	□	□	□	□
Protecting the environment is important to me	□	□	□	□	□
I want to conserve the stream for future generations	□	□	□	□	□

34. What is the highest level of education you received? *(Circle a letter.)*

Attended high school — D. Bachelor's or associate's degree
Graduated high school — E. Some graduate study
Attended some college — F. Graduate degree (e.g., MA, MD, PhD)

35. In the last two years, have you... *(Please check one box per line.)*

	Yes	No
Signed a petition about a local issue?	□	□
Attended a formal public meeting sponsored by a government agency?	□	□
Written a letter to a public official or newspaper?	□	□

36. How would you describe your political views? *(Circle one.)*

Very conservative	1	2	3	4	5	Very liberal

37. Please describe your involvement with the organizations listed below. *(Please check one per row.)*

	Active member	Non-active member	Familiar, not a member	Not familiar
A local chapter of Trout Unlimited or Ducks Unlimited	□	□	□	□
A national environmental organization (e.g., Sierra Club)	□	□	□	□
A national farming organization (e.g., Farm Bureau)	□	□	□	□
ClearWater Conservancy	□	□	□	□
A watershed association (e.g., Spring Cr. W'shed Community)	□	□	□	□
A sportsman's group (e.g. rod and gun club)	□	□	□	□
A fraternal organization (e.g., Mason's, Elks Club)	□	□	□	□
A local landowner's association	□	□	□	□
Other: ___________________________	□	□	□	□

38. What is your gender? ___F ___M *(Please check one.)*

39. In what year were you born? 19_____ Year *(Please fill in a year.)*

Thank you for your help!
Please use the space provided for anything else you'd like to share.

Appendix H. Non-response telephone survey script

Spring Creek Watershed Riparian Landowner Survey
Non-Respondent Telephone Survey

Name of landowner:

Phone Number:

ID#:

Parcel Size: _______

Methods: I will use a random number generator to a sequence of integers with the highest number equal to that of the number of non-respondents. This sequence will be assigned to my sample of landowners sorted alphabetically. Then, I will contact landowners in the order of their random number assignment. Landowners will be contacted until I have up to 30 surveys completed. I will use a variety of calling days and times.

	Date	Day	Time	Result
1st attempt				
2nd attempt				
3rd attempt				

Hi, my name is Andrea Armstrong. I'm a graduate student working with the Penn State Cooperative Wetlands Center. May I please speak with _________?

⇨ If he/she is not available: When may I call back to reach him/her?
Date and time: ________________________

I am working with a research team at Penn State to learn more about how landowners manage the land next to their streams. About a month ago, we mailed you a yellow survey in a large white envelope that asked your opinions about the stream on your property.

I realize that it is a busy time of year and you may not have had a chance to fill out this survey, however, it is important to our results that everyone with a stream responds, not just those with the strongest views. I would like to ask you a few of the most important questions, and it will only take about 5 minutes. May I continue?

____ Yes (cont.)

____ No: Is there a more convenient time when I can call back? ___________

If they still refuse, thank them and end the interview.

1. Do you have a stream on your property?   Y N ⟹ Skip to Q's 4 and 8

2. How regularly does the stream on your property have water in it?
    a. Always;   Most of the time;   Sometimes;   Rarely

3. Do you have farm crops of animals on your property? [For landowners with 3+ acres]
    i. No
    ii. Yes → What kind? How many animals/acres?

4. How concerned are you about water quality in the Spring Creek Watershed?

    Not at all   Slightly   Somewhat   Very

5. Stream buffers are borders of permanent vegetation alongside a stream. Before now, on a scale of 1 to 5, with 1 being nothing and 5 being a great deal, how much have you heard or read about buffers?
    1   2   3   4   5
    If greater than 1: Where did you hear about them from? ______________

6. About how much of the stream on your land has a buffer?

None   less than ½   about ½   more than ½   all of the stream

7. How willing are you to increase the amount of your property under a stream buffer?

    Not at all   Not very   somewhat willing   willing   very willing

8. Last question: Please indicate your feelings about the following three statements, choosing from Strongly Agree; Agree; Neutral; Disagree; and Strongly Disagree:
    a. I have a moral obligation to maintain water quality: SA   A   N   D   SD

    b. I don't want others to decide what is on my property: SA   A   N   D   SD

    c. I am the kind of person who is willing to take a few more risks than others:
        SA   A   N   D   SD

That completes the interview. Thank you very much for your time and cooperation!

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