POTENTIAL ADOPTION OF NATIVE FRUIT AND NUT TREE RIPARIAN BUFFERS ON PRIVATE LAND IN WESTERN VIRGINIA

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ABSTRACT

Riparian corridors are often farmed or grazed because they are typically productive and offer a low cost water supply for livestock. These areas are also critical in terms of water quality, soil retention, and aquatic and terrestrial wildlife habitat. Conservation of riparian areas can be conflicting due to loss of productive land for other uses. Agroforestry riparian buffers planted with native fruit and nut trees could help integrate conservation and production in this valuable space by giving landowners the opportunity to provide beneficial environmental services, while enhancing their opportunities for revenue. In order to realize potential use of this type of system, it is important to understand how to communicate benefits and improve prediction of adoption. With this in mind, we conducted a mail survey of creek side owners within three Virginia subwatersheds to 1) create typologies of underlying groups of landowners in order to develop relevant communication strategies for native fruit and nut tree ripairan buffers and 2) test the Unified Theory of Acceptance and Use of Technology (UTAUT) singularly and with additional agroforestry concepts to predict intention to adopt native fruit and nut tree ripairan buffers. Three landowner types were identified within the larger population of creek owners and exhibit differences that merit tailored communication strategies. Both models predict a noteworthy amount of intention to plant native fruit and nut tree riparian buffers. However, when agroforestry measures were added they explained a notable portion of variance.

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TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION 1
1.1 Background 1
1.2 Objectives 2
1.3 Organization 2
CHAPTER 2. LITERATURE REVIEW 3
2.1 Temperate Agroforestry 3
2.2 Riparian Forest Buffers 3
2.3 Adoption of Agroforestry, Conservation, and Riparian Practices 6
2.4 Unified Theory of Acceptance and Use of Technology and Agroforestry Concepts 10
2.5 Summary 12
CHAPTER 3. COMMUNICATING THE BENEFITS OF NATIVE FRUIT AND NUT TREE RIPAIRAN BUFFERS 13
3.1 Introduction 13
3.2 Riparian Forest Buffers 14
3.3 Adoption of Agroforestry Riparian Buffers 16
3.4 Methods 18
3.5 Results 23
3.6 Discussion 33
3.7 Conclusion 40
CHAPTER 4. MODELING LANDOWNER INTENTION TO ADOPT NATIVE FRUIT AND NUT TREE RIPAIRAN BUFFERS 42
4.1 Introduction 42
4.2 Unified Theory of Acceptance and Use of Technology and Agroforestry Concepts 43
4.3 Adoption of Agroforestry Riparian Buffers 45
4.4 Native Fruit and Nut Tree Riparian Buffers 46
4.5 Methods 48

4.6 Results 54
4.7 Discussion 58
4.8 Conclusion 61
CHAPTER 5. CONCLUSION 62
5.1 Summary 62
5.2 Conclusion 62
5.3 Recommendations for Future Research 64
REFERENCES 65
APPENDIX A. SURVEY COVER LETTER 74
APPENDIX B. SURVEY INSTRUMENT 75
APPENDIX C. INSTITUTIONAL REVIEW BOARD PERMISSION LETTER 84

LIST OF TABLES

Table 3.1. Landowner populations with creek sides in 3 subwatersheds, the random sample drawn from each population, and the landowners within them that had non-forested creek side areas who were sent surveys. 19
Table 3.2. Breakdown of amenity and monetary reasons for owning land adapted from (Butler and Leatherby 2007). 21
Table 3.3. Indicators for outcomes that affect intention to plant native fruit and nut tree riparian buffers 22
Table 3.4. Percent and number of cases for each owner variable within the two-step cluster owner types. 23
Table 3.5. Demographics and characteristics of respondents within each type by percent or mean in each category. 25
Table 3.6. Biophysical characteristics of land possessed by owners in each type 26
Table 3.7. Results of χ^2 cross tabulations of landowner types and land management objective indicators. 27
Table 3.8. Results of χ^2 cross tabulations of landowner types and perceived impacts of riparian buffers. 27
Table 3.9. Results of χ^2 cross tabulations of landowner types and activators of intention to plant native fruit and nut trees.. 27
Table 3.10. Significant χ^2 results for cross tabulations of land management objectives and owner types 30
Table 3.11. Significant χ^2 results for cross tabulations of riparian buffer perceptions and owner types 31
Table 3.12. Significant χ^2 results for cross tabulations of preferred outcomes of planting native fruit and nut tree riparian buffers and owner types 32
Table 4.1 Landowner populations with creek sides in 3 subwatersheds, the random sample drawn from each population, and the landowners within them that had non-forested creek side areas who were sent surveys.. 49
Table 4.2. Construct indicators tested as possible predictors of intention of landowners to plant native fruit and nut tree riparian buffers. 50

Table 4.3. Confirmatory Factor Analyses (CFA) goodness-of-fit indices for hypothesized latent predictors Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Risk Expectancy (RE)........ 51
Table 4.4. Respondent demographics by the percent belonging to each category 54
Table 4.5. Model 1 multiple linear regression results using UTAUT predictors, controls and interaction terms on intention to plant native fruit and nut tree riparian buffers. Only significant interaction terms are reported. 55
Table 4.6. Model 2 multiple linear regression using predictors, controls and interactions from UTAUT with additional agroforestry measures of risk expectancy and biophysical variables from Pattanayak et al. (2003) to predict intention to plant native fruit and nut tree riparian buffers........ 56
Table 4.7. Contribution of risk expectancy and biophysical variables to the model adapted from UTAUT (Model 1) as seen from R^2 Change........ 56

LIST OF FIGURES

Figure 2.1 Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) 11
Figure 3.1 Study area subwatersheds in western Virginia: Smith Creek, Catawba Creek, and Lower Reed Creek 18
Figure 3.2 Image of a native fruit and nut tree riparian buffer shown before asking respondents about their intention to plant native fruit and nut trees in the next three years........ 22
Figure 4.1 Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) 43
Figure 4.2 Study area subwatersheds in western Virginia: Smith Creek, Catawba Creek, and Lower Reed Creek 48
Figure 4.3 Image of a native fruit and nut tree riparian buffer shown before asking respondents about their intention to plant native fruit and nut trees in the next three years........ 51
Figure 4.4 Hypothesized latent measures tested using confirmatory factor analysis (CFA) where risk expectancy (RE) has been added to the baseline UTAUT model as an independent predictor of intention to plant native fruit and nut tree ripairan buffers. 52

CHAPTER 1. INTRODUCTION

1.1 Background

Riparian forest buffers are defined as areas adjacent to streams and bodies of water with naturally occurring or planted trees. They are one way to help reduce non-point source pollution through stream bank stabilization and filtration of environmental contaminants and can also contribute valuable aquatic and terrestrial wildlife habitat along with carbon sequestration (Montagini and Nair 2004; Shultz et al. 2009).

However, riparian forest buffers can also decrease the area available for production of crops or livestock (Castelle et al. 1994; Robles-Diaz-de-Leon 1998). The result can be conflicting because landowners must choose between setting aside riparian areas for conservation or continuing to use these areas for production or aesthetic uses (Robles-Diaz-de-Leon 1998). Native fruit and nut trees are a potential solution because they can merge conservation and production in streamside zones (Brooks et al. 1994; Robles-Diaz-de-Leon 1998; Klapproth and Johnson 2001; Shultz et al. 2009). Furthermore, these types of riparian plantings could supply fruit and nuts to consumers to potentially capitalize on increases in the demand for local produce (Connor et al. 2009; Wilson 2010).

Riparian forest buffers are one of five temperate agroforestry practices along with forest farming, windbreaks, alley cropping, and silvopasture (Gold and Garrett 2009; Shultz et al. 2009). Temperate agroforestry is the intensive and intentional integration of trees and/or shrubs with crops and/or livestock (Gold and Garrett 2009). Understanding agroforestry applications in temperate settings requires a compliment of adoption-focused research (Mercer and Miller 1998; Montambault and Alavalapati 2005). Adoption research has generally been lacking in the United States (US) (Valdivia and Poulos 2009). However, several recent studies have focused on developing theoretical frameworks that may aid in explaining agroforestry adoption in the US (Workman et al. 2003; Skelton et al. 2005; McGinty et al. 2008; Arbuckle et al. 2009; Valdivia and Poulos 2009).

1.2 Objectives

The goals of this research are to contribute to agroforestry adoption theory and develop social marketing strategies for communicating potential benefits of native fruit and nut tree riparian buffers. Specific theoretical objectives were to verify underlying latent constructs to test the suitability and differences between a model following Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT) and one that added agroforestry concepts to the initial UTAUT model. Social marketing objectives were to segment landowners into groups, describe the landowners and their land within each group, test for differences between the types based on perceptions, objectives, and preferred outcomes, and use the results to develop communication strategies for each type.

1.3 Organization

Chapter 2 reviews relevant literature. Chapter 3 presents landowner groupings and describes social marketing strategies. Chapter 4 compares the hypothesized UTAUT model and UTAUT with added agroforestry-specific concepts to test the capabilities of these models in predicting intention to plant native fruit and nut tree riparian buffer systems. Chapter 5 summarizes the findings and suggests additional study.

CHAPTER 2. LITERATURE REVIEW

2.1 Temperate Agroforestry

Temperate agroforestry is the intensive and intentional integration of trees and/or shrubs with crops and/or livestock (Gold and Garrett 2009). Thought not in name, agroforestry can be identified in research literature since at least the 1930's (e.g. Smith 1929; Young et al. 1980; Tedders 1983). For the most part, agroforestry research has been conducted in tropical settings; however, the level of research in temperate systems has notably increased (Lassoie et al. 2009).

A significant base of scientific literature explains the basic functionality and structure of agroforestry systems (Mercer and Miller 1998). However, Mercer and Miller (1998) and Montambalt and Alavalapati (2005) argue that understanding agroforestry applications in temperate settings requires a compliment of research about adoption. Adoption research has generally been lacking in the United States (US), though, several recent studies provide theoretical frameworks that may aid in explaining adoption (Workman et al. 2003; Skelton et al. 2005; McGinty et al. 2008; Arbuckle et al. 2009; Valdivia and Poulos 2009).

2.2 Riparian Forest Buffers

Riparian forest buffers are studied in fields from agroforestry to urban development (e.g. Peterjohn and Correll 1983; Daniels and Gilliam 1996; Governo and Lockaby 2004; Kenwick et al. 2009; Shultz et al. 2009). In general, riparian forest buffers are defined as areas near streams, rivers or other bodies of water that have planted or naturally occurring trees, shrubs, and other vegetation that protect the water from contaminants such as sediment, chemicals, and nutrients while stabilizing stream banks and providing habitat for terrestrial and aquatic wildlife (Lowrance et al. 1985; Welcsh 1991; Prichard 1993; Palone and Todd 1997).

Riparian forest buffers can control the morphology of the stream bank by stabilizing soil and can act to recharge local groundwater by slowing water flow into the stream and allowing absorption into the soil (Shultz et al. 2009). Furthermore, riparian forest buffers can filter groundwater as it moves below the surface toward a water body (Lowrance et al. 1997). In flood events, riparian forest buffers can act to absorb excess water, which can reduce flood stream velocity and the intensity of flooding downstream (Klapproth and Johnson 2000A). They can also moderate flooding by slowing down water and collecting sediment and debris. If damaged many of the species can regenerate (Shultz et al. 2009)

Three fourths of most watersheds are comprised of first to third order streams, which because of their structure, allow for greater transfer of sediment into the water system (Leopold et al. 1964; Shultz et al. 2009). Riparian forest buffers are most effective on these streams because they can filter and retain large volumes of sediment that could otherwise enter the watershed (Klapproth and Johnson 2000A; Ward and Jackson 2005; Shultz et al. 2009).

Riparian buffers can greatly reduce non-point source pollution by immobilizing, storing and transforming contaminants such as nitrogen, phosphorus, and herbicides (Peterjohn and Correll 1983; Brooks et al. 1994; Klapproth and Johnson 2000A; Pinho et al. 2008; Shultz et al. 2009). Additionally, agroforestry systems such as riparian buffers can be a source of carbon sequestration (Montagnini and Nair 2004).

Riparian forest buffers also play a critical role in providing food, water, cover, nesting sites, and travel corridors for terrestrial animals. Furthermore, they provide food, cover, shade, water flow, a source of organic matter (e.g. carbon), and improved water quality for aquatic wildlife (Klapproth and Johnson 2000B; Governo and Lockaby 2004; Shultz et al. 2009).

The structure of riparian forest buffers can differ based on management objectives (Palone and Todd 1997). If managing for aquatic insects and wildlife, for example, Weigel et al. (2005) argue that buffer width should be 120 feet. Castelle et al. (1994) on the other hand, suggest that buffer widths of 100 feet are needed to manage for biological health, whereas stream physiology objectives only require a width of 50 feet.

For this study we used a 3-zone agroforestry riparian buffer system recommended by the US Department of Agriculture (Welsh 1991). Vegetation in zone 1 includes fast growing and flood tolerant tree and shrub species in a 15-foot wide strip directly adjacent to the stream. This zone is not intended for production, but rather to stabilize the stream bank, protect water quality, and improve terrestrial and aquatic habitat. The second zone is upslope from the first zone and 60 feet or more in width. This zone is available for tree-based production. Zone three is upslope from Zone 2 and can consist of a strip of grasses at least 20 feet wide. The third zone disperses surface water as it enters the riparian buffer and can be grazed, grown for hay, or periodically mown (Schultz et al. 2009).

A variety of products can be managed for in Zone 2, including fruits, nuts, honey, maple syrup, floral products, weaving and dying materials, timber, cooking wood, and pharmaceuticals (Klapproth and Johnson 2001; Shultz et al. 2009). Diversifying production through actively managed riparian forest buffers could benefit system resiliency by improving its diversity (Brooks et al. 1994). We focused on native fruit and nut trees as a component of Zone 2 because they allow for diverse objectives such as local food production, recreation, and wildlife habitat. Examples of native fruit and nut species appropriate for Zone 2 in the study region include: pawpaw (*Asimina triloba)*, American hazelnut (*Corylus americana)*, American persimmon (*Diospyros americana)*, American plum (*Prunus americana)*, black walnut (*Juglans* *nigra)*, elderberry (*Sambucus canadensis)*, and downy serviceberry (*Amelanchier arborea)* (Welsh 1991; Klapproth and Johnson 2001). There is also potential for using black raspberry (*Rubus occidentalis*), blackberry (*Rubus alleganensis*) and blueberry (*Vaccinium* spp.) in the transition from Zone 2 to Zone 3 or planted among trees in Zone 2. We will refer to these systems as native fruit and nut tree riparian buffers.

Narrow, fragmented buffers generally do not provide as much protection as wide, un-fragmented buffers (Weigel et al. 2005). However, establishing a continuous riparian buffer within a watershed is challenging because landowners have varied objectives for these areas. A suite of riparian buffer systems may need to accompany conservation initiatives if they are to succeed. Some landowners may be drawn to conservation or biological benefits, while others may seek a design focusing solely on production. Native fruit and nut tree buffers could allow landowners to produce fruits, nuts, and wood fiber while also conserving water, soil, and habitat (Robles-Diaz-de-Leon 1998). Analyzing what different groups of landowners perceive and believe about these systems will contribute to our understanding of potential adoption.

2.3 Adoption of Agroforestry, Conservation, and Riparian Practices

Social marketing is a process wherein marketing concepts and techniques are applied to promote socially desirable ideas. Techniques specific to social marketing include population segmentation and message design (Tyson et al. 1998). Butler and Leatherby (2007) suggest that these tools can be used to craft outreach messages relevant to landowner groups within a larger population. Social marketing has been used in the field of agroforestry to study potential adoption of agroforestry practices and to design outreach strategies (Strong and Jacobson 2005; Barbieri and Valdivia 2010). Strong and Jacobson (2005) identified four groups of forest owners, 3 of which focused on timber, livestock, and specialty crops and one group was considered non-adopters. Findings suggest potential adoption of agroforestry practices may vary between the types. Barbieri and Valdivia (2010) studied landowners based on their perceptions and from whom they obtained information and found two groups: "productivists" and "ruralists." Groups differed in important ways and the authors argued that they should be approached with different messages and deliveries. Cluster analysis is often used to segment for social marketing purposes (Kluender and Walkingstick 2000; Kendra and Hull 2005; Strong and Jacobson 2005; Butler and Leatherby 2007; Majumdar et al. 2008; Munsell et al. 2008; Barbieri and Valdivia 2010).

Diffusion of innovations is a generalizable cross-cultural framework that characterizes adoption of new practices, processes and ideas in fields such as public health, information technology, and agriculture (Rogers 2003). Diffusion, in general, hinges on communication. Potential adopters can be categorized according to their innovativeness or the rate at which they adopt a new innovation with five distinct categories: early innovators, early adopters, early majority, late majority, and laggards.

Income, economic motivations, and cost-shares are thought to affect adoption of agroforestry systems and riparian buffer plantings more specifically (Konyar and Osborn 1990; Featherstone and Goodwin 1993; Matthews et al. 1993; Lynch and Brown 2000; Pattanayak et al. 2003; McGinty et al. 2008; Arbuckle et al. 2009). Pattanayak et al. (2003) found that income positively correlated with agroforestry adoption, whereas Featherstone and Goodwin (1993) found that while other economic factors mattered, income did not significantly affect conservation expenditures. While economics have been found to influence adoption, others have found that amenity and cultural motivations also influence adoption, and in some cases are more important (Matthews et al. 1993; Ryan et al. 2003; Workman et al. 2003; Strong and

Jacobson 2005; Arbuckle et al. 2009; Barbieri and Valdivia 2010). Some examples are wildlife habitat, soil conservation, water quality, and aesthetics (Workman et al. 2003). Ryan et al. (2003) found that adoption was affected by aesthetics of the riparian buffer practice. Some time later Arbuckle et al. (2009) and Barbieri and Valdivia (2010) found that environmental and recreational motivations were important correlates of interest in agroforestry.

A general sense of stewardship is also important. Matthews et al. (1993) found that despite the potential for an increase in effort and cost, landowners who identified more strongly with land stewardship principles were more likely to be interested in adopting agroforestry systems. Additionally, Strong and Jacobson (2005) found that landowners thought the most important benefits of agroforestry practices were environmental services. However, in some cases landowner awareness of environmental problems is inversely related to a belief that fixing problems such as water quality can be accomplished by their actions (Klapproth and Johnson 2001).

Landowners and farmers with higher degrees of education were more likely to be interested in voluntary riparian buffer programs (Hagan 1996). Traore et al. (1988) found a similar relationship between education and adoption of conservation practices. Land use has been found to affect interest in conservation and agroforestry riparian buffer plantings (Featherstone and Goodwin 1993; Matthews et al. 1993; Arbuckle et al. 2009; Kaunekis and York 2009). Featherstone and Goodwin (1993) found that landowners who primarily managed livestock made smaller investments in conservation. However, Matthews et al. (1993) found that livestock producers were often more interested in riparian buffers than row crop producers.

Landowner characteristics such as age, social relations, the characteristics of their land, and technical assistance have been found to affect adoption of agroforestry riparian buffers and other conservation practices (Konyar and Osborn 1990; Hagan 1996; Salamon et al. 1997; Alig et al. 1999; Klapproth and Johnson 2001; Pattanayak et al. 2003; Raedeke et al. 2003; McGinty et al. 2008; Atwell et al. 2009; Maminianina et al. 2010). Hagan (1996) found that younger landowners are more interested in participating in riparian buffer programs. Similarly, Valdivia and Poulos (2009) found that interest in riparian buffers decreased with age. However, age and adoption are often positively correlated in international studies and others have found that age is not related to adoption (Matthews et al. 1993; Pattanayak et al. 2003).

Social relations also affect adoption. Pattanayak et al. (2003) found that membership in community organizations increased interest in agroforestry practices. Salamon et al. (1997) highlighted the importance of family factors in influencing adoption of sustainable farming practices. Furthermore, Raedeke et al. (2003) found that family relations were key to understanding interest in riparian buffer cost share participation. Additionally, Atwell et al. (2009) found that community interactions such as face-to-face communication, local social networks, norms, and local support structures play a critical role in adoption.

Adoption can also be affected by land characteristics such as parcel size and use. Studies indicate that parcel size affects landowner interests and participation in conservation and agroforestry practices (Konyar and Osborn 1990; Featherstone and Goodwin 1993; Pattanayak et al. 2003). However, Raedeke et al. (2001) found that acreage did not affect participation in riparian cost share programs and Matthews et al. (1993) found that farm size was unrelated in riparian buffer adoption. Valdivia and Poulos (2009) found that stream frontage without trees also did not affect interest to adopt riparian plantings. On the other hand, Featherstone and Goodwin (1993) found that larger farms were more likely to make conservation investments.

Finally, the role of government programs and technical assistance has been studied in the adoption of conservation practices such as riparian buffer systems. Skelton et al. (2005) found that landowners who have adopted riparian buffer practices are more willing to participate in government payment programs. However, in other cases government payments were rated the least likely reason to adopt riparian buffers (Ryan et al. 2003). Furthermore, Valdivia and Poulos (2009) found that interest in riparian buffers did not relate to familiarity with government incentive programs. Pattanayak et al. (2003) found that resource endowments, such as technical assistance, were a critical factor in adoption of agroforestry systems. Additionally, landowners who had access to technical assistance such as professional foresters were more likely to manage their forest (Alig et al. 1999; Maminiaina et al. 2010). Possible technical barriers to keep in mind in relation to riparian forest buffer adoption are planting trees, installing deer protection, mowing grass, and maintaining the buffer (Klapproth and Johnson 2001).

2.4 Unified Theory of Acceptance and Use of Technology and Agroforestry Concepts

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a validated and unified model of technology adoption (Venkatesh et al. 2003) (Figure 2.1). It was developed using eight behavioral models: theory of reasoned action (Fishbein and Ajzen 1975), technology acceptance model (TAM) (Davis 1989), motivational model (Davis et al. 1992), theory of planned behavior (TPB) (Ajzen 1991), combined model of TAM and TPB (Taylor and Todd 1995), model of personal computer utilization (Thompson et al. 1991), innovation diffusion theory (Rogers 2005), and social cognitive theory (Compeau and Higgins 1995). The UTAUT model uses expected performance and effort along with social influence as predictors of behavioral intention and draws upon facilitating conditions as a predictor of actual behavior.

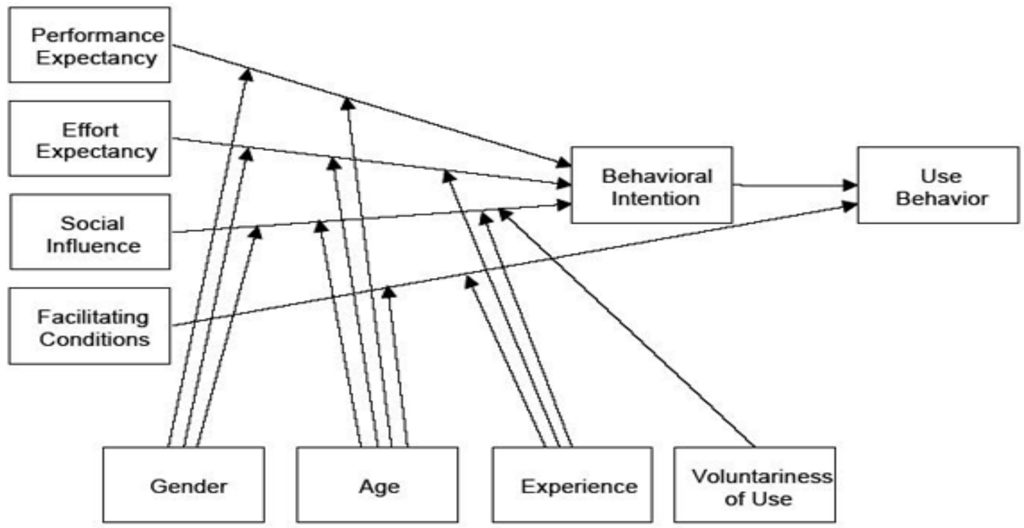

Figure 2.1. Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003)

Moderators of these theoretical relationships are gender, age, experience, and voluntariness of use.

The model was developed for information technology; however, its generalizability makes it useful for predicting intention to use other technologies (Venkatesh et al. 2003). UTAUT measures in relation to agroforestry riparian buffers are described below. Performance expectancy (PE) is how well a landowner expects the buffer system to perform in terms of survival, production, and conservation services. Effort expectancy (EE) is the expected effort required to plan, plant, and manage an agroforestry riparian buffer. Social influence (SI) is the extent to which groups or individuals such as family, neighbors, and other landowners support creek side plantings and affect a landowner's intention to plant. Facilitating conditions (FC) are the help and support a landowner believes is available for implementing these systems. Examples of facilitating conditions include educational materials, outreach, and financial assistance (Venkatesh et al. 2003). Age, gender, and experience using riparian buffers were measured to account for interactions hypothesized by Venkatesh et al. (2003).

Pattanayak et al. (2003) identified five factors within the literature that generally influence agroforestry adoption: *preferences, resource endowments, market incentives, biophysical factors*, and *risk and uncertainty*. *Preferences* are landowner characteristics that can affect adoption of agroforestry such as attitude and perceptions but common proxies include age, gender, and education. *Resource endowments* are assets that landowners have access to for agroforestry implementation. *Market incentives* are economic factors that either lower the cost and/or increase benefits of adoption. *Biophysical factors* are characteristics of the land such as slope, soil, and plot size. *Risk and uncertainty* represent the unknown challenges of implementing agroforestry practices. In relation to UTUAT, *preferences, resource endowments* and *market incentives* are present in UTAUT either as moderators or independent predictors. Yet, *risk* and *biophysical factors* were not accounted for within UTAUT.

2.5 Summary

In summary, riparian forest buffers are a type of agroforestry practice where trees are either planted or allowed to naturally regenerate to protect water quality, stream banks, and wildlife habitat. This study focuses on landowner adoption of a riparian forest buffer structure that allows for production of native fruit and nut trees. Social marketing can be used to develop appropriate communication strategies for underlying landowner groups to aid in the diffusion of innovation process. Adoption of conservation practices such as riparian forest buffers also depend on economics, amenity motivations, a general sense of stewardship, level of education, income, age, social relations, and land characteristics to name a few. Finally, a theory from information technology can be used in fields beyond computer technology to predict intentions with additional field specific measures potentially increasing predictive power.

CHAPTER 3. COMMUNICATING THE BENEFITS OF NATIVE FRUIT AND NUT TREE RIPAIRAN BUFFERS

3.1 Introduction

Riparian forest buffers are areas adjacent to streams and bodies of water with naturally occurring or planted trees that are important for water quality, stream bank stability, and wildlife habitat (Montagini and Nair 2004; Shultz et al. 2009). However, riparian forest buffers can decrease the area available for production of crops and livestock (Castelle et al. 1994; Robles-Diaz-de-Leon 1998). The result is that landowners must choose between setting aside riparian areas for conservation and continuing to use them for production (Robles-Diaz-de-Leon 1998).

Native fruit and nut trees could overcome such polarization through the merger of conservation and production in streamside zones (Brooks et al. 1994; Robles-Diaz-de-Leon 1998; Klapproth and Johnson 2001; Shultz et al. 2009). These types of riparian plantings could supply fruit and nuts to consumers to potentially capitalize on increases in the demand for local produce (Connor et al. 2009; Wilson 2010). In light of this possibility, our main research question is whether underlying landowner types exist within the larger group of respondents in terms of landowner characteristics, perceptions, beliefs and land holdings. Findings could help conservation initiatives refine communication strategies that resonate with specific types of landowners.

Social marketing concepts and techniques have been employed in situations such as these where a concept, such as conservation, is being promoted to diverse stakeholders (Tyson et al. 1998). We surveyed owners of non-forested creeksides within three Virginia subwatersheds and used the data to segment and describe respondents. We then tested if the clusters differed in terms of management objectives, perceptions of riparian plantings, and preferred outcomes of planting. We found that certain environmental services were important across all groups, but differences exist between the groups in terms of barriers and what matters most regarding potential adoption native fruit and nut tree riparian buffers. These results indicate that tailoring communication strategies to each type may be effective for conservation initiatives.

3.2 Riparian Forest Buffers

Riparian forest buffers are defined as areas near streams, rivers or other bodies of water that have planted or naturally occurring trees, shrubs, and other vegetation that can protect water from contaminants such as sediment, chemicals, nutrients, and thermal pollution while stabilizing stream banks and providing habitat for terrestrial and aquatic wildlife (Lowrance et al. 1985; Welcsh 1991, Prichard 1993; Palone and Todd 1997). Riparian forest buffers are studied in fields from agroforestry to urban development (e.g. Peterjohn and Correll 1983; Daniels and Gilliam 1996; Governo and Lockaby 2004; Kenwick et al. 2009; Shultz et al. 2009). Riparian buffer structure can differ based on management objectives (Palone and Todd 1997). If managing for aquatic insects and wildlife, for example, Weigel et al. (2005) argue that buffer width should be 120 feet. Similarly, Castelle et al. (1994) suggest that buffer widths of 100 feet are needed to manage for biological health, whereas stream physiology objectives only require a width of 50 feet.

In 1991, the US Department of Agriculture (USDA) published a report describing a 3-zone agroforestry riparian buffer system (Welsh 1991). The first zone includes fast growing and flood tolerant tree and shrub species in a 15-foot wide strip directly adjacent to the stream. This zone is intended for stream bank stabilization, water quality protection, and terrestrial and aquatic habitat management. This zone is not used for production. The second zone is upslope from the first zone, is 60 feet or more in width, and available for tree-based production. Zone 3 is upslope from Zone 2 and can consist of a strip of grasses at least 20 feet wide. This third zone is important for dispersing surface water as it enters the buffer and can be grazed, grown for hay, or periodically mown (Schultz et al. 2009).

A variety of products can be managed for in Zone 2, including fruits, nuts, honey, maple syrup, floral products, weaving and dying materials, timber, cooking wood, and pharmaceuticals (Klapproth and Johnson 2001; Shultz et al. 2009). Diversifying production through actively managed riparian forest buffers could benefit system resiliency by improving diversity (Brooks et al. 1994). We focused on native fruit and nut trees as a component of Zone 2 because they allow for diverse objectives such as local food production, recreation, and wildlife habitat. Examples of native fruit and nut species appropriate for Zone 2 in this study region include: pawpaw (*Asimina triloba)*, American hazelnut (*Corylus americana)*, American persimmon (*Diospyros americana)*, American plum (*Prunus americana)*, black walnut (*Juglans nigra)*, elderberry (*Sambucus canadensis)*, and downy serviceberry (*Amelanchier arborea)* (Welsh 1991; Klapproth and Johnson 2001). There is also potential for using black raspberry (*Rubus occidentalis)*, blackberry (*Rubus alleganensis)*, and blueberry (*Vaccinium sp.)* in the transition from Zone 2 to Zone 3, or planted among trees in Zone 2. We will refer to these systems as native fruit and nut tree riparian buffers.

Narrow, fragmented buffers generally do not provide as much protection as wide, un-fragmented buffers (Weigel et al. 2005). However, establishing an un-fragmented riparian buffer within a watershed is challenging because landowners have varied objectives for these areas. A suite of riparian buffer systems may need to accompany conservation initiatives if they are to succeed. Some landowners may be drawn to conservation or biological benefits, while others may seek a design focusing solely on production. Native fruit and nut tree buffers could allow landowners to produce fruits, nuts, and wood fiber while also conserving water, soil, and habitat (Robles-Diaz-de-Leon 1998). Analyzing what different groups of landowners perceive and believe about these systems will contribute to our understanding of potential adoption.

3.3 Adoption of Agroforestry Riparian Buffers

Social marketing is when marketing concepts and techniques are used to promote ideas. Specific marketing techniques include population segmentation and message design (Tyson et al. 1998). Butler and Leatherby (2007) suggest that social marketing research can be used to craft outreach messages relevant to landowner groups. It has been used in the field of agroforestry to study potential adoption of agroforestry practices and to design outreach strategies (Strong and Jacobson 2005; Barbieri and Valdivia 2010). Strong and Jacobson (2005) identified four groups of forest owners, 3 of which focused on timber, livestock, and specialty crops and one group was considered non-adopters. Barbieri and Valdivia (2010) studied landowners based on their perceptions and from whom they obtained information and found two groups: "productivists" and "ruralists." Findings from both studies suggest potential adoption of agroforestry practices may vary between types of landowners (Strong and Jacobson 2005; Barbieri and Valdivia 2010). Cluster analysis is often used as the tool to segment a population for social marketing purposes (Kendra and Hull 2005; Strong and Jacobson 2005; Butler and Leatherby 2007; Munsell et al. 2008; Barbieri and Valdivia 2010).

Income, economic motivations, and cost-shares are thought to affect adoption of agroforestry systems and riparian buffer plantings more specifically (Konyar and Osborn 1990; Featherstone and Goodwin 1993; Matthews et al. 1993; Lynch and Brown 2000; Pattanayak et al. 2003; McGinty et al. 2008; Arbuckle et al. 2009). Pattanayak et al. (2003) found that income positively correlated with agroforestry adoption, whereas Featherstone and Goodwin (1993) found that while other economic factors mattered, income did not significantly affect conservation expenditures. While economics have been found to influence adoption, others have found that amenity and cultural motivations also influence adoption, and in some cases are more important (Matthews et al. 1993; Ryan et al. 2003; Workman et al. 2003; Strong and Jacobson 2005; Arbuckle et al. 2009; Barbieri and Valdivia 2010). Some examples are wildlife habitat, soil conservation, water quality, and aesthetics (Workman et al. 2003). Ryan et al. (2003) found that adoption was affected by aesthetics of the riparian buffer practice. Some time later Arbuckle et al. (2009) and Barbieri and Valdivia (2010) found that environmental and recreational motivations were important correlates of interest in agroforestry.

A general sense of stewardship is also important. Matthews et al. (1993) found that despite the potential for an increase in effort and cost, landowners who identified more strongly with land stewardship principles were more likely to be interested in adopting agroforestry systems. Additionally, Strong and Jacobson (2005) found that landowners thought the most important benefits of agroforestry practices were environmental services. However, in some cases landowner awareness of environmental problems is inversely related to a belief that fixing problems such as water quality can be accomplished by their actions (Klapproth and Johnson 2001).

Landowners and farmers with higher levels of education were more likely to be interested in voluntary riparian buffer programs (Hagan 1996). Cooper and Jacobson (2009) and Traore et al. (1998) found a similar relationship between education and adoption of conservation practices. Land use has also been found to affect interest in conservation, agroforestry systems, and riparian buffer plantings (Featherstone and Goodwin 1993; Matthews et al. 1993; Arbuckle et al. 2009; Kaunekis and York 2009). Featherstone and Goodwin (1993) found that landowners who primarily managed livestock had lower investment in conservation. However, Matthews et al. (1993) found that livestock producers were often more interested in riparian buffers when compared to row crop producers.

Potential adopters can be categorized according to their innovativeness or the rate at which they adopt a new innovation with early adopters being those to implement the innovation first. While early adopters may not be the majority, they can play an important role in the adoption process (Rogers 2003).

3.4 Methods

Data were collected from a sample of family landowners with non-forested creek sides in three western Virginia watersheds (Figure 3.1). The watersheds have similar amounts of farm and forestland yet differ in the extent and type of riparian conservation initiatives. The Smith Creek Watershed is one of three Natural Resources Conservation Service (NRCS) priority

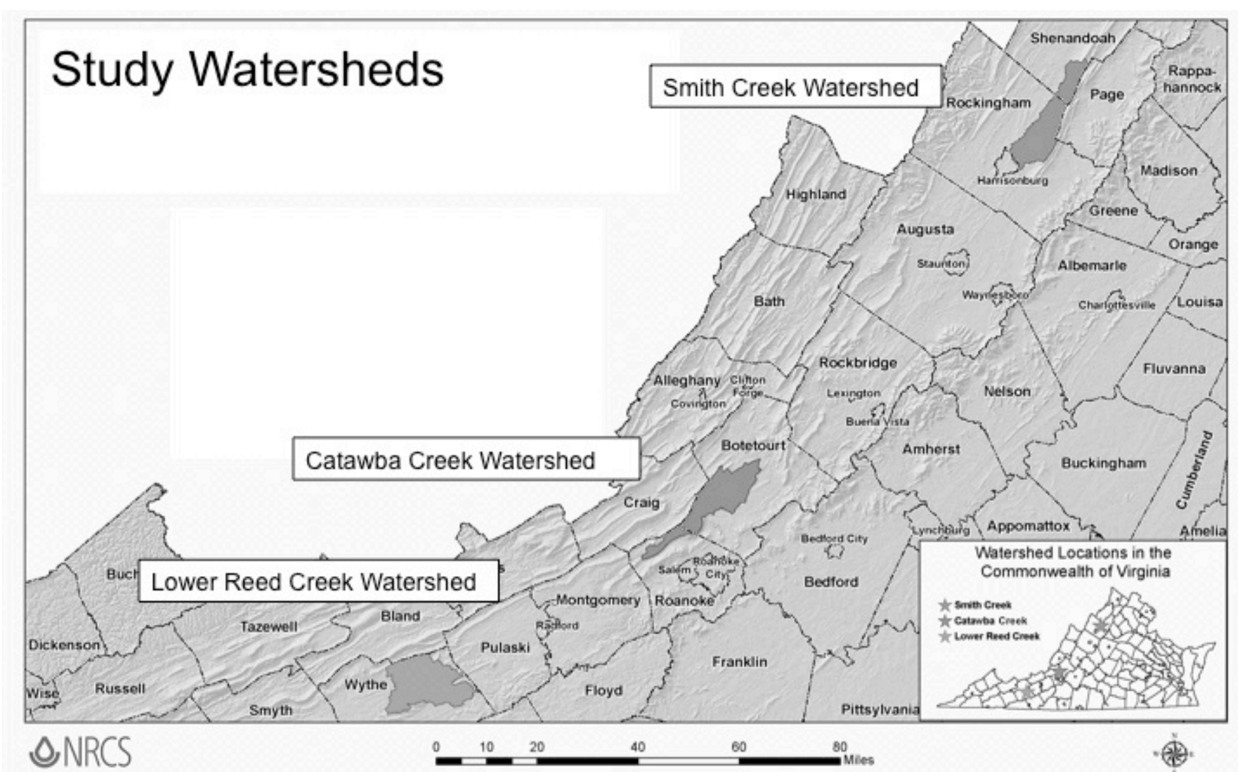

Figure 3.1. Study area subwatersheds in western Virginia: Smith Creek, Catawba Creek, and Lower Reed Creek.

watersheds in the larger Chesapeake Bay Watershed. A great deal of attention and conservation funding is focused on this watershed. The Catawba Creek Watershed has engaged, conservation-oriented landowner groups, is situated near a major land grant university, and located in the headwaters of the Chesapeake Bay Watershed. The Lower Reed Creek Watershed is in the New River Watershed and included to account for the two major watersheds in western Virginia. It resembles Smith and Catawba Creek Watersheds in terms of landform and use.

We surveyed a random sample of family landowners who own non-forested creek sides on parcels of at least 5 acres (Table 3.1). The acreage floor is intended to limit rural residential properties and focus on larger units. We used geospatial information systems (GIS) and digitized county level property data to identify the landowner population. We representatively sampled this population with 95% confidence assuming a 0.03 margin of error and removing duplicate cases (Dillman et al. 2009). Landowners with a creek side that has less than 10 percent canopy cover over an area that is 75 lateral feet and at least 60 feet in linear length qualified for the study. These dimensions constitute the lowest acreage NRCS will include in the Conservation Reserve Enhancement Program (CREP) (1/10th acre). CREP is a cost share program and land rental agreement where landowners are paid a rental fee to conserve riparian buffer areas (USDA Farm Service Agency2012). The sample was compiled using aerial

Table 3.1. Landowner populations with creek sides in 3 subwatersheds, the random sample drawn from each population, and the landowners within them that had non-forested creek side areas who were sent surveys.

VA Subwatershed	Population	Sample	Non-Forested Creek Sides
Smith Creek	507	344	169
Catawba Creek	639	400	158
Lower Reed Creek	583	377	142
Total	1729	1121	469

imagery, the National Hydrography Dataset, and tax parcel information. Because the National Hydrography Dataset (waterways) was created from maps developed in the 1970s, we asked landowners to return the survey with "no creek" written in the comments section if they no longer have a stream that runs at least part of the year.

We administered a preliminary questionnaire with 33 landowners outside the study area and revised it to strengthen the internal consistency. We sent the revised mail questionnaire to 469 landowners according to the Tailored Design Method (Dillman et al. 2009). A letter notified landowners that a questionnaire would be forthcoming. A survey followed with an invitation cover letter that described the research. A reminder post card followed by a replacement survey was sent later for landowners that had not yet responded.

The survey measured current riparian buffer use, reasons for owning land, demographics, land management objectives, perceived impacts of planting riparian buffers and influence of potential benefits on landowner intentions to plant. We also compiled biophysical data for each parcel using tax parcel information, National hydrography data, and NRCS soil survey geographic data (SSURGO).

Questionnaire items were designed using conservation, forestry, agroforestry, and riparian buffer adoption literature. Use characteristics focused mainly on whether livestock drink from the creek, but also considered primary reasons for owning land. Landowners were asked to select the top three reasons they own land using a discrete list. If a landowner had two or more responses that were monetary in nature, they were categorized as having "monetary" reasons for owning land. If they selected two or more amenity-focused objectives they were categorized as having "amenity" reasons for owning land. Items were developed after Butler and Leatherby (2007) (Table 3.2)

Table 3.2. Breakdown of amenity and monetary reasons for owning land adapted from (Butler and Leatherby 2007).

Reasons for Owning Land	
Monetary	Amenity
Farming	Beauty and scenery
Land investment	Hunting
Leasing	Pass land to heirs
Growing timber	Wildlife habitat
Home investment	Nature

Demographic measures included the watershed where their parcel is located, landowner age, gender, education, income, work status, years of property ownership, whether a landowners considers themselves to be a farmer or not, whether they live more than 9 months each year on their property, and previous planting experience. Biophysical variables included parcel size, stream frontage, plantable area, and amount of highly erodible soil, non-erodible soil, and prime farmland within the defined riparian area. Stream frontage is the linear stream feet present on the property. Plantable areas are the summated space 75 feet from the creek on one side without tree or shrub cover. The amounts of highly erodible and non-erodible soil were determined by soil type. Highly erodible soil and non-erodible soil are mutually exclusive.

Land management objectives were measured on a 4-point importance scale, where 1=not at all important, 2=somewhat important, 3=important, and 4=very important. We used an agreement scale to measure perceived impacts of riparian buffer plantings where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree. We tested affects of hypothetical outcomes on intention to plant native fruit and nut trees on creek sides (Adapted from Finkel et al. 2002). To do this we associated particular outcomes with the planting of native fruit and nut trees and asked whether intention to plant increases if the outcome were true (Table 3.3). We measured the effects using a 1-5 scale, where 1=not at all increase, 2=increase a little, 3=increase somewhat, 4=increase quite a bit, and 5=increase a lot. Specific items for this measurement are

Table 3.3. Indicators for outcomes that affect intention to plant native fruit and nut tree riparian buffers.

If the following outcomes were true, how much would each <u>increase</u> your intention to plant native fruit and nut trees on your creek sides in the next 3 years?	
Outcomes	You get 75% of the planting paid for by the government
	You make money selling fruits and nuts
	You supply your friends and family with fruits and nuts
	You improve the local economy near your land
	You improve water quality in the region
	You improve wildlife habitat on your land
	You enhance scenery on your land
	You decrease soil loss on your creek side

listed in Table 3.3. Before asking questions about native fruit and nut tree riparian buffers we presented an image of how the system may look (Figure 3.2). A similar image without the native fruit and nut tree boundaries was presented before asking about perceived impacts of riparian buffers.

We used two-step cluster analysis and standardized data to group landowner respondents according to a silhouette measure of cohesion and separation, even distribution between groups, and group relevance. The two-step procedure was used because it allows for both categorical and continuous grouping variables. Indicators used to group respondent landowners were

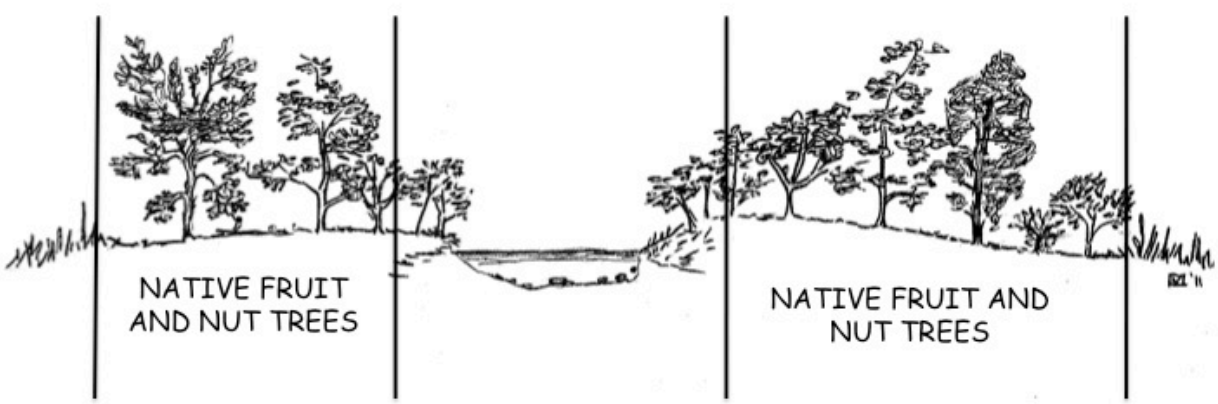

Figure 3.2. Image of a native fruit and nut tree riparian buffer shown before asking respondents about their intention to plant native fruit and nut trees in the next three years.

reasons for owning land, possession of livestock, and whether livestock primarily drink water from the creek. Demographics and land characteristics were evaluated for each cluster. We then used χ^2 tests to identify significant differences between the clusters in terms of their management objectives, perceived impacts of riparian buffers, and affected planting intentions.

3.5 Results

Four hundred and sixty questionnaires were successfully delivered. Two hundred and seventy-seven landowners returned the questionnaire for an adjusted response rate of 49.3%. Fifty-five, or 24%, of the 277 indicated they did not have a creek that ran at least part of the year. One hundred and fifty-eight landowners returned useable surveys. Respondents own 63 miles of stream frontage with 539 acres of non-forested creek sides. One hundred and fifty respondents completed the survey responses necessary for this analysis.

Cluster groups have a good silhouette measure of cohesion and separation (0.6), meaning owners within groups are adequately similar and owners between groups are adequately different. The distribution of respondents across clusters is relatively even. The first cluster consists of 62 landowners that graze livestock, use their creek as a primary water source for livestock and mostly own land for monetary purposes. We refer to this group as "creek source producers." Thirty-five of 37 landowners in cluster 2 graze livestock, but use an alternative

Table 3.4. Percent and number of cases for each owner variable within the two-step cluster owner types.

		Two-Step Cluster Landowner Groups (*n*=150)		
Landowner Variables	Category	Creek Source (*n*=62)	Alternative Source (*n*=37)	Non-producers (*n*=51)
Livestock grazed	Yes	100% (*n*=62)	95% (*n*=35)	0% (*n*=0)
Livestock water from creek	Yes	100% (*n*=62)	0% (*n*=0)	0% (*n*=0)
Reasons for owning land	Monetary	71% (*n*=44)	73% (*n*=27)	37% (*n*=19)
	Amenity	29% (*n*=18)	27% (*n*=10)	63% (*n*=32)

water source. The majority of these landowners own land for monetary reasons. The silhouette measure of the groups is good meaning that the 2 owners in cluster 2 who do not graze livestock were included because they resemble owners in this group based on their reasons for owning land. We refer to this group as "alternative source producers." The third cluster consists of landowners that do not graze livestock and primarily own land for amenity reasons. We refer to this group as "non-producers" (Table 3.4).

Males predominate in each group (Table 3.5). About 60% of owners are not retired and most live more than nine months per year on their property. On average, landowners in each cluster have held property for similar amounts of time.

Creek source producers are generally evenly distributed between the three subwatersheds (Table 3.5). They are generally between 50 and 69 years of age (60%) and 44% have bachelors or graduate degrees, 30% have an associate's degree or some college and 26% are high school educated. About 16% make more than $100,000. Forty-five percent make between $50,000 and $100,000 and 16% make more than $100,000. Farmers make up 23% of this group and about two thirds of owners in this group (66%) make more than $1,000 from their property per year. Only 10% have planted creek sides before.

Alternative source producers were evenly distributed between the three subwatersheds. Sixteen percent of landowners are less than 49 years of age, 46% of respondents are between the ages of 50 and 69, and 38% are above the age of 70. Thirty-eight percent have bachelors or graduate degrees, 24% have an associate's degree or some college and 38% have a high school degree. Twenty-nine percent make greater than $100,000 and 34% make between $50,000 and $100,000. Only 16% report being farmers, yet, 50% make more than $1,000 from their property in a year. Landowners who have planted creek sides make up 16% of the group.

Table 3.5. Demographics and characteristics of respondents within each type by percent or mean in each category.

Owner Variables	Categories	Creek Source	Alternative Source	Non-producers
Subwatershed	% Smith Creek	34	35	35
	% Catawba Creek	37	30	41
	% Lower Reed Creek	29	35	24
Age	% < 49 years	16	16	12
	% 50-69 years	60	46	65
	% >70 years	24	38	22
Gender	% Male	66	76	65
	% Female	34	24	35
Education	% High school	26	38	29
	% Associate/Some College	30	24	14
	% Bachelors/Graduate	44	38	57
Income	% < $25,000	17	13	12
	% $25,000-$50,000	23	25	20
	% $50,000-$100,000	45	34	39
	% $100,000-$150,000	8	16	15
	% > $150,000	8	13	15
Retired	Yes	38	43	43
	No	62	57	57
Live >9 months on property	Yes	71	76	69
	No	29	24	31
Years owned	Mean (years)	22	25	19
Farmer	Yes	23	16	8
	No	77	84	92
Make >$1000 from the property/yr	Yes	66	50	14
	No	34	50	86
Planted creek side before	Yes	10	16	26
	No	90	84	74

Non-producers are less evenly distributed across the three subwatersheds. Landowners in this cluster are generally between 50 and 69 years of age (66%). Landowners with bachelors or graduate degrees make up 57% of the population and 30% make more than $100,000. Only 8% of this group is farmers with just 14% making greater than $1,000 off their property in a year. Somewhat differently, 26% have planted sections of their creek sides.

Creek source producers own an average of 78 acres with stream frontage of 0.5 miles on average (Table 3.6). Average plantable area is 4.2 acres, with 1.5 acres of highly erodible soil, and 2.2 acres of non-erodible soils within the plantable area. Alternative source producers possess an average of 1.7 acres of highly erodible soil and only averaged 0.7 acres of non-erodible soil. Average parcel size is 61 acres and stream frontage is 0.3 miles. Parcels for non-producers average 38 acres, 2.3 acres of plantable area, 0.7 acres of highly erodible soil, and 1.2 acres of non-erodible soil.

χ^2 tests indicate that the observed frequencies for importance of improving wildlife habitat, keeping land manicured, making money, and producing goods significantly differ from expected frequencies (Table 3.7). Keeping a natural state and improving the environment were not significantly different. Perceptions that riparian buffer plantings do not severely complicate creek side access, do not make creek sides look unkempt, and can considerably reduce erosion

Table 3.6. Biophysical characteristics of land possessed by owners in each type.

	Type											
	Creek Source				Alternative Source				Non-producers			
Variable	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE	Min	Max
Parcel Size (ac)	78	11	5.00	320	61	11	5.00	253	38	7	5.00	246
Stream frontage (miles)	0.5	0.1	0.04	2.1	0.3	0.1	0.03	1.3	0.3	0.1	0.04	2.1
Plantable area (ac)	4.2	0.5	0.41	19.1	3.7	0.6	0.40	13.4	2.3	0.3	0.20	12.4
Highly erodible soil* (ac)	1.5	0.3	0.00	14.1	1.7	0.4	0.00	9.8	0.7	0.2	0.00	5.8
Non erodible soil area* (ac)	2.2	0.3	0.00	8.7	0.7	0.2	0.00	4.1	1.2	0.3	0.00	10.2
Prime farmland area* (ac)	1.9	0.3	0.00	8.7	1.6	0.3	0.00	6.6	1.1	0.2	0.00	8.7

*Represent soil characteristics within the non-forested creek side areas (plantable areas)

Table 3.7. Results of χ^2 cross tabulations of landowner types and land management objectives.

Land management objective	χ^2	DF	p-value
Producing goods	40.16	6	< 0.01[a]
Making money	16.42	6	0.01[a]
Keeping land well manicured	12.95	6	0.04[a]
Keeping a natural state	7.84	6	0.25
Improving wildlife habitat	18.25	6	0.01[a]
Improving the environment	4.06	6	0.67

[a] Significant at $\alpha \leq 0.05$

Table 3.8. Results of χ^2 of cross tabulations of landowner types and perceived impacts of riparian buffers.

Perceived Impacts	χ^2	DF	p-value
Reduce erosion	16.06	8	0.04[a]
Do not decrease production	9.80	8	0.28
Improve water quality	4.64	8	0.80
Do not make creek sides look unkempt	16.98	8	0.03[a]
Enhance wildlife habitat	8.01	8	0.43
Do not make creek side access practically impossible	24.17	8	< 0.01[a]

[a] Significant at $\alpha \leq 0.05$

Table 3.9. Results of χ^2 cross tabulations of landowner types and activators of intention to plant native fruit and nut trees.

Outcome	χ^2	DF	p-value
Baseline: intention to plant native fruit and nut trees	11.97	8	0.15
Supply family and friends with Native Fruit and Nuts	11.41	8	0.18
Make money selling Native Fruit and Nuts	7.03	8	0.53
Improve water quality	16.15	8	0.04[a]
Improve wildlife habitat	12.54	8	0.13
Improve the local economy	4.97	8	0.76
Enhance scenery	17.01	8	0.04[a]
Decrease erosion	14.97	8	0.06
Have 75% cost paid	12.90	8	0.12

[a] Significant at $\alpha \leq 0.05$

significantly differed from expected values (Table 3.8). Indicators that riparian buffers decrease production, improve water quality, and enhance wildlife, did not significantly differ. Tests also indicate that enhanced scenery on property and improved water quality in the region increases reported intentions (Table 3.9). On the other hand, improving wildlife habitat and the local economy, decreasing erosion, having 75% of the cost paid, making money by selling native fruits and nuts, and supplying family and friends with native fruits and nuts did not significantly differ.

The majority of creek source producers think it is most important to render goods when managing their land yet making money is generally not important. Also important is keeping their land well manicured followed by improving wildlife habitat (Table 3.10). Creek source producers mostly agreed that riparian buffer plantings considerably reduce erosion and do not make creek sides look unkempt. Yet, responses were somewhat polar for the aesthetic indicator, with 26% disagreeing and 59% agreeing that creek sides do not look unkempt. This polar trend continued with 35% agreeing and 45% disagreeing that riparian buffer plantings do not make creek side access practically impossible (Table 3.11). Enhancing scenery increases reported intentions to plant native fruit and nut trees on creek sides by at least a little among up to 75% of creek source producers. Improving water quality had a similar result with about 85% indicating it would increase their intention (Table 3.12).

Alternative source producers think it is most important to produce goods when managing their land. Keeping the land well manicured was also a popular objective and was more important than improving wildlife, although wildlife enhancement had its champions. Making money when managing their land was generally least important (Table 3.10). Overall, these producers do not believe buffer plantings make creek sides look unkempt or that they make creek side access practically impossible. However, they do believe that riparian buffer plantings can considerably reduce erosion (Table 3.11). Around 80% of alternative source producers said the idea of improving water quality in the region increases their intention to plant. Nearly 70% of landowners said the idea of enhancing scenery would increase their intention to plant (Table 3.12).

The majority of non-producers think it is most important to improve wildlife habitat with 42% believing it is very important. Keeping their land well manicured was next and both producing goods and making money were generally not important (Table 3.10). These owners were very likely to agree that riparian buffer plantings considerably reduce erosion. They are also likely to believe that buffer plantings do not make creek sides look unkempt. Most do not agree that these plantings make creek side access practically impossible (Table 3.11). Fifty-four percent of non-producers reported that their intention would either increase a lot or quite a bit if the plantings enhanced the scenery of their land, while around 70% said their intention would increase by at least a little. Improving water quality had a similar effect (Table 3.12).

Results of cross tabulations of types and intention to plant indicate non-producers had the highest intention mean score for planting native fruit and nut trees followed by alternative source producers. Creek source producers had the lowest mean intention score (Table 3.12).

Table 3.10. Significant χ^2 results for cross tabulations of land management objectives and owner types.

Indicator					Two-step cluster owner types (n=150)		
How important is……	χ^2	df	p-value	Response	Creek Source	Alternative Source	Non-producers
Improving wildlife habitat when managing your land?	18.25	6	0.01	Not at All Important	10% (n=6)	11% (n=4)	8%(n=4)
				Somewhat Important	32% (n=19)	37% (n=13)	10% (n=5)
				Important	42% (n=25)	17% (n=6)	40% (n=20)
				Very Important	17% (n=10)	34% (n=12)	42% (n=21)
Keeping your land well manicured when managing your land?	12.95	6	0.04	Not at All Important	5%(n=3)	6% (n=2)	22% (n=11)
				Somewhat Important	19% (n=11)	31% (n=11)	28% (n=14)
				Important	46% (n=27)	37% (n=13)	32% (n=16)
				Very Important	31% (n=18)	26% (n=9)	18% (n=9)
Making money when managing your land?	16.42	6	0.01	Not at All Important	20% (n=12)	37% (n=13)	52% (n=26)
				Somewhat Important	37% (n=22)	23% (n=8)	28% (n=14)
				Important	22% (n=13)	17% (n=6)	16% (n=8)
				Very Important	20% (n=12)	23% (n=8)	4% (n=2)
Producing goods when managing your land?	40.16	6	< 0.01	Not at All Important	5% (n=3)	6% (n=2)	47% (n=23)
				Somewhat Important	20% (n=12)	21% (n=7)	18% (n=9)
				Important	29% (n=17)	32% (n=11)	25% (n=12)
				Very Important	46% (n=27)	41% (n=14)	10% (n=5)

Table 3.11. Significant χ^2 results for cross tabulations of riparian buffer perceptions and owner types.

Indicator					Two-step cluster owner types (n=150)		
Riparian forest buffer plantings….	χ^2	df	p-value	Response	Creek Source	Alternative Source	Non-producers
Do not make creek side access practically impossible	24.27	8	< 0.01	Strongly Disagree	12% (n=7)	0% (n=0)	8% (n=4)
				Disagree	33% (n=19)	14% (n=5)	8% (n=4)
				Neutral	21% (n=12)	34% (n=12)	30% (n=15)
				Agree	16% (n=9)	31%(n=11)	44% (n=22)
				Strongly Agree	19% (n=11)	20% (n=7)	10% (n=5)
Do not make creek sides look unkempt.	16.98	8	0.03	Strongly Disagree	14% (n=8)	0% (n=0)	2% (n=1)
				Disagree	12% (n=7)	9% (n=3)	12% (n=6)
				Neutral	16% (n=9)	17% (n=6)	18% (n=9)
				Agree	21% (n=12)	40% (n=14)	46% (n=23)
				Strongly Agree	38% (n=22)	34% (n=12)	22% (n=11)
Considerably reduce erosion	16.06	8	0.04	Strongly Disagree	7% (n=4)	9% (n=3)	0% (n=0)
				Disagree	3% (n=2)	9% (n=3)	6% (n=3)
				Neutral	22% (n=13)	11% (n=4)	8% (n=4)
				Agree	34% (n=20)	49% (n=17)	31% (n=15)
				Strongly Agree	34% (n=20)	23% (n=8)	54% (n=26)

Table 3.12. Significant χ² results for cross tabulations of preferred outcomes of planting native fruit and nut tree riparian buffers and owner types.

					Two-step cluster owner types (n=150)		
Indicator	χ^2	df	p-value	Response	Creek Source	Alternative Source	Non-producers
I intend to plant native fruit and nut trees on my creek side in the next 3 years	11.97	8	0.15	Strongly Disagree	25% (*n*=15)	14% (*n*=5)	22% (*n*=11)
				Disagree	30% (*n*=18)	39% (*n*=14)	18% (*n*=9)
				Neutral	30% (*n*=18)	25% (*n*=9)	27% (*n*=13)
				Agree	8% (*n*=5)	11% (*n*=4)	27% (*n*=13)
				Strongly Agree	7% (*n*=4)	11% (*n*=4)	6% (*n*=3)
How much would your intention to plant native fruit and nut tree riparian buffers increase if you could…?							
Indicator	χ^2	df	p-value	Response	Creek Source	Alternative Source	Non-producers
Enhance scenery on your land	16.01	8	0.04	Not at all	24% (*n*=14)	27% (*n*=9)	27% (*n*=13)
				Increase a little	12% (*n*=7)	21% (*n*=7)	2% (*n*=1)
				Increase somewhat	29% (*n*=17)	15% (*n*=5)	17% (*n*=8)
				Increase quite a bit	12% (*n*=7)	9% (*n*=3)	29% (*n*=14)
				Increase a lot	22% (*n*=13)	27% (*n*=9)	25% (*n*=12)
Improve water quality in the region	16.15	8	0.04	Not at all	14% (*n*=8)	18% (*n*=6)	22% (*n*=10)
				Increase a little	24% (*n*=14)	12% (*n*=4)	7% (*n*=3)
				Increase somewhat	28% (*n*=16)	30% (*n*=10)	15% (*n*=7)
				Increase quite a bit	14% (*n*=8)	15% (*n*=5)	37% (*n*=17)
				Increase a lot	21% (*n*=12)	24% (*n*=8)	20% (*n*=9)

3.6 Discussion

The major land management objective of creek source producers is production and many within this group believe that riparian plantings make creek side access extremely difficult. Few owners in this group have planted their creek sides with woody plants, which is not unexpected as riparian areas are most likely used by livestock en route to water in the creek. Creek source producers own a significant amount of highly erodible sections of creek, especially when considering potential livestock traffic (Raganath et al. 2009). However, notable amounts of non-erodible land/prime farmland within riparian areas may enable their production-focused objectives and compete with conservation due to loss of productive farmland (Ryan et al. 2003).

Creek source producers constitute the greatest percent that consider themselves farmers and make more than $1,000 annually from their land. Ryan et al. (2003) found that farmers whose primary income is from their land are more likely to adopt conservation practices that are inline with their production. Furthermore, Barbieri and Valdivia (2009) found that production focused owners were less likely to adopt agroforestry practices. Featherstone and Goodwin (1993) found that landowners who primarily managed livestock had lower investment in conservation. Conflicts with production objectives might be a reason that creek source owners have the least intention to plant native fruit and nut tree riparian buffers. It could also be monetary reasons for owning land. Ryan et al. (2003) and Arbuckle et al. (2003) found farmers were less likely to adopt conservation practices if their land management was motivated by economics. Matthews et al. (1993) found landowners used economics as a major factor when determining the future adoption of agroforestry.

Creek source producers also believe it is important to keep their property well manicured. However, a notable amount of owners believe riparian plantings make creek sides look unkempt.

This finding is similar to Ryan et al. (2003) where many farmers did not consider riparian buffer plantings well manicured or visually pleasing and only neat and tidy riparian buffers were appealing to most. If native fruit and nut tree riparian buffers can be guaranteed to be aesthetically pleasing, there would likely be an increase in owners' intentions to plant within this group.

Despite conflicts with planting, creek source producers believe it is important to manage for wildlife habitat on their property and that riparian buffers can decrease soil erosion. Furthermore, they are generally more likely to plant if it could lead to better water quality in the region. These findings are in line with those of Strong and Jacobson (2005) where environmental benefits such as these were considered important benefits of adoption by landowners. These services could be useful to address when communicating to creek source producers.

Native fruit and nut tree conservation initiatives geared for this group would need to address how riparian buffer plantings can be compact and visually appealing to minimize losses in productive and manicured spaces. Also, demonstrations and more information could be provided as to how riparian buffers can be productive with native fruit and nut trees. Workman et al. (2003) found that in general Southeastern landowners felt they did not have enough familiarity or access to demonstrations of agroforestry practices such as riparian buffers. However, it is important to keep in mind that creek source producers still may not see the advantage of native fruit and nut tree riparian buffers relative to livestock production or may expect higher levels of effort to get sufficient production. It may also be too risky to spend time managing trees without substantial familiarity or opportunities to see demonstrations.

Wildlife habitat enhancement, soil erosion reduction, and potential to improve regional water quality can possibly counter barriers to adoption of native fruit and nut tree riparian buffers. Emphasizing these outcomes may be the most realistic communication strategy to conserve creek source producers' sizable and potentially vulnerable planting space, especially if designing a riparian buffer around production, tidy appearance, and function proves too difficult.

Though not in possession of the greatest plantable space or stream frontage, alternative source producers have considerable amounts of highly erodible creek side soil. Thus, while alternative source producers do not have livestock traffic in their riparian areas, they are an important group to work with regarding conservation initiatives. Additionally, the vulnerability of their creek sides may explain why an alternative water source is provided for livestock and possibly why their intention to plant using native fruit and nut tree systems is higher when compared to creek source producers.

Alternative source producers tend to be a little older when compared to the other groups. Fewer consider themselves farmers relative to creek source producers and only half of the group makes greater than $1,000 from production on their land each year. The greater intentions of alternative source producers to adopt compared to creek source producers is in line with Barbieri and Valdivia's (2009) finding that decreasing levels of production lead to increased adoption of agroforestry practices. However, a considerable amount of alternative source producers do not intend to plant native fruit and nut tree riparian buffers. This reaction could possibly be due to monetary reasons for owning land. Ryan et al. (2003) and Arbuckle et al. (2003) found farmers were less likely to adopt conservation practices if their land management was motivated primarily by economics.

Similar to creek source producers, the most important land management objective to alternative source producers is production and few have planted their creek sides. However, the majority of alternative source producers do not believe riparian buffer plantings decrease access to creek sides, which is one less barrier to adoption of these systems than creek source producers. This difference is not unexpected because these landowners likely do not require much access to their creek side areas with an alternative source of water for livestock and therefore, may experience less conflict with native fruit and nut tree riparian buffer plantings (Ryan et al. 2003). However, while they are production oriented, their intentions are not extremely high, meaning they may not be interested in managing fruit and nut trees, which may require substantial effort.

Visual quality is also an important land management objective of alternative source producers, but to a lesser degree when compared to creek source producers. Higher levels of intention are experienced if the buffer is guaranteed to be aesthetically pleasing. In contrast to creek source producers, alternative source producers do not generally think buffer plantings look unkempt, which is different from findings in Ryan et al. (2003) where the majority of farmers thought woody vegetation was visually displeasing.

Alternative source producers believe it important to manage their land for wildlife habitat enhancement, see that soil erosion can be reduced with riparian buffer plantings, and express higher intention levels if native fruit and nut tree riparian systems can improve regional water quality. A concern for environmental services such as these is similar to findings of Strong and Jacobson (2005) where environmental benefits were considered important benefits of adoption and could be useful concepts to address when communicating to creek source producers.

Ultimately, alternative source producers may be more on the fence about planting native fruit and nut tree riparian buffer systems than the other groups because they may not see an advantage in planting these trees compared to allowing natural re-vegetation. It could also be that they expect a great deal of effort for establishment and maintenance or that they are unfamiliar with the system. For these reasons, relatively little effort on the part of conservation initiatives may be needed for greater adoption by alternative source producers compared to creek source producers. Adoption by alternative source producers could have sizable conservation payoffs due to their substantial amounts of vulnerable riparian soil. Communication strategies for this group should address required levels of effort for establishment and maintenance. Additionally, an emphasis on wildlife habitat enhancement, soil stability, and the potential to improve regional water quality may bolster the argument for native fruit and nut tree riparian buffers. Furthermore, demonstrations may provide better familiarity with aesthetic quality and the system in general, which could lead to a better chance of adoption.

In contrast to creek source and alternative source producers, the vast majority of non-producers think it is most important to enhance wildlife habitat when managing their land. Keeping their land well manicured and producing goods are less important. Non-producers tend to be the highest educated with greatest incomes. Most are not farmers and very few make more than $1,000 a year from their property. Non-producers own land for mostly amenity reasons, which is similar to findings of Ryan et al. (2003) where intrinsically motivated farmers were most likely to plant woody vegetation on their streamsides. It is also similar to findings of Arbuckle et al. (2009) where farmers with environmental and recreational motivations were more likely to adopt agroforestry practices. Furthermore, Barbieri and Valdivia (2009) found a typology that closely resembles non-producers in that they highly value wildlife habitat, mostly own land for non-economic reasons, and are more receptive to adopting agroforestry practices.

Non-producers widely agree that buffer plantings can decrease erosion and do not negatively impact visual quality or make creek sides inaccessible. In general they have higher intention to plant native fruit and nut trees. Additionally, their intention to plant native fruit and nuts increases a great deal if the plantings enhance scenery and improve regional water quality. Also, many of these landowners have already planted their creek sides suggesting that riparian plantings are compatible with current land management. Ryan et al. (2003) found that landowners who have already implemented conservation practices were more likely to plant woody vegetation on their creek sides

Overall, non-producers seem most readily open to the idea of planting native fruit and nut trees and face the fewest barriers. One explanation is they have discretionary income and risk is potentially more acceptable. Studies have found that income is positively correlated with agroforestry adoption (Ryan et al. 2003, Pattnaayak et al. 2003). Another possibility is that they are less dependent on production and therefore, more interested in conservation projects (Ryan et al. 2003). It could also be that they see native fruit and nut forest buffers as something that would greatly enhance wildlife habitat on their property. Furthermore, the education levels among this group may positively influence their willingness to adopt (Hagan 1996; Traore et al. 1998; Cooper and Jacobson 2009).

While the landholdings of non-producers is not the most sizable or vulnerable, they could play a valuable role in conservation initiatives by adopting these systems early and providing low-cost, informal demonstrations for creek source and alternative source producers (Rogers 2007). Non-producers are likely to have the time and income to handle risk and may be more willing to accept trial and error and lack of demonstrations. When tailoring communication to this group, wildlife habitat enhancement, soil stability, water quality improvements and enhanced scenery matter most.

Surprisingly, there were no differences between groups than considered normal in regards to changes in intention if a cost share conservation program covered 75% of the cost of planting. This finding corresponds with Ryan et al. (2003) where government payments were the least likely reason to adopt conservation practices. However, it could be that the relationship might be different with respect to those that make only moderate incomes. We expected production-focused owners to be interested in selling native fruits and nuts for revenue. On the contrary, making money was not an important objective for any type. This could be due to social desirability in the response set, but it may also be that despite production levels, other types of motivations may be more important for making decisions about conservation practices. Ryan et al. (2003) found that intrinsic motivations affected farmers' intention to plant woody vegetation more than economic motivations.

Perhaps initially counter intuitive, results suggest that owners that are not necessarily production oriented are most likely to plant native fruit and nut trees. Similarly, Ryan et al. (2003) found that as farming participation decreased, intention to plant woody vegetation on stream banks increased. It seems that this native fruit and nut tree riparian buffer systems may be too risky for producers to easily accept without a substantive basis such as effective demonstrations. For this reason, outcomes of planting are likely to be considered conflicting and not complimentary at this point. These results are similar to those found in Workman et al. (2003) highlighting the need of greater familiarity and demonstrations of these practices.

Common to all three types was an interest in enhancing wildlife habitat, a belief that soil is more stable with riparian plantings, and concern for regional water quality. Aesthetic quality increases intention for all groups meaning that if these systems were guaranteed to be visually pleasing, intention to plant could increase dramatically across the three groups. This finding emphasizes that aesthetics should be considered when designing riparian buffer systems. The challenge for future research is to figure out the differences between the groups based on what they believe is an aesthetically pleasing riparian buffer. Environmental services and aesthetic quality could be valuable to include in communication strategies across the board, but otherwise tailored communications strategies for each type will likely be most effective.

Non-producers are the most likely to plant native fruit and nut trees. Most compelling to this group are the services such as wildlife habitat and aesthetics. Adoption among non-producers could pay dividends for conservation initiatives by providing low-cost demonstrations that could serve as a part of the communication strategies for creek source and alternative source producers, making these systems more approachable for production-oriented owners in the future. In other words, producers may initially be less inclined, but could eventually adopt if the right combination of outcomes were to be demonstrated by others. Nevertheless, results suggest that there is good reason to believe some production focused landowners would also plant native fruit and nut trees on their creek sides if demonstrations and markets are available.

3.7 Conclusion

Because riparian forest buffers are receiving much attention as a tool to increase watershed health, defining landowner types is increasingly relevant for conservation-based communication and outreach strategies. For example, President Barack Obama signed Executive Order 13508 in 2009, which sets goals to dramatically improve the health of Chesapeake Bay Watershed and includes the objective to restore and maintain 181,440 miles of total riparian forest buffers by 2025. This equates to establishing an additional 14,400 miles of riparian forest buffers (Federal Leadership Committee for the Chesapeake Bay 2010). This study identified underlying types of landowners within a larger population; which can be used to develop communication and outreach strategies to promote conservation practices.

We segmented creek side owners with plantable space into 3 groups with results pointing to potential adoption of native fruit and nut tree riparian buffer systems. Owner groups differed according to production levels, livestock creek access, and creek side vulnerability. Owners also differed by management objectives, perceived impacts of riparian buffer plantings, and reasons they would be likely to plant native fruit and nut trees on their creek sides. However, common to all three types was an interest in enhancing wildlife habitat, a belief that soil is more stable with riparian plantings, concern for regional water quality, and a preference for visual quality. These environmental services could be valuable to include in communication strategies wholesale, but otherwise tailored communications strategies using unique facets for each type will likely be most effective. Further research into what each group believes is an aesthetically pleasing riparian buffer design could be useful for conservation initiatives.

Otherwise, creek source producers are likely most interested in compact and well-maintained buffers. Alternative source producers may be most influenced by the effort involved in establishing and maintaining these systems. Non-producers are most receptive to services such as wildlife habitat enhancement or water quality improvement. While non-producers may not provide the greatest ecological impact, social traction associated with their adoption and potential to provide informal demonstrations could pay dividends over the long term. Creek source producers may be least likely to plant right now and alternative source producers are still on the fence, but in the future, native fruit and nut tree riparian buffers may have the familiarity needed for greater adoption.

CHAPTER 4. MODELING LANDOWNER INTENTION TO ADOPT NATIVE FRUIT AND NUT TREE RIPAIRAN BUFFERS

4.1 Introduction

Temperate agroforestry is the intensive and intentional integration of trees and/or shrubs with crops and/or livestock (Gold and Garrett 2009). Formalized temperate agroforestry systems are fairly new, but many of the practices are not. In fact, several have been used for hundreds of years in North America, China, and Northern Europe (Brookfield and Padoch 1994; Davies 1994; Herzog 2000). Historically, most agroforestry research has occurred in tropical settings; however, projects in temperate systems have increased in recent years (Lassoie et al. 2009).

Understanding applications of agroforestry in temperate settings requires a compliment of adoption-focused research (Mercer and Miller 1998; Montambault and Alavalapati 2005). Agroforestry adoption research has generally been lacking in the United States (US) (Valdivia and Poulos 2009). Though, several relatively recent studies have focused on theoretical frameworks to explain agroforestry adoption in the US (Workman et al. 2003; Skelton et al. 2005; McGinty et al. 2008; Arbuckle et al. 2009; Valdivia and Poulos 2009).

To build on agroforestry adoption theory, we used data from 3 watersheds in Virginia to model landowner intentions to plant native fruit and nut tree riparian buffer systems. To do this we asked whether the Universal Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003) predicts adoption of native fruit and nut tree riparian buffers and if agroforestry specific measures from Pattanayak et al. (2003) increase UTAUT's predictive power.

Data are from a mail survey of 469 owners of non-forested creek sides within the three watersheds. Confirmatory factor analysis (CFA) was used to verify the underlying latent measures. Multiple linear regression was used to test the baseline UTAUT model and the baseline model with added agroforestry adoption constructs. Results indicate UTAUT is a fairly robust model, but can be improved by adding agroforestry measures.

4.2 Unified Theory of Acceptance and Use of Technology and Agroforestry Concepts

UTAUT is a validated and unified model of technology adoption (Venkatesh et al. 2003) (Figure 4.1). It was developed using eight behavioral models: theory of reasoned action (Fishbein and Ajzen 1975), technology acceptance model (TAM) (Davis 1989), motivational model (Davis et al. 1992), theory of planned behavior (TPB) (Ajzen 1991), combined model of TAM and TPB (Taylor and Todd 1995), model of personal computer utilization (Thompson et al. 1991), innovation diffusion theory (Rogers 2005), and social cognitive theory (Compeau and Higgins 1995). The UTAUT model uses expected performance and effort along with social influence as predictors of behavioral intention and facilitating conditions as an antecedent of actual behavior. Gender, age, experience, and voluntariness of use moderate these predictors.

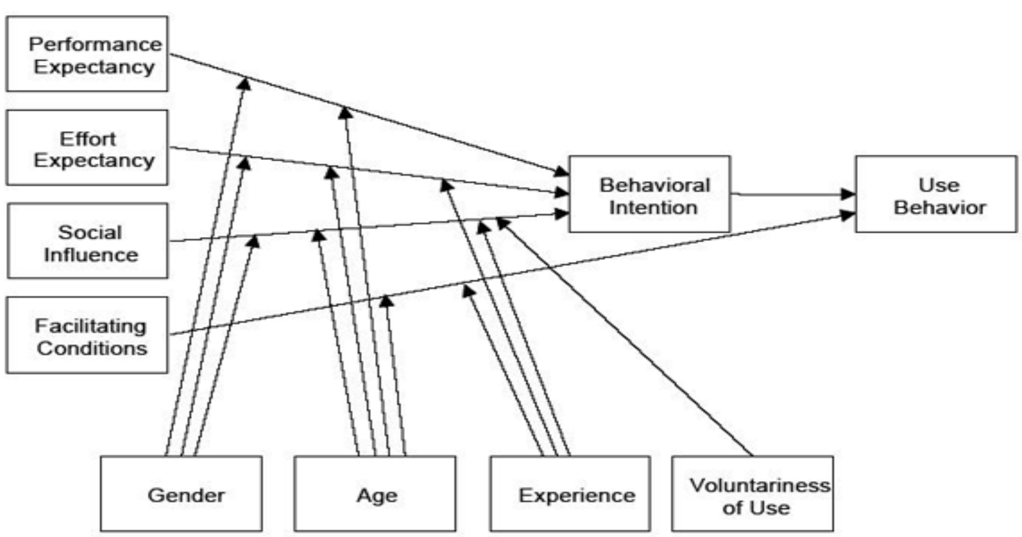

Figure 4.1 Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003).

The model was developed for information technology; however, its generalizability makes it useful for predicting intention to use other technologies (Venkatesh et al. 2003). UTAUT measures in relation to agroforestry riparian buffers are described below. Performance expectancy (PE) is how well a landowner expects the buffer system to perform in terms of survival, production, and conservation services. Effort expectancy (EE) is the expected effort required to plan, plant, and manage an agroforestry riparian buffer. Social influence (SI) is the extent to which groups or individuals such as family, neighbors, and other landowners support creek side plantings and affect a landowner's intention to plant. Facilitating conditions (FC) are the help and support a landowner believes is available for implementing these systems. Examples of facilitating conditions include educational materials, outreach, and financial assistance (Venkatesh et al. 2003). Age, gender, and experience using riparian buffers were measured to account for interactions hypothesized by Venkatesh et al. (2003).

Pattanayak et al. (2003) used literature synthesis to identify five common factors that can influence agroforestry adoption. *Preferences* are landowner characteristics such as age, gender, and education that affect adoption of agroforestry plantings. *Resource endowments* are assets that landowners can access to implement agroforestry practices. *Market incentives* are economic factors that either lower the cost and/or increase benefits of adoption. *Biophysical factors* are influential land characteristics such as slope, soil, and plot size. Finally, there is *risk and uncertainty* associated with implementing agroforestry practices. When comparing Pattanayak et al. (2003) to UTUAT, we found that *preferences, resource endowments* and *market incentives* are accounted for either as moderators or independent predictors. However, *risk* and *biophysical* factors were not accounted for within the model.

4.3 Adoption of Agroforestry Riparian Buffers

Age has been found to relate to adoption of agroforestry riparian buffers. Hagan (1996) found that younger landowners are more interested in participating in riparian buffer programs in the US. Similarly, Valdivia and Poulos (2009) found that interest in riparian buffers decreases as age increases. Pattanayak et al. (2003) found that age and adoption are often positively correlated in international studies, while Matthews et al. (1993) found that age is not related to adoption.

Social relations also affect adoption. Pattanayak et al. (2003) found that interest in agroforestry practices increases with membership in community organizations. Salamon et al. (1997) highlighted the importance of family factors in influencing adoption of sustainable farming practices. Furthermore, Raedeke et al. (2003) found that family relations were key in understanding riparian buffer cost share participation. Additionally, Atwell et al. (2009) found that community interactions such as face-to-face communication, local social networks, norms, and support structures play a critical role in adoption.

Adoption is also driven by land characteristics such as parcel size. Some studies indicate that parcel size affects landowner interests and participation in agroforestry practices (Konyar and Osborn 1990; Featherstone and Goodwin 1993; Pattanayak et al. 2003). Featherstone and Goodwin (1993) found that larger farms were more likely to make conservation investments. Raedeke et al. (2001) found that acreage did not affect participation in riparian cost share programs and Matthews et al. (1993) found that farm size was unrelated to riparian buffer adoption. Also, Valdivia and Poulos (2009) found that non-forested stream frontage did not related to interest in adopting riparian plantings.

The relationship between government programs, technical assistance and adoption has also been studied. Skelton et al. (2005) found that landowners who have adopted riparian buffer practices are more willing to participate in government payment programs. However, in other cases government payments were rated the least likely reason to adopt riparian buffers (Ryan et al. 2003). Furthermore, Valdivia and Poulos (2009) found that interest in riparian buffers was not affected by being familiar with governmental conservation incentive programs. Yet Pattanayak et al. (2003) found that resource endowments were a large factor in adoption of agroforestry systems, which can encompass technical assistance. Possible technical barriers to adoption are planting trees, installing deer protection, mowing grass, and maintenance (Klapproth and Johnson 2001).

4.4 Native Fruit and Nut Tree Riparian Buffers

Riparian buffers are one of five common temperate agroforestry practices and are generally described as areas near streams, rivers or other bodies of water that have planted or naturally occurring trees, shrubs, and other vegetation that protect the water from contaminants while stabilizing stream banks and providing habitat for terrestrial and aquatic wildlife (Palone and Todd 1997; Gold and Garret 2009). The structure of agroforestry riparian forest buffers can vary. For this study, we focused on a 3-zone system published by the US Department of Agriculture (Welsh 1991). In Zone 1, vegetation types include fast growing and flood tolerant tree and shrub species in a 15-foot wide strip directly adjacent to the stream and not intended for production. The purpose of this zone is to stabilize the stream bank, protect water quality, and improve terrestrial and aquatic habitat. The second zone, upslope from the first zone is 60 feet or more in width and available for tree-based production. Zone three is upslope from the Zone 2 and can consist of a strip of grasses at least 20 feet wide. This third zone is important for dispersing surface water as it enters the riparian buffer and can be grazed, grown for hay, or periodically mown (Schultz et al. 2009).

Many have highlighted the opportunity of planting trees and shrubs that produce useful products in creek side areas such as fruits, nuts, honey, maple syrup, floral products, weaving and dying materials, timber, cooking wood (Klapproth and Johnson 2001; Shultz et al. 2009). We focused on native fruit and nut trees as a component of Zone 2 because they allow for diverse objectives such as local food production, recreation, and wildlife habitat. Examples of native fruit and nut species appropriate for Zone 2 in the study region include: pawpaw (*Asimina triloba)*, American hazelnut (*Corylus americana)*, American persimmon (*Diospyros americana)*, American plum (*Prunus americana)*, black walnut (*Juglans nigra)*, elderberry (*Sambucus canadensis)*, and downy serviceberry (*Amelanchier arborea)* (Welsch 1991; Klapproth and Johnson 2001). There is also potential for using black raspberry (*Rubus occidentalis*), blackberry (*Rubus allenganensis)* and blueberry (*Vaccinium* spp.) in the transition from Zone 2 to Zone 3 or planted among the trees in Zone 2. We refer to these systems as native fruit and nut tree riparian buffers.

4.5 Methods

Data were collected from a sample of family landowners with non-forested creek sides in three western Virginia watersheds (Figure 4.2). The watersheds have similar amounts of farm and forestlands yet differ in the extent and type of riparian conservation initiatives. The Smith Creek Watershed is one of three Natural Resources Conservation Service (NRCS) priority watersheds in the Chesapeake Bay Watershed. The Catawba Creek Watershed has engaged, conservation-oriented landowner groups, is situated near a land grant institution, and is located in the headwaters of the Chesapeake Bay Watershed. The Lower Reed Creek Watershed is in the New River Watershed and included to account for the major watersheds in western Virginia. It resembles Smith and Catawba Creek Watersheds in terms of landform and use.

We surveyed a random sample of family landowners who own non-forested creek side

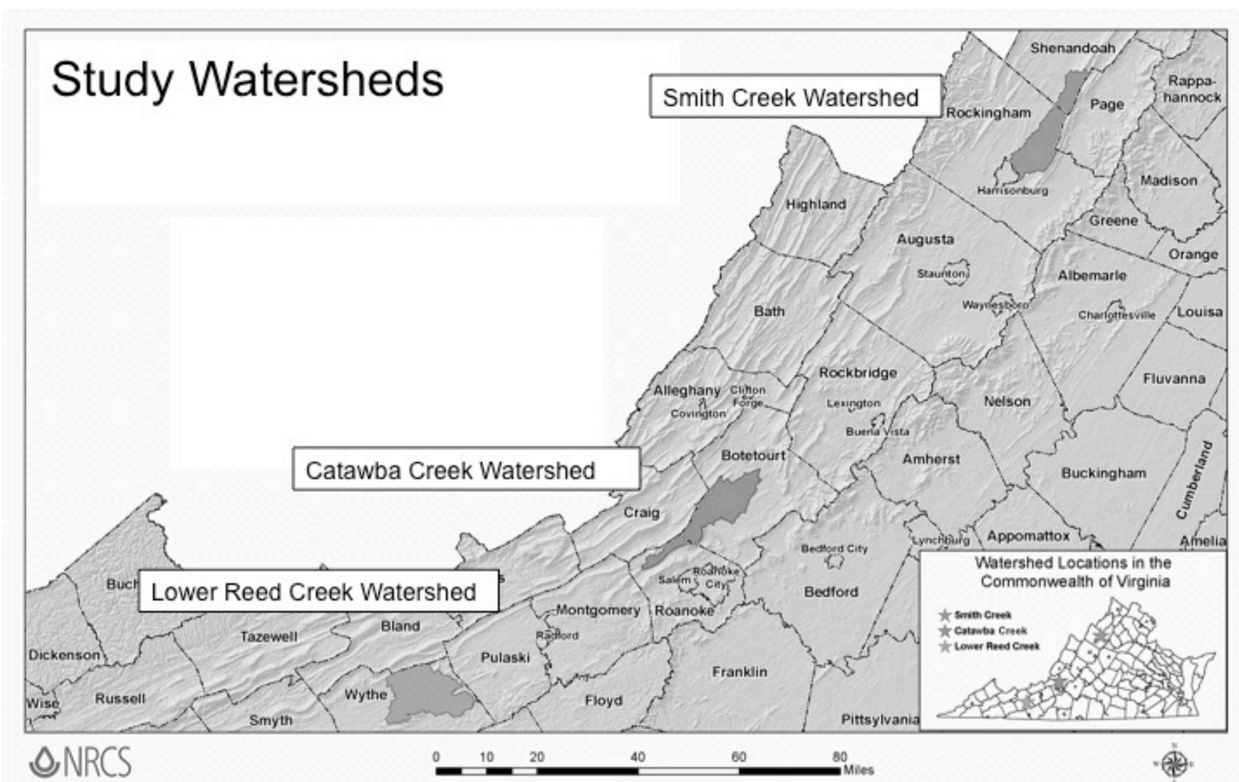

Figure 4.2. Study area watersheds in western Virginia: Smith Creek, Catawba Creek, and Lower Reed Creek.

areas on parcels of at least 5 acres. The acreage floor is intended to limit rural residential properties and focus on larger units. We used geospatial information systems (GIS) and digitized county level property data to identify the landowner population frame. We representatively sampled the population frame with 95% confidence assuming a 0.03 margin of error and removing duplicate cases (Dillman et al. 2009). Table 4.1 depicts the population and sample frames.

Landowners with less than 10 percent canopy cover on creek side areas that are 75 lateral feet from the creek and at least 60 feet in linear length qualified for the study. These dimensions constitute the lowest acreage that NRCS will include in the Conservation Reserve Enhancement Program (CREP) (1/10th acre). CREP is a cost share program and land rental agreement wherein landowners conserve riparian buffer areas on their property (USDA Farm Service Agency 2012). The sample was compiled using aerial imagery, the National Hydrography Dataset, and tax parcel information. Because the National Hydrography Dataset (waterways) was created from maps developed in the 1970s, we asked landowners that no longer have a stream that runs at least part of the year to return the survey with "no creek" written in the comment section.

We mailed the questionnaire to 469 landowners according to the Tailored Design Method (Dillman et al. 2009). A letter notified landowners that a questionnaire would be forthcoming.

Table 4.1. Landowner populations with creek sides in 3 subwatersheds, the random sample drawn from each population, and the landowners within them that had non-forested creek side areas who were sent surveys.

VA Subwatershed	Population	Sample	Non-Forested Creek Side
Smith Creek	507	344	169
Catawba Creek	639	400	158
Lower Reed Creek	583	377	142
Total	1729	1121	469

A survey followed with an invitation letter that described the research. Reminder post cards followed by a replacement survey were sent later for landowners that had yet to respond.

Agroforestry adoption literature and UTAUT were used to develop survey measures (Table 4.2). Intention to plant native fruit and nut trees was measured using a 5-point Likert response scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree and confined to a 3-year behavioral horizon. An image was presented to respondents before asking about their intention to plant (Figure 4.3). PE was measured on a 5-point scale with 1=extremely unlikely, 2=unlikely, 3=somewhat unlikely, 4= likely, and 5= extremely likely (Table 4.2). EE was measured on a 5-point scale with 1=none, 2=not much, 3=some, 4=quite a bit, and 5=a lot. SI and RE were measured using the same 5-point scale as intention to plant

Table 4.2. Construct indicators tested as possible predictors of intention of landowners to plant native fruit and nut trees on creek sides.

Construct	Question	Indicator
Performance Expectancy (PE)	*If you were to plant your creek sides with native fruit and nut trees, how likely do you think the following outcomes would be?*	The trees that live would grow lots of food
		Water quality in the creek would significantly improve
		The amount of wildlife would dramatically increase
Effort Expectancy (EE)	*How much effort do you think each of the following steps would take?*	Planning for a creek side planting of fruit and nut trees
		Planting a creek side with fruit and nut trees
		Managing a creek side of fruit and nut trees
Social Influence (SI)	*How much do you agree or disagree with the following statements?*	People who are important to me would strongly favor creek side plantings on my land
		Fellow landowners think creek side plantings are very beneficial
		Folks that live near my land are generally not interested in creek side plantings
Risk Expectancy (RE)	*How much do you agree or disagree with the following statements about creek side plantings using native fruit and nut trees?*	Putting money into it would be very risky
		I am not certain how I would benefit
		The planting would not be worth my time

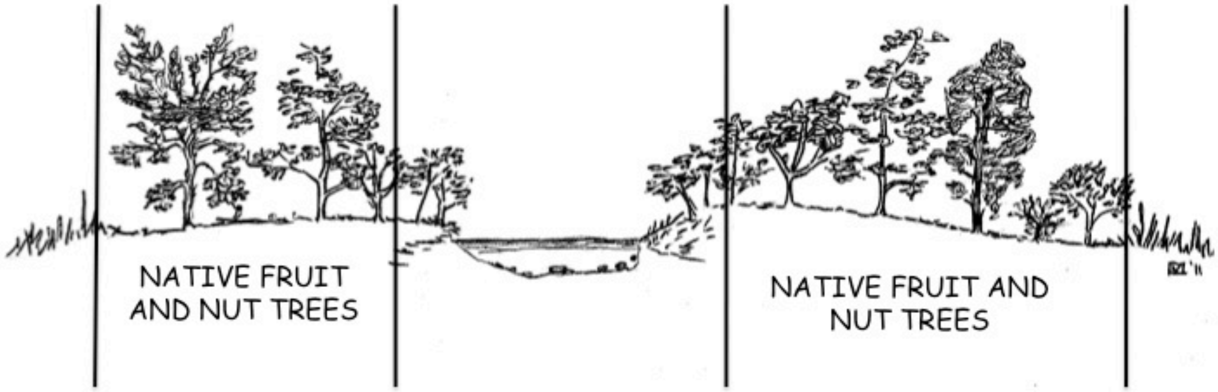

Figure 4.3. Image of a native fruit and nut tree riparian buffer shown before the asking respondents about their intention to plant native fruit and nut trees in the next three years.

native fruit and nut trees.

We tested a draft of the survey with 33 creek side owners outside the study area to strengthen the internal consistency of constructs. We used Confirmatory Factor Analysis (CFA) to verify the hypothesized latent measures of PE, EE, SE and RE (Table 4.3). CFA is used to determine if the reliability and validity of latent measurement scales is acceptable. χ^2 significance, χ^2/df (CMIN/DF), which accounts for the sensitivity of χ2 to sample size, comparative fit index (CFI), root mean square error of approximation (RMSEA), and if the alternate hypothesis that RMSEA is greater than 0.05 (PCLOSE) were used to confirm the fit of hypothesized latent constructs. In general, significant χ^2, CMIN/DF less than 3.0, CFI above

Table 4.3. Confirmatory Factor Analyses (CFA) goodness-of-fit indices for hypothesized latent predictors Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Risk Expectancy (RE).

X^2	p	df	CMIN/DF	CFI	RMSEA	PCLOSE
101.83	0.06	80	1.26	0.97	0.04	0.62

Note: CMIN/DF = X^2/df; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; PCLOSE = p value for hypothesis that RMSEA is greater than 0.05

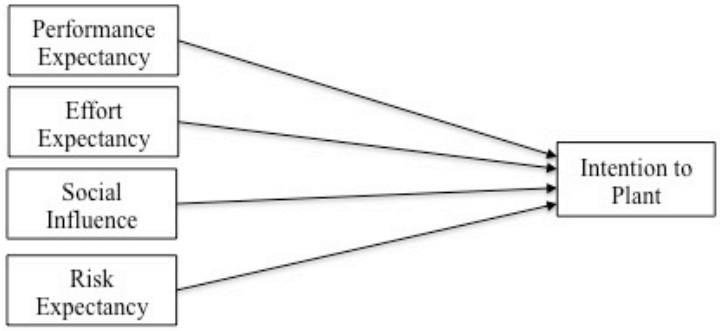

Figure 4.4. Hypothesized latent measures tested using confirmatory factor analysis (CFA) where risk expectancy has been added to the baseline UTUAT model as an independent predictor of intention to plant native fruit and nut tree riparian buffers.

0.95, RMSEA of 0.05 and below and PCLOSE of greater than 0.05 indicate a good fit. $\chi 2$ for the structure is less than 3.0, CFI is above 0.95, RMSEA below 0.05, and PCLOSE surpasses 0.05, which verifies the latent structure of constructs. Results suggest that the hypothesized structure has an adequate fit and validates risk expectancy as an independent factor (Figure 4.4).

Multiple linear regression was used to test two hypothesized models. Model 1 included UTAUT predictors (PE, EE, SI) and interaction terms (age, gender, experience) regressed on intention to plant native fruit and nut trees. Model 2 included predictors and interaction terms in Model 1 plus the risk expectancy (RE) construct and biophysical variables. We tested Model 1 to determine if UTAUT predicts adoption of native fruit and nut tree riparian buffers. Model 2 was tested to see if adding agroforestry measurements to UTAUT would increase its explanatory power.

Hypothesized interaction terms of UTAUT were included in the models based on whether the R^2 value changed significantly when the interaction term was added to model predictors and controls. However, because there are no mandatory creek side management practices in the study area, voluntariness of use from Venkatesh et al. (2003) was held constant and not tested as an interaction in the model.

Categorical interaction terms were analyzed as dummy variables. Young respondents are less than 49 years old, middle age respondents are between the age of 50 and 69 and old age respondents are those greater than 70 years. Old age served as the reference category. Gender and planted creek before are binary dummy variables and coded as 1=female, 0=male and 1=planted, 0=not planted.

Biophysical variables included in the second model were distance of the center of the buffer area to the nearest road (RD), suitability of hand planting in the buffer (Suit), and the parcel size (Acres). RD was measured using geospatial technology, national hydrography data, and Virginia Department of Transportation road data. Suit was obtained from the SURRGO NRCS soil data and indicates the suitability of planting trees by hand within the riparian area on a scale 0 (suitable) to 1 (unsuitable). It accounts for slope, depth to restrictive layer, content of sand, plasticity index, rock fragments on or below the surface, depth to the water table, and ponding. Finally, Acres was measured using geospatial county tax parcel data. These variables were analyzed both for their unique and combined contribution to Model 2. Combined contribution was determined based on whether the R^2 value changed significantly when the biophysical variables were added to model predictors and controls.

Model fit was evaluated using kurtosis, skewness, and Shapiro-wilk statistics of studentized residuals. Multicollinearity, outliers, autocorrelation, and non-linearity were also evaluated. To cross validate the models, we performed a holdout test using a random selection of 70% of the respondents. The remaining 30% were used to calculate the predicted dependent using the constant, unstandardized coefficients, and data for each variable.

4.6 Results

Four hundred and sixty questionnaires were successfully delivered. Two hundred and seventy-seven landowners responded for an adjusted rate of 49.3%. Fifty-five respondents, or 24%, of the 277 indicated they did not have a creek that ran at least part of the year. One hundred and fifty-eight landowners returned usable surveys. Respondents were mainly between the ages of 50 and 69 (58%) and about two-thirds were male (68%) (Table 4.4). Owners with a Bachelors or Graduate degree made up nearly half of the respondents. A large percent make between $50,000 and $100,000 per year (41%). About 17% had planted a portion of their creek

Table 4.4. Respondent demographics by the percent belonging to each category.

Owner Variables	Categories	Respondents
Age	< 49 years	15%
	50-69 years	58%
	>70 years	27%
Gender	Male	68%
	Female	32%
Education	High school	30%
	Associate/Some College	23%
	Bachelors/Graduate	47%
Income	< $25,000	14%
	$25,000-$50,000	22%
	$50,000-$100,000	41%
	$100,000-$150,000	12%
	> $150,000	11%
Planted creek side before	Yes	17%
	No	83%
Retired	Yes	38%
	No	62%
Farmer	Yes	23%
	No	77%

Table 4.5. Model 1 multiple linear regression results using UTAUT predictors, controls and interaction terms on intention to plant native fruit and nut tree riparian buffers. Only significant interaction terms are reported.

Variable	*b*	β	SE	p-value
Performance Expectancy (PE)	0.58	0.45	0.16	<0.01
Effort Expectancy (EE)	-0.28	-0.21	0.09	<0.01
Social Influence (SI)	0.52	0.29	0.13	<0.01
Younger age	-1.24	-0.38	0.89	0.17
Middle age	0.10	0.42	0.60	0.10
Gender	-0.03	-0.01	0.18	0.88
Planted Creek	0.59	0.20	0.20	0.00
PE*Younger age	0.42	0.42	0.28	0.14
PE*Middle age	-0.34	-0.47	0.19	0.08

n=139; Adj R^2=0.41; F=11.56; p-value=<0.01; Shapiro-Wilk=0.99 (p=0.46)

sides prior to filling out the survey.

Model 1 was significant at $\alpha \leq 0.001$ with an F value of 11.55, and an adjusted R^2 of 0.41. PE, EE, SI and whether the respondent had planted their creek before were significant at $\alpha \leq 0.05$. Middle age is significant at $\alpha \leq 0.10$ (Table 4.5). The interaction between PE and middle age was also significant, with a significant R^2 change (0.032) when added to the model, meaning PE varies by respondent age. However, the interaction of respondents of younger age and PE was not significant. Males do not significantly differ from females in their intention to plant native fruit and nut trees.

Unstandardized coefficients suggest that intention to plant increases by over half a point (0.58) for each unit increase in PE (Table 4.5). Similarly, there is half a point increase (0.52) for each unit increase in SI. Conversely, for every unit increase in EE, intention to plant decreases by about a third of a point (0.28). Experience planting prior to the survey corresponded to an increase in intention to plant native fruit and nut trees by 0.59 points. From the unstandardized

Table 4.6. Model 2 multiple linear regression using predictors, controls and interactions from UTAUT with additional agroforestry measures of risk expectancy and biophysical variables from Pattanayak et al. (2003) to predict intention to plant native fruit and nut tree riparian buffers.

Variable	*b*	β	SE	p-value
Performance Expectancy (PE)	0.49	0.38	0.16	<0.01
Effort Expectancy (EE)	-0.15	-0.12	0.10	0.11
Social Influence (SI)	0.47	0.26	0.14	<0.01
Younger age	-1.22	-0.38	0.85	0.16
Middle age	0.86	0.36	0.59	0.15
Gender	-0.14	-0.05	0.18	0.43
Planted Creek	0.51	0.17	0.20	0.01
PE*Young age	0.38	0.38	0.27	0.16
PE*Middle age	-0.32	-0.44	0.19	0.09
Risk Expectancy (RE)	0.33	0.22	0.12	0.01
Hand Planting Suitability (Suit)	0.00	0.12	0.00	0.08
Distance to Nearest Road (RD)	0.42	0.10	0.27	0.12
Parcel Size (Acres)	-0.00	-0.13	0.00	0.06

n=139; Adj R^2=0.45; F=9.76; p-value=<0.01; Shapiro-Wilk=0.99 (p=0.73)

Table 4.7. Contribution of risk expectancy and biophysical variables to the model adapted from UTAUT (Model 1) as seen from R^2 Change.

Measures	R^2 Change	F Change	Sign. F Change
Risk Expectancy (RE)	0.02	5.57	0.02
Biophysical Variables	0.03	2.88	0.04

coefficient of the interaction term between PE and middle age, a person in the middle age category would have about a third of a point less on the intention scale than an older aged person.

Model 2 included the predictors, controls and interaction terms in Model 1 with additional agroforestry measures of RE and biophysical variables (RD, Suit, and Acres). Model 2 is significant at $\alpha \leq 0.001$ with an F value of 9.76 and adjusted R^2 of 0.45 (Table 4.6). The same variables were significant in Model 2 as in Model 1 except EE and middle age, and the interaction of middle age and PE. Suit and acres were significant at ($\alpha \leq 0.1$) whereas RD was not.

Unstandardized coefficients in Model 2 indicate a single unit increase in PE corresponds to about a half a point increase in intention to plant (0.49) (Table 4.6). Similarly, for each unit increase in SI, intention to plant increases by about a half a point (0.47). Experience planting prior to the survey corresponded to an increase in intention to plant native fruit and nut trees by 0.51 points. One unit increase in RE increases intention levels by about a third of a point.

With each acre increase in parcel size intention to plant decreases by 0.002 of a point, or 0.2 points for every 100 acres ($\alpha \leq 0.1$). While hand-planting suitability is also significant at $\alpha \leq 0.1$, it does not have any noticeable effect on intention to plant (0.000). Results indicate that RE accounts for 2.3 % of the variance present in the dependent variable and biophysical factors collectively account for 3.4% of the variance in Model 2 (Table 4.7).

Shapiro-wilk statistics for studentized residuals were insignificant for Models 1 and 2. Kurtosis and skewness are within an acceptable range for both and neither model exhibits multicollinearity, outliers, autocorrelation, and non-linearity. Through cross validation we found both models are relatively good predictors with most predicted values falling within 1 unit of observed values.

4.7 Discussion

Results indicate that Model 1 explains about 41% of the variance in intention to plant, while Model 2 explains about 45%. Because RE and biophysical predictors explain variance in Model 2, there is evidence that these constructs are useful for predicting an owner's intention to plant native fruit and nut tree riparian buffers. In other words, the addition of constructs from agroforestry literature significantly improved explanatory power of the baseline UTAUT model (Model 1).

In Model 2, PE relates most strongly to intention to plant meaning that landowner expectations of how well a native fruit and nut tree riparian buffer system performs could be most important when predicting intentions. EE was no longer significant when RE was added to Model 1 suggesting that risk may be more useful when predicting planting intentions among landowners. RE relates second most strongly to adoption; with increases in RE, intention levels decrease. This result corresponds to findings in Pattanayak et al. (2003) where higher perceived risk related to decreased adoption of agroforestry practices.

The interaction of PE and age in Model 1 is contrary to Matthews et al. (2003) who found age is not related to adoption. However it is consistent with other findings that suggest older respondents are less likely than younger respondents to adopt conservation practices (Hagan 1996; Valdivia and Poulos 2009). However, these results are contrary to Pattanayak et al. (2003) where age often positively correlated with adoption. In this study, older landowners may be less likely than middle age landowners to associate performance of the system with intention to plant. With the addition of RE and biophysical variables in Model 2, the interaction term between PE and age became insignificant, which is consistent with Matthews et al. (2003) and contrary to others (Hagan 1996; Pattanayak et al. 2003; Valdivia and Poulos 2009)

Landowners who had already planted creek sides had higher levels of intention to do so again with native fruit and nut trees. This suggests that once landowners plant riparian areas, they may be likely to expand plantings, particularly with respect to native fruit and nut trees. Therefore, previous planting of riparian buffers can help to predict intention to plant native fruit and nut tree riparian buffers. This finding is similar to that of Ryan et al. (2003) where farmers who had implemented conservation practices previously were more likely to adopt woody vegetation plantings along their creek sides.

Intention to plant increases quite a bit when landowners perceive that family members, other landowners, and neighbors think these riparian systems are desirable. Similarly, Salamon et al. (1997) and Raedeke et al. (2003) found that family support was important for decision-makers when choosing to implement sustainable farming practices. Also, Atwell et al. (2003) found that community networks and norms play a large role in adoption of perennial agricultural systems. The significance of SI in the models reveals that perceptions of what others think about native fruit and nut tree riparian plantings is a useful predictor of landowner intentions.

While the relationship of parcel size to adoption of native fruit and nut tree riparian buffers is significant, the effect is so small that it is negligible. This is contrary to Featherstone and Goodwin (1993) who found that larger farms were more likely to make conservation investment. However, the effect of parcel size in this study is affirmed by Raedeke et al. (2001) and Matthews et al. (1993) who found that acreage was not related to adoption of riparian buffer practices. As another measure of how area relates to adoption, Valdivia and Poulos (2009) found that stream frontage without trees did not relate to interest in planting riparian buffers. Because parcel size did not uniquely affect intention to plant, it could be that size is more or less unimportant when predicting intentions.

Hand planting suitability also does not uniquely affect intention to plant, which could indicate that intention is not a product of how difficult or easy it may be to plant trees by hand. The non-significance of distance from the buffer to the nearest road was unexpected and demonstrates that landowner intentions are more strongly related to other factors. Nonetheless, when combined, the biophysical variables affected the tested model. Future research could help to parse out the effects of each of these variables and determine if other biophysical factors from agroforestry literature may aid in predicting intention to plant native fruit and nut tree riparian buffers.

Facilitating conditions were theorized by Venkathesh et al. (2003) to play an important role in actual behavior. Thus landowners are not the only factors that play a role in adoption. Technical assistance and resources will need to be understood more fully if trying to better understand actual adoption of native fruit and nut tree riparian buffers.

Both models tested in this study explain about twice as much variance in intention when compared to other agroforestry adoption models (e.g. Valdivia and Poulos 2009). Model 2 with RE and biophysical variables included, explains about 4% more variance in intention to plant than Model 1. Nevertheless, the UTAUT model in its own right helps to predict 41% of the variance in intention to plant native fruit and nut tree riparian buffer systems. The addition of agroforestry variables associated with risk and biophysical characteristics improves the model as it relates to predicting intention to adopt native fruit and nut tree riparian buffers. Further study is needed to identify other factors and variables that could additionally influence intention.

4.8 Conclusion

This study focused on predicting adoption of native fruit and nut tree riparian buffers using UTAUT and agroforestry models. Results indicate that predicting intentions hinge on expected performance, perceived risk, perceptions of others ideas about the system, the extent to which landowners have adopted similar technologies, and characteristics of the land. However, a lack of unique effects associated with biophysical variables impacts complete clarity of the effects. Therefore, further research about the unique effects of the biophysical factors on intention to plant could be useful in building upon the second model in our study.

The UTAUT (Model 1) and UTAUT model with agroforestry concepts (Model 2) both explain significant amounts of variance in an owner's intention to plant. The addition of agroforestry predictors is merited because they explain part of the variance and Model 2. While these models have proven their use in native fruit and nut tree riparian buffer adoption, results provide a platform for further research to identify other variables that might affect intention to adopt both riparian buffers and agroforestry practices in general.

CHAPTER 5. CONCLUSION

5.1 Summary

The two main purposes of this study were to better understand underlying typologies within the population of creek owners in order to craft relevant messages to each group and to build on agroforestry adoption theory by testing UTAUT and UTAUT with additional agroforestry concepts to determine if these two models help predict intentions to plant native fruit and nut tree riparian buffers.

We used a two-step cluster analysis to identify types of owners and their management objectives, perceived effects of riparian plantings, and preferred outcomes, which can be used to inform development of communication strategies. In determining the predictive power of the two models, we first used confirmatory factor analysis to determine the validity and fit of the hypothesized constructs and then tested a model adapted from UTAUT (Model 1) and a model that included all measures from Model 1 with additional agroforestry adoption measures (Model 2) using multiple linear regression.

5.2 Conclusion

Because riparian forest buffers are receiving much attention as a tool to increase watershed health, defining landowner types is increasingly relevant for conservation-based communication and outreach strategies. For example, President Barack Obama signed Executive Order 13508 in 2009, which sets goals to dramatically improve the health of Chesapeake Bay Watershed and includes the objective to restore and maintain 181,440 miles of total riparian forest buffers by 2025. This equates to establishing an additional 14,400 miles riparian forest buffers (Federal Leadership Committee for the Chesapeake Bay 2010).

This study identifies underlying groups that exist within the larger population; the characteristics of which can be used to develop communication and outreach strategies to promote conservation practices. Furthermore, both tested models help predict and explain a noteworthy amount of intentions to plant native fruit and nut tree riapiran buffers. However, when agroforestry concepts were added it helped to explain additional variance signifying the value of these measures.

Owner groups differed according to production levels, livestock creek access, and creek side vulnerability. Owners also differed by management objectives, perceived impacts of riparian buffer plantings, and reasons they would be likely to plant native fruit and nut trees on their creek sides. However, common to all three types was an interest in enhancing wildlife habitat, a belief that soil is more stable with riparian plantings, concern for regional water quality, and preference for aesthetics. These environmental services could be valuable to include in communication strategies across the board, but otherwise tailored communications strategies for each type will likely be most effective. Creek source producers are most interested in compact and well-maintained buffers. Alternative source producers may be most affected by the effort involved in establishing and maintaining these systems. Non-producers are most receptive to services such as wildlife habitat enhancement or water quality improvement rather than fruit and nut production.

Prediction of landowner behavior in relation to native fruit and nut tree riparian buffers is useful in determining potential impacts to conservation. Results indicate that predicting intentions to plant these systems hinge on expected performance, perceived risk, perceptions of others ideas about the system, the extent to which landowners have adopted similar technologies, and characteristics of the land.

To conclude, we have listed the major findings of this study:

- Three underlying groups were identified within a larger population of creek side respondents. Owner types differ in terms of management objectives, perceived impacts of riparian buffer plantings, and reasons they would be likely to plant native fruit and nut trees on their creek sides.
- Environmental services are broadly important for wholesale communication strategies, but otherwise, tailored communications strategies for each type will likely be most effective.
- UTAUT combined with agroforestry measures explain a significant amount of the variance in intention to plant native fruit and nut tree riparian buffer plantings.

5.3 Recommendations for Future Research

Additional research addressing variability in aesthetic preferences among different landowner types may help define unique needs. Designing a suite of riparian buffer systems that are aesthetically pleasing could dramatically increase adoption of native fruit and nut tree riparian buffers.

A lack of unique effects associated with biophysical variables impacts complete clarity of these effects. Therefore, further research about the unique effects of the biophysical factors on intention to plant could be useful in building upon the second model in our study. While the UTAUT model with agroforestry concepts explains (Model 2) a noteworthy amount of the variance in intention to plant native fruit and nut tree riparian buffers, it provides a platform to further study intention to adopt unique riparian buffer systems and general agroforestry practices.

REFERENCES

Ajzen, I. 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes 50(2):179-211.

Alig, R.J, K.J. Lee, and R.J. Moulton. 1990. Likelihood of timber management on non-industrial private forests: Evidence from research studies. U.S. Department of Agriculture Forest Service Publication GTR-SE-60.

Arbuckle, J.G., C. Valdivia, A. Raedeke, J. Green, and J.S. Rikoon. 2009. Non-operator landowner interest in agroforestry practices in two Missouri watersheds. Agroforestry Systems 75:73-82.

Atwell, R.C., L.A. Schulte, and L.M. Westphal. 2009. Linking resilience theory and diffusion of innovations theory to understand the potential for perennials in the U.S. Corn Belt. Ecology and Society 14(1):30-47.

Barbieri, C., and C. Valdivia. 2010. Recreational multifunctionality and its implications for agroforestry diffusion. Agroforestry Systems 79:5-18.

Brookfield, H., and C. Padoch. 1994. Appreciating agrodiversity: A look at the dynamism and diversity of indigenous farming practices. Environment 36(5):6-20.

Brooks, K.N., H.M. Gregersen, and P.F. Ffolliott. 1994. Role of agroforestry in sustainable land-use systems. Paper presented at the Agroforestry and Sustainable Systems Symposium. Fort Collins, CO.

Butler, B.J., and E.C. Leatherby. 2004. America's Family Forest Owners. Journal of Forestry 102(7):4-14.

Castelle, A.J., A.W. Johnson, and C. Conolly. 1994. Wetland and stream buffer size requirements—A review. Journal of Environmental Quality 23(5):878-882.

Compeau, D.R., and C.A. Higgins. 1995. Computer self-efficacy: Development of a measure and initial test. MIS Quarterly 19(2):189-211.

Connor, D.S., Montri A.D., Montri D.N, and M.W. Hamm. 2009. Consumer demand for local produce at extended season farmers' markets: Guiding farmer marketing strategies. Renewable Agriculture and Food Systems 24(4):251-259.

Cooper, E.R., and M.G. Jacobson. 2009. Establishing conservation easements on forested riparian buffers: Opportunities for long-term streamside protection. Small-scale forestry 8:263-274.

Daniels, R.B., and J.W. Gilliam. 1996. Sediment and chemical load reduction by grass and riparian filters. Soil Science Society of America Journal 60:246-251.

Davies, K.M. 1994. Some ecological aspects of northeastern American Indian agroforestry practices. Northern Nut Growers Association 85:25-37.

Davis, F.D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly 13(3):319-339.

Davis, F.D., R.P. Bagozzi, and P.R. Warshaw. 1992. Extrinsic and intrinsic motivation to use computers in the workplace. Journal of Applied Social Psychology 22(14):1111-1132.

Dillman, D.A., J.D. Smyth, and L.M. Christian. 2009. Internet, Mail and Mixed-Mode Surveys: The Tailored Design Method, 3rd ed. John Wiley & Sons, Hoboken, New Jersey.

Featherstone, A.M, and B.K. Goodwin. 1993. Factors influencing a farmer's decision to invest in long-term conservation improvements. Land Economics 69(1):67-81.

Federal Leadership Committee for the Chesapeake Bay. 2010. Executive order 13508: Strategy for protecting and restoring the Chesapeake Bay watershed. EPA-903-S-10-001.

Fishbein, M. and I. Ajzen. 1975. Belief, attitude, intention and behavior: An introduction to theory and research. Addison-Wesley, Reading, Massachusetts.

Gold, M.A., and H.E. Garrett. 2009. Agroforestry nomenclature, concepts, and practices. In: Garrett H.E. (ed) North American agroforestry: An integrated science and practice. American Society of Agronomy: Madison, pp. 1-23.

Governo, R., and B.G Lockaby. 2004. Silvicultural management within streamside management zones of intermittent streams: Effects on decomposition, productivity, nutrient cycling, and channel vegetation. Southern Journal of Applied Forestry 28(4):211-224.

Hagan, P.T. 1996. Evaluating determinants of participation in voluntary riparian buffer programs: a case study of Maryland's buffer incentive program. Master's thesis. University of Maryland.

Herzog, F. 2000. The importance of perennial trees for the balance of northern European agricultural landscapes. Unasylva 200(51):42-48.

Kendra, A., and R. B. Hull. 2005. Motivations and Behaviors of New Forest Owners in Virginia. Forest Science 51:142-154.

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

Klapproth, J.C, and J.E. Johnson. 2000A. Understanding the science behind riparian forest buffers: Effects on water quality. Virginia Cooperative Extension Publication 420-151.

Klapproth, J.C, and J.E. Johnson. 2000B. Understanding the science behind riparian forest buffers: Effects on plant and animal communities. Virginia Cooperative Extension Publication 420-152.

Klapproth, J.C, and J.E. Johnson. 2001. Understanding the science behind riparian forest buffers: Benefits to communities and landowners. Virginia Cooperative Extension Publication 420-153.

Kluender, R. A. and T. L. Walkingstick. 2000. Rethinking How Nonindustrial Landowners View Their Lands. Southern Journal of Applied Forestry 24:150-158.

Konyar, K. and C.T. Osborn. 1990. A national-level economic analysis of conservation reserve participation: A discrete choice approach. Journal of Agricultural Economic Research 42(2):5-12.

Lassoie, J.P., L.E. Buck, and D. Current. 2009. The development of agroforestry as an integrated land use management strategy. In: Garrett H.E. (ed) North American agroforestry: An integrated science and practice. American Society of Agronomy: Madison, pp. 1-23.

Leopold, L.B., M.G. Wolman, and J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman: San Francisco.

Lowrance, R., L.S. Altier, J.D. Newbold, R.R. Schnabel, P.M. Groffman, J.M. Denver, et al. 1997. Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. Environmental Management 21(5):687-712.

Lowrance, R., R. Leonard, and J. Sheridan. 1985. Managing riparian ecosystems to control nonpoint source pollution. Journal of Soil and Water Conservation 40:87-91.

Lowrance, R., R. Todd, JJr. Fail, O.Jr. Hendrickson, and R. Leonard. 1984. Riparian forests as nutrient filters in agricultural watersheds. BioScience 34(6):374-377.

Lynch, L., and C. Brown. 2000. Landowner decision making about riparian buffers. Journal of Agricultural and Applied Economics 32(3):585-596.

Majumdar, I., L. Teeter, and B. Butler. 2008. Characterizing family forest owners: A cluster analysis approach. Forest Science 54(4):176-184.

Maminiaina, R.S., J.E. Johnson, and R.B. Hull. 2010. Adoption of woodland management practices by private forest owners in Virginia. Forest Science 56(5):444-452.

Matthews, S., S.M. Pease, A.M. Gordon, and P.A. Williams. 1993. Landowner perceptions and the adoption of agroforestry practices in southern Ontario, Canada. Agroforestry Systems 21:159-168.

McGinty, M.M., M.E. Swisher, and J. Alavalapati. 2008. Agroforestry adoption and maintenance: Self-efficacy, attitudes, and socio-economic factors. Agroforestry Systems 73:99-108.

Mercer, D.E., and R.P. Miller. 1998. Socioeconomic research in agroforestry: progress, prospects, and priorities. Agroforestry Systems 38:177-193.

Montagnini, F., and P.K.R. Nair. 2004. Carbon sequestration: An underexploited environmental benefit of agroforestry systems. Agroforestry systems 61:281-295.

Montambault, J.R., and J.R.R Alavalapati. 2005. Socioeconomic research in agroforestry: A decade in review. Agroforestry systems 65:151-161

Munsell, J. F., R. H Germain, and I.A. Munn. 2008. A Tale of Two Forests: Case Study Comparisons of Sustained Yield Management on Mississippi and New York Nonindustrial Private Forestland. Journal of Forestry 106:431-439.

Palone, R.S., and A.H. Todd (ed.). 1997. Chesapeake Bay riparian handbook: A guide for establishing and maintaining riparian forest buffers. NA-TP-02-97. USDA Forest Service, Radnor, PA.

Pattanayak, S.K, D.E. Mercer, E. Sills, and J. Yang. 2003. Taking stock of agroforestry adoption studies. Agroforestry Systems 57:173-186.

Peterjohn, W.T., and D.L. Correll. 1984. Nutrient dynamics in the agricultural watershed: Observations on the role of a riparian forest. Ecological Society of America 65(5): 1466-1475.

Pinho, A.P., A.M. Lawrence, C.R. Jackson, J.W. White, P.B. Bush, and A.T. Matos. Contaminant retention potential of forested filter strips established as SMZs in the piedmont of Georgia. Journal of the American Water Resources Association 44(6): 1564-1577.

Prichard, D. 1993. Riparian area management. Technical Reference 1737-9. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

Raedeke, A.H., C.H. Nilon, and J.S. Rikoon. 2001. Factors affecting landowner participation in ecosystem management: a case study in south-central Missouri. Wildlife Society Bulletin 29(1):195-206.

Raedeke, A.H., J.J Green, S.S. Hodge, and C. Valdivia. 2003. Farmers, the practice of farming and the future of agroforestry: An application of Bourdieu's concepts of field and habitus. Rural Sociology 68(1):64-86.

Ranganath, S.C., W.C. Hession, and T.M. Wynn. 2009. Livestock exclusion influences on riparian vegetation, channel morphology, and benthic macroinvertebrate assemblages. Soil and Water Conservation Society. 64(1):33-42.

Robles-Diaz-de-Leon, L. F. 1998. Evaluation of potential gross income from non-timber products in a model riparian forest for the Chesapeake Bay watershed. Agroforestry Systems 44(2/3):215-225.

Rogers, E.M. 2003. Diffusion of Innovations, 5th ed. The Free Press, New York, USA.

Ryan, R.L., D.L. Erickson, and R. De Young. 2003. Farmers' motivations for adoption conservation practices along riparian zones in a mid-western agricultural watershed. Jour of Env Planning and Mangement 46(1):19-37.

Salamon, S., R.L. Farnsworth, D.G. Bullock, and R. Yusuf. 1997. Family factors affecting adoption of sustainable farming systems. Journal of Soil and Water Conservation 52(2):265-271.

Schultz, R.C., T.M. Isenhart, J.P. Colleti, W.W. Simpkins, and R.P. Udawatta. 2009. Riparian and upland buffer practices. In: Garrett H.E. (ed) North American Agroforestry: An integrated science and practice. American Society of Agronomy: Madison, pp. 163-217.

Skelton P., S.J. Josaih, J.W. King, J.R. Brandle, G.A. Helmers, and C.A. Francis. 2005. Adoption of riparian forest buffers on private lands in Nebraska, USA. Small-Scale Forestry Economics, Management and Policy 4(2):185-204.

Smith, J.R. 1929. Tree crops: A permanent agriculture. New York: Harcourt Brace.

Strong, N.A., and M.G. Jacobson. 2005. Assessing agroforestry adoption potential utilizing market segmentation: A case study in Pennsylvania. Small-scale Forest Economic, Management, and Policy 4(2):215-228.

Taylor, S., and P.A. Todd. 1995. Assessing IT usage: The role of prior experience. MIS Quarterly 19(2):561-570.

Tedders, W.L. 1983. Insect management in deciduous orchard ecosystems: Habitat manipulation. Environmental Management 7(1):29-34.

Thompson, R.L., C.A. Higgins, and J.M. Howell. 1994. Personal computing: Toward a conceptual model of utilization. MIS Quarterly 15(1):124-143.

Traore, N., R. Landry, and N. Amara. 1998. On-farm adoption of conservation practices: The role of farm and farmer characteristics, perceptions, and health hazards. Land Economics 74(1):114-127.

Tyson, C.B., S.H. Broderick, and L.B. Snyder. 1998. A social marketing approach to landowner education. Journal of Forestry 96(2):34-40.

USDA Farm Service Agency. 2012. Conservation reserve enhancement program. Retrieved Mar 29, 2012 from http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep

Valdivia, C. and C. Poulos. 2009. Factors affecting farm operators' interest in incorporating riparian buffers and forest farming practices in northeast and southeast Missouri. Agroforestry Systems 75(1):61-71.

Valdivia, C., M. Gold, L. Zabek, J. Arbuckle and C. Flora. 2009b. Human and institutional dimensions of agroforestry. In: Garret H.E. (ed) North American agroforestry: An integrated science and practice. American Society of Agronomy: Madison, pp. 339-366.

Venkatesh, V., M.G. Morris, G.B. Davis, F.D. Davis. 2003. User acceptance of information technology: Toward a unified view. MIS Quarterly 27(3):425-478.

Virginia Outdoors Foundation. 2010. Riparian buffers: An introduction. Retrieved February 20, 2011 from http://www.virginiaoutdoorsfoundation.org/VOF_resource-ripbuffer.php

Ward, J.M., and C.R. Jackson. 2004. Sediment trapping within forestry streamside management zones: Georgia piedmont, USA. Journal of the American Water Resources Association. 40(6):1421-1431.

Weigel, B.M., E.E. Emmons, J.S. Steward, and R. Bannerman. 2005. Buffer width and continuity for preserving stream health in agricultural landscapes. Wisconsin Department of Natural Resources 56.

Welsch, D.J. 1991. Riparian forest buffers: Function and design for protection and enhancement of water resources. NA-PR-07-91. USDA Forest Service, Radnor, PA.

Wilson, I. 2010. Demand for local produce outpaces production. The Frederick News-Post, Maryland. April 22, 2010.

Workman, S.W., M.E. Bannister, and P.K.E. Nair. 2003. Agroforestry potential in the southeastern United States: perceptions of landowners and extension professionals. Agroforestry Systems 59(1):73-83.

Young, R.A., T. Huntrods, and W. Anderson. 1980. Effectiveness of vegetated strips in controlling pollution from feedlot runoff. Journal of Environmental Quality 9(3): 483-487.

APPENDIX A. SURVEY COVER LETTER

VirginiaTech
College of Natural Resources and Environment

Department of Forest Resources and Environmental Conservation
Katie Trozzo
304 Cheatham Hall (0324)
Blacksburg, Virginia 24061
Email: ketrozzo@vt.edu

October 13, 2011

NAME
ADDRESS LINE
CITY STATE ZIPCODE

Dear ________ County Landowner,

We wrote to you about a week ago regarding a project that focuses on landowner opinions about creek side plantings in __________ County. Your property on _____ Rd in ______ County was randomly selected from publicly available tax parcel records that were recorded as having a stream.

Because there are only a limited amount of landowners with creek sides, your participation is very important. Please know that your responses are useful even if you do not know or care about creek side plantings. In the case that you do not have a creek that runs at least at times on your property, there is no need to complete the survey, but please write "no creek" at the end in the comment section and return the survey in the business reply envelope so we make sure to remove you from the mailing list.

The questionnaire should take about 10 minutes to complete. Your participation is completely voluntary and your responses will be kept confidential. This project has been reviewed and approved by Virginia Tech's Institutional Review Board, which protects the rights of participants in Virginia Tech projects.

If you would like a summary of the project results, please write your name and email address or mailing address on a separate piece of paper and enclose it with your completed questionnaire. If you have questions or concerns do not hesitate to email me at ketrozzo@vt.edu or contact Tracey Sherman at 540-231-7671.

Please answer the survey with your property on ______Rd in ________ County in mind. It is important to answer with this parcel in mind because it was randomly chosen as part of the project.

Thank you very much for your time, effort, and consideration. I look forward to hearing from you.

Respectfully,

Katie Trozzo
Masters of Science Candidate

John Munsell
Associate Professor

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APPENDIX B. SURVEY INSTRUMENT

Creek Side Trees and Shrubs

Your responses to this questionnaire will help us understand your opinions about planting trees and shrubs on your creek sides. The questionnaire is short and should take no longer than 10 minutes.

Thank you very much for your participation!

VirginiaTech
College of Natural Resources and Environment

This questionnaire pertains to your land mentioned in the cover letter. Please answer the following questions with this piece of land in mind.

1. How many years have you owned your land?

   ________Years

2. What are the **top 3 reasons** you own your land? (**Please check only 3 reasons**)

REASONS	Check Here
Beauty and scenery	
Land investment	
Part of home	
Growing timber	
Hunting	
Farming (cattle, hay, crops, etc)	
Wildlife habitat	
Leasing	
Nature	
Pass land on to heirs	
Other:	

When answering questions about creek sides within the survey, please think of the area shown in the drawing below

3. How much do you agree or disagree with the following statements?
   (Please circle only 1 number for each statement)

   I believe planting creek sides with trees and shrubs…

STATEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Greatly improves water quality	1	2	3	4	5
Significantly decreases livestock and crop production	1	2	3	4	5
Enhances wildlife habitat a great deal	1	2	3	4	5
Makes creek sides look sloppy	1	2	3	4	5
Considerably reduces the loss of soil	1	2	3	4	5
Makes creek side access practically impossible	1	2	3	4	5

4. How much do you agree or disagree with the following statement? (**Please circle only 1 response)**

I <u>do not intend</u> to plant trees and shrubs along my creek side <u>in the next 3 years</u>.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

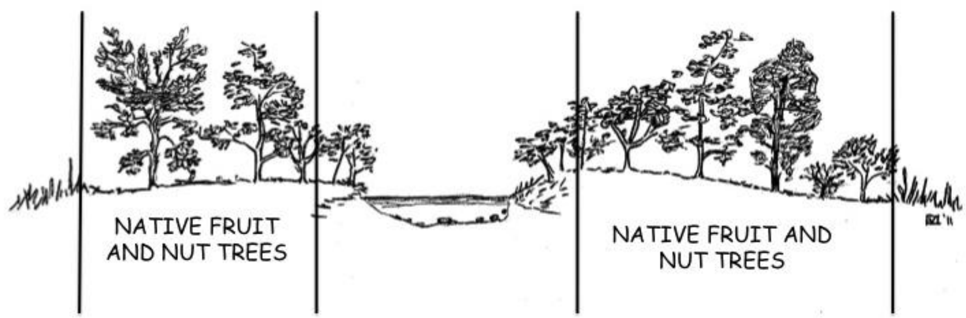
We are interested in whether you would like to plant native fruit and nut trees and shrubs on your creek sides.

Some fruit and nut trees and shrubs native to the region are:

Black walnut	***Blackberry***	***Pawpaw***
Blueberry	***Elderberry***	***Hazelnut***
Persimmon	***American plum***	***Hickory***

*We will refer to these plants throughout the survey as **"native fruit and nut trees"***

When answering questions about native fruit and nut trees planted on creek sides, please think of the zones of the creek side shown in the drawing below



5. Would your intention to plant your creek sides in the next 3 years **<u>increase</u>** if native fruit and nut trees could be used?

YES or **NO** **(Please circle only 1 response)**

6. How much do you agree or disagree with the following statements? (**Please circle only 1 response for each statement)**

I *<u>do not intend</u>* to plant <u>native fruit and nut trees</u> on my creek sides in the next 3 years.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

I am *<u>interested</u>* in planting <u>native fruit and nut trees</u> on my creek sides in the next 3 years.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. If the following outcomes were true, how much would each increase your intention to plant native fruit and nut trees in the next 3 years? (**Please circle only 1 number for each outcome)**

OUTCOMES	Not at All	Increase a Little	Increase Somewhat	Increase Quite A Bit	Increase A lot
You get 75% of the planting paid for by the government	1	2	3	4	5
You make money selling fruits and nuts	1	2	3	4	5
You supply your friends and family with fruits and nuts	1	2	3	4	5
You improve the local economy near your land	1	2	3	4	5
You improve water quality in the region	1	2	3	4	5
You improve wildlife habitat on your land	1	2	3	4	5
You enhance scenery on your land	1	2	3	4	5
You decrease soil loss on your creek side	1	2	3	4	5

8. If you were to plant your creek sides with native fruit and nut trees, how likely do you think the following outcomes would be? (**Please circle only 1 number for each outcome)**

OUTCOMES	Extremely Unlikely	Unlikely	Somewhat Likely	Likely	Extremely Likely
Most of the trees would survive	1	2	3	4	5
The trees that live would grow lots of food	1	2	3	4	5
Water quality in the creek would significantly improve	1	2	3	4	5
The amount of wildlife would dramatically increase	1	2	3	4	5

9. How much effort do you think each of the following steps would take? (**Please circle only 1 number for each step)**

			EFFORT		
STEPS	None	Not Much	Some	Quite A Bit	A lot
Planning for a creek side planting using fruit and nut trees	1	2	3	4	5
Planting a creek side with fruit and nut trees	1	2	3	4	5
Managing a planted creek side of fruit and nut trees	1	2	3	4	5
Harvesting fruit and nuts from a planted creek side	1	2	3	4	5

10. To the best of your ability, please indicate how much you agree or disagree with the following statements about creek side plantings using native fruit and nut trees? **(Please circle only 1 number for each statement)**

STATEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Putting money into it would be very risky	1	2	3	4	5
I have the financial resources needed for this type of planting	1	2	3	4	5
There is a market for native fruits and nuts produced on my land	1	2	3	4	5
I know what to expect from this type of planting	1	2	3	4	5
I have the know-how to carry out this type of planting	1	2	3	4	5
I could get financial assistance to plant	1	2	3	4	5
I am not certain how I would benefit	1	2	3	4	5
I am aware of professionals that assist landowners with creek side plantings	1	2	3	4	5
I could sell the native fruits and nuts I produce	1	2	3	4	5
The planting would not be worth my time	1	2	3	4	5

YOU ARE MORE THAN HALF WAY DONE. PLEASE KEEP GOING.

11. How much do you agree or disagree with the following statements?
(Please circle only 1 number for each statement)

STATEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
People who are important to me would strongly favor creek side plantings on my land	1	2	3	4	5
Fellow landowners think creek side plantings are very beneficial	1	2	3	4	5
Government organizations sufficiently support creek side plantings	1	2	3	4	5
Folks that live near my land are generally not interested in creek side plantings	1	2	3	4	5
I trust the government to provide good information about creek side plantings	1	2	3	4	5
Landowners should be left alone to manage their creek sides	1	2	3	4	5
I trust the government to offer useful creek side planting incentive programs	1	2	3	4	5
Some regulations are needed to ensure creek sides are protected	1	2	3	4	5
I trust the government to make good decisions about creek side management policy	1	2	3	4	5

12. Think of your creek as a squiggly line. The parts of the line that do not have lots of trees on them would be plantable. Please estimate the <u>percentage</u> of the plantable creek side on your property that you would be willing to grow native fruit and nut trees on.
(Please fill in the blank with only 1 number from 0-100)

_______ Percent (0% to 100%)

13. How important are each of the following objectives to you when managing your land? **(Please circle only 1 number for each objective)**

OBJECTIVES	Not at All Important	Somewhat Important	Important	Very Important
Making money	1	2	3	4
Improving the environment	1	2	3	4
Producing goods (cattle, hay, crops, etc)	1	2	3	4
Keeping a natural state	1	2	3	4
Keeping my land well-manicured	1	2	3	4
Improving wildlife habitat	1	2	3	4

14. How much would your <u>intention</u> to plant native fruit and nut trees on your creek sides <u>increase</u> if the following scenario was true? **(Please circle only 1 response)**

You pay only *$300* of the *$1250* needed to establish a creek side planting on 600 feet of stream 75 feet wide (1 acre).

Not Increase → Increase A Little → Increase Some → Increase Quite A Bit → Increase A lot

15. Do you live on your land more than 9 months a year? **(Please check only 1 response)**

☐ Yes ☐ No

16. Do you sell more than $1,000 worth of products from your land in a year? **(Please check only 1 response)**

☐ Yes ☐ No

17. Have you ever planted your creek sides with trees or shrubs? **(Please check only 1 response)**

☐ Yes ☐ No

18. Are livestock grazed on your property? **(Please check only 1 response)**

☐ Yes ☐ No

If yes, do they get most of their drinking water in the creek?

☐ Yes ☐ No

19. How difficult or easy is it to access your creek side? (**Please circle only 1 response)**

Very Difficult → Difficult → Not Very Difficult → Not Difficult At All

If you are *not interested* in planting native fruit and nut trees on your creek sides please skip to question 23 on the next page. If you have some level of interest, however small, please answer numbers 20-22.

20. Which fruits and nuts would you be the most interested in growing?
____

21. Please **check only 3** of the following list that you believe would be most helpful if you were to plant native fruit and nut trees on your creek sides. **(Please check only 3 responses)**

☐ Educational materials for the process
☐ Help planning and designing the planting
☐ Reduced cost of deer protection
☐ Visits to landowners who have planted
☐ Reduced cost of plants
☐ Demonstration sites
☐ Labor for planting

22. Are there any other forms of creek side owner assistance that you believe would be helpful?
____
____
____
____

THE SURVEY IS MORE THAN 75% COMPLETE. YOU ARE ALMOST DONE!

23. What is your age? **(Please check only 1 box)**

☐ Less than 30
☐ 30 to 39
☐ 40 to 49
☐ 50 to 59
☐ 60 to 69
☐ 70 to 79
☐ 80 to 89
☐ Over 90

24. What is your primary occupation? ____

If retired, what was your primary occupation? ________________________________

25. What is the highest level of school that you have completed? **(Please check only 1 box)**

☐ Some high school
☐ High school graduate or GED
☐ Some college
☐ Associate degree
☐ Bachelors degree
☐ Graduate degree

26. What was your approximate 2010 household income before taxes? **(Please check only 1 box)**

☐ Less than $25,000
☐ $25,000 to $50,000
☐ $50,000 to $100,000
☐ $100,000 to $150,000
☐ $150,000 to $200,000
☐ Over $200,000

27. What is your gender? **(Please check only 1 box)** ☐ Male ☐ Female

28. If you have comments about creek side plantings with native fruit and nut trees or anything else please write them in the space below.

If you have further comments, please feel free to write on the back of this page.

If you would like a copy of the project results, please write your email or name and address on a separate piece of paper and enclose it with your completed questionnaire.

Thank you for your time and effort.

Please fold the survey in thirds and return it in the pre-addressed, envelope.

No is postage required.

This number is a way for us to tell if you have returned the survey so we do not send you additional materials. We use a number so that your name is not on the survey. →

APPENDIX C. INSTITUTIONAL REVIEW BOARD PERMISSION LETTER

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: October 3, 2011

TO: John Munsell, Katie Trozzo

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: Landowner Adoption of Native Woody Edible Riparian Buffers in the Chesapeake Bay Watershed

IRB NUMBER: 11-381

Effective October 3, 2011, the Virginia Tech IRB Administrator, Carmen T. Green, approved the amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Exempt, under 45 CFR 46.101(b) category(ies) 2**
Protocol Approval Date: **4/6/2011**
Protocol Expiration Date: **NA**
Continuing Review Due Date*: **NA**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Date*	OSP Number	Sponsor	Grant Comparison Conducted?
4/6/2011		USDA National Agroforestry Center	Not Required (exempt protocol)

*Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

cc: File