Barriers and Incentives to Stream Conservation: The Influence of Culture on Buffer Design and Implementation

A Capstone Project

by

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Abstract

Water quality is of great concern in the Chesapeake Bay watershed, and the negative effects of both point source and non-point source pollution are being addressed. Agricultural land uses, among other sources of pollution, are cited as one of the leading contributors to degraded water quality in the United States. In efforts to reduce the negative impacts of agriculture on water quality, several conservation techniques and best management practices are being promoted by both government and non-government organizations. Riparian buffers, including forest buffers, grass buffers, and stream fencing, are popular strategies that promote improved water quality in the agricultural landscape. Since a large percentage of the fresh water resources in Pennsylvania are located on private land, several studies have explored landowner perceptions of riparian buffers across the United States.

This project adds to previous landowner studies by addressing the cultural significance of landscape and the consequent barriers and incentives to stream conservation practices in a rural agricultural community of central Pennsylvania. This study takes place in the Kishacoquillas Valley, a region located in Mifflin County, whose cultures include many Amish and Mennonite farmers. The study area is located in the headwaters of the Chesapeake Bay watershed. Many streams in this area are designated as “impaired” by the U.S. Environmental Protection Agency’s total maximum daily load reduction requirements and the dominant land use in this area is agriculture. The Kishacoquillas Valley is home to a diverse set of community groups whose farming methodologies range from large mechanized dairy farms with modern farm equipment, to smaller farms dominated by traditional horse drawn implements. The overall goal of this study is to understand better, local landowner perceptions of stream conservation through interviewing landowners of different sub-cultures. From these interviews, alternative buffer designs,
implementation process suggestions, and a proposed action plan are developed to inform future efforts. These alternatives are intended to combine the landowner’s interests and local culture with existing riparian buffer standards.
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Part I

Barriers and Incentives to Stream Conservation: The Influence of Culture on Buffer Design and Implementation
INTRODUCTION

Environmental impacts have become of increasing concern since the environmental movements of the late 1960’s to early 1970’s. It is evident that we are living in a world suffering from increasing anthropogenic influences and finally we are realizing the severity of human development on the earth. Among these influences are the negative effects of agriculture on water quality. Water quality has been attracting important environmental attention, historically accelerated by policy efforts such as the Clean Water Act of 1972. In the past few years, agriculture has been designated as a leading contributor to water pollution and aquatic resource degradation in the United States. Negative impacts of agriculture were first noticed on large scale commercial farms in the Mid-west, but regulations are responding to farms nationwide. Several organizations and incentive programs are committed to alleviating the negative impacts of agriculture on the environment, but reducing these impacts is not a simple process. Nested within water quality protection on farms, are several other issues. These include landowner acceptance and understanding of conservation practices, cultural influences on farming methodology and land use practices, and current stream conservation approaches and programs.

This study focuses on water quality protection in the Kishacoquillas Valley (Kish Valley) of central Pennsylvania (Figure 1 and 2). This area is of great importance to water quality in the Chesapeake Bay Watershed, since the majority of water in a watershed enters through low order headwater streams (Figure 2). Many of the streams in this area are already designated as impaired in compliance with the United States Environmental Protection Agency’s (EPA) pollution diet outlined in the total maximum daily load requirements (TMDL). In many ways similar to other small watersheds dominated by an agricultural land use, the Kish Valley has an important difference in that many of its residents represent the Amish and Mennonite heritage. Accepting the idea that culture influences landscape, the sub-cultures of the Kish Valley add complexity to water quality issues.

Currently, funding and incentives for stream conservation in the Kish Valley are readily available, but there has been hesitancy and slow acceptance by landowners to adopt these practices. Landowners in this study area play a large role in water quality issues since the majority of Pennsylvania’s riparian areas are located on private property (Alliance for Chesapeake Bay 1997). This study explores the reasons for landowner hesitancy and the overall
awareness of water quality issues in the Kish Valley through landowner interviews. Part II of this project defines prominent issues with riparian buffer design and buffer implementation practices in response to landowner preferences.

Figure 1: Location of study area within the Chesapeake Bay Watershed
BACKGROUND

Agricultural Impacts on Aquatic Ecosystems

Since the early 1900’s, agricultural practices in the United States were altered dramatically by the invention of the internal combustion engine and the discovery of synthesized nitrogen. The development of these two technological innovations was further accelerated by advancements in mechanization during WWII. As a result of these technological advances, alterations to the landscape increased in intensity and scale. While beneficial to the economy, the resulting and lasting effects of these advancements on the environment is a much different story. The current model of agriculture that exists today has been described as “slick and clean,”
“commercial,” “sterile,” etc. (Leopold 1939, Boody 2004, Jackson 2008). Many environmental
care concerns associated with modern agriculture methods have received considerable attention. Two
main areas of concern in regard to agriculture and water resources are excess nutrients and
sedimentation.

Excess nutrients are often associated with the application of fertilizer to row crops and
pasture. After the successful discovery of synthesizing nitrogen into fertilizer in 1909, increased
crop yields became more easily attainable through readily available and inexpensive nutrient
amendments (Smil 2001). Ever since, fertilizer application has become a common practice for
farmers across the United States. While technologies continue to increase fertilizer application
efficiency, variables such as weather and affordability of equipment can minimize the benefits of
this technology. Over-application and poor application practices lead to excess nutrient
problems. Leachate from fertilizer applied to corn and soybeans can result in a loss of up to 60%
of the applied material (Jackson 2008). Leachate and runoff are two main transportation vectors
for nutrients, moving them from desired areas into ground water and streams. Nutrient
enrichment in streams causes eutrophication which eventually leads to alterations in ecosystem
function through unusually large algal blooms and reduced oxygen levels. An extreme example
of this is the zone of hypoxia in the Gulf of Mexico where 74% of excess nutrients are attributed
to agriculture (Opdyke 2006).

Sedimentation is another major issue degrading aquatic resources in agricultural areas.
Sediment transport is a natural function of streams but excessive sediment loads (influenced by
poor soil stability) decrease water quality, degrade habitat, and increase further sedimentation,
flooding, and turbidity (Federal Interagency Stream Restoration Group 1998). Sedimentation has
two main sources, (1) over land sheet flow and (2) stream bank erosion (Zaimes 2004).
Agricultural activities contribute largely to overland flow (runoff) through tillage, compaction,
cattle grazing, and crop residue removal. Studies show that forest buffers, row crops, and grazing
areas significantly influence mean rates of erosion. Zaimes (2004) concluded that if 6-9 year old
riparian buffers were in place, instead of row crops and pastures, stream bank erosion could be
reduced by up to 72%. Stream bank erosion is often encouraged by channelization and the
removal of riparian vegetation. Channelization is another typical alteration to streams in an effort
to make the farm more “efficient” (Federal Interagency Stream Restoration Group 1998).
Channelized streams increase water flow velocity, thus increasing erosive power downstream (Zaimes 2004).

**Aquatic Resource Policy**

In response to the degradation of water quality, policy formation and implementation has attempted to protect valuable water resources. Goals in the management of aquatic ecosystems and the enforcing bodies have changed significantly throughout the history of the United States.

The first policy governing the use of inland waterways in the United States was The Swamplands Acts in the mid-1800s. This series of acts allowed lowland areas, such as wetlands, to be drained for agricultural purposes. Several decades later, the Reclamation Act of 1902 allowed for the construction of irrigation projects to support agriculture. In the 1930s, watershed development transitioned from a local to a national issue. The Federal Water Resource Council managed water systems by engineering dams, waterways, and levees. Much like previous policy, the attitudes towards water resources focused on their development, primarily for economic and “sanitary” purposes. Some early policies echoed sound ecological motives, foreshadowing a change that would come about in the second half of the 19th century. After the environmental movements of the late 1960s and early 1970s, attitudes affecting the focus of water resource policy started to shift from economic to environmental. The Federal Pollution Control act of 1972, later amended by the Clean Water Act of 1977, regulates water quality issues. Changes in management of water resources echoed the changing focus. Management shifted from Federal Agencies to the EPA and individual States (National Research Council 1992, 41-47).

Current policies/regulations that apply to the study region in the Kish Valley include the Federal Clean Water Act, PA Nutrient Management Act, PA Code 102 Erosions and Sediment Control, the PA Clean Streams Law, and the Chesapeake Bay TMDL requirements (Beegle 2012). Major enforcement agencies of these policies include the Army Corp of Engineers, the EPA, and the Pennsylvania Department of Environmental Protection (DEP) (Dombroskie 2012).

The Clean Water Act states the objective to “restore and maintain the chemical, physical, and biological integrity of the nation’s waters” (FWPCA 2002, 3). The EPA is the enforcement agency of the Clean Water Act and has primarily focused on point source pollution. The Clean
agency of the Clean Water Act and has primarily focused on point source pollution. The Clean Water Act states many goals on reducing the effects of nonpoint pollution sources; however, these are not yet enforced by legislation (NRC 1992, 43-46).

The Army Corps of Engineers primarily regulates issues under Section 404 of the Clean Water Act. Section 404 deals primarily with permits for the discharge of fill materials into Waters of the United States (Dombroskie, 2012).

The PA Nutrient Management Act passed in 1993, and replaced by Act 38 in 2005, requires all Concentrated Animal Operations (CAOs) to develop a nutrient management plan which must then be approved by the State Conservation Commission. The act defines CAOs as any farm that “exceeds 2 animal equivalent units (AEU) per acre on an annual basis” (Beegle and Martin 2010, 1). Additionally, the Pennsylvania Code 102 states that “all plowing and tilling operations need to have a conservation plan.” This plan was recently updated in 2010 to require that Animal Heavy Use Areas (AHUA’s) be covered by a conservation plan or erosion and sediment control plan.

The PA Clean Streams Law was implemented to “preserve and improve the purity of the water for public health, animal and aquatic life, and for industrial consumption and recreation.” This legislation (Section 401) prohibits municipalities or landowners from discharging any substance defined as a pollutant into the waters of the Commonwealth.

Finally, the Chesapeake Bay TMDL Requirements were established by the EPA in response to insufficient progress of previous policy. This policy identifies necessary reductions in total nitrogen (25%), phosphorus (24%) and sediment (20%) throughout the Chesapeake Watershed. Reductions for specific watershed were determined by modeling done by the EPA. Currently states are required to submit watershed implementation plans (WIP) showing how they plan to achieve the reductions for each county. Counties were not required to have WIP’s; however, some (such as Mifflin County) created their own WIP’s in order to secure grant funding for local projects. Proposed TMDL reductions are scheduled to be achieved by 2025, but a benchmark of 60% is expected by 2017 (USEPA 2010).
Conservation Buffers

Conservation buffers are a popular and effective best management practice (BMP) used to reduce negative effects of the disturbed landscape on water resources. A conservation buffer is defined as “strips of vegetation placed in the landscape to influence ecological processes and provide a variety of goods and services to people” (Bentrup 2008, 1). Conservation buffers were present in historical agricultural landscapes, but the term became popular only in the 1970’s (Lovell and Sullivan 2004). The main function of buffers is to “improve resource conditions by enhancing certain landscape functions” (Bentrup 2008, 5). Conservation buffers have many uses beyond stream conservation including wind protection, erosion control, habitat, biodiversity, sound screening, and improved aesthetics.

Riparian conservation buffers (or riparian buffers) usually consist of linear allotments of space along water bodies (typically streams) that are left relatively undisturbed, allowing for the growth and establishment of vegetation. The benefits of riparian buffers are well documented and include reductions in nutrient runoff, promotion of water infiltration, creation of habitat/biodiversity, improvement of water quality, etc. (Schlosser 1981; Welsh 1991; Lovell and Sullivan 2006; Carline and Walsh 2007; McTammany et al. 2007). Riparian buffer implementation is widely encouraged, even required by multiple environmental and government organizations.

There are multiple funding agencies that provide monetary incentives for riparian buffer implementation (Cooper 2005). The specific programs often change over time as funding becomes available. Major organizations that provide funding for stream conservation within the study area include the Chesapeake Bay Foundation (CBF), Pennsylvania Department of Environmental Protection (DEP), local chapter of Trout Unlimited, United States Department of Agriculture (USDA), the Conservation Reserve Enhancement Program (CREP), and the Mifflin County Conservation District (MCCD).

Specific buffer design and buffer effectiveness have been debated, but priorities on forested buffers are backed by research and are promoted by most of the previously mentioned organizations. Typical minimum setbacks for many of these models are 35 feet from the top of bank on either side of the stream. Several models exist to illustrate parameters for optimal buffer

While this project recognizes that these models and specifications promote maximum buffer performance, the alternative buffer designs (Part II) addressed by this project are geared toward landowner preferences as opposed to nutrient uptake rates, run-off reductions, and infiltration rates. The alternatives strive to produce hybrid solutions to landowner and management agency buffer preferences.

Figure 3: Natural Resource Conservation Service riparian buffer requirements. NRCS Field Office Technical Guidelines Section IV (391DP) 2011
Figure 4: Diagram of a riparian forest buffer. (Welsch 1991)
Figure 5: Guidelines for grass buffer widths and efficiency for nutrient or sediment reductions.
(Bentrup 2008, p. 33-34)
Previous Landowner Studies

There are several studies that focus on riparian conservation strategies and successes in regard to landowner perceptions and riparian buffer design. Several of these studies examine barriers and incentives to stream conservation through semi-structured interviews or surveys of landowners and local residents (Dutcher 2000, Shandas 2007, Kenwick et al. 2009, Armstrong 2012). While some of these studies deal indirectly with cultural influences, the Kish Valley provides a unique situation. The benefits of riparian buffers are well documented (Welsh 1991; Lovell and Sullivan 2006; Carline and Walsh 2007; McTammany et al. 2007); however, slow acceptance rates and hesitation to implement these practices are common (Lovell and Sullivan 2006, Shandas 2007, Kenwick et al. 2009).

Vivek Shandas surveyed landowners with stream side property in the Puget Lowland, Washington, to evaluate three proposed challenges - aesthetics, trust, and barriers and personal values for promoting riparian conservation on private property. Shandas’s findings included that most landowners prefer natural looking riparian areas, prefer to work with local non-governmental and university scientists, and are less trusting of county, state, or federal government. Common barriers included lack of information, concerns about property value, lack of time, and participation in government programs. Incentives included wildlife and fish habitat, protecting stream for future generations, scenic beauty, improved water quality, and economic benefits (Shandas 2007, 177-178). Ultimately, Shandas concluded that humans are an integral part of ecological systems and must be included in conservation planning (Shandas 2007, 182).

A similar study by Kenwick et al. (2009) utilized a similar approach in Illinois, researching preferences of both residents and planners through a photo-questionnaire. Main findings were the general preference for forested streams, the presence of earthen banks, and meandering stream channel configurations. Some of the perceived benefits were aesthetic and ecological benefits, while some of the negatives included buffer maintenance and limited access.

Although, these studies show barriers and incentives to stream restoration they deal with a large population of residential communities and professionals, but represent a limited amount of farmers specifically. Several other studies analyze farmer preferences for riparian conservation (Dutcher 2000, Lovell and Sullivan 2006).
A study in the Chesapeake Bay watershed, conducted by Dutcher (2000), surveyed landowners in Centre and Huntingdon counties to explore landowner opinions, knowledge, and willingness to establish riparian forests. Dutcher cited the Technical Advisory Committees for Pennsylvania’s Riparian Buffer Initiative Implementation Plan as identifying categories of barriers to riparian forests. These included: “economics, education and awareness, marketing, policy, planning, legislation; physical, chemical, or biological barriers; and attitudes” (Pennsylvania Department of Environmental Protection 1998). Dutcher’s interviews and surveys defined similar and different key issues including: attitudes toward government, tradition, land use, and landowner attitudes.

Finally a body of literature recognizes the need for planning and design for riparian buffers (examined further in Part II). These papers acknowledge the need for implementation on a large scale and also recognize the necessity of aesthetic and place based solutions for riparian buffer success. These ideas are further driven by the need for comprehensive planning of buffers that represent the environment and culture (Dutcher 2000, Nassauer 2001, Lovell and Sullivan 2006, Shandas 2007, Jackson 2008).

**Cultural Significance to Landscape**

The cultural significance of landscape in the agriculture setting is indeed evident. There is a unique vernacular landscape or patterned landscapes that results from agricultural practices. Landscape architect Terence Harkness studied these culturally influenced landscape patterns and applied these patterns to garden design. He based his approach on the idea that “the common cultural-physical landscape is a container and reflector of diverse, diffuse, and often ambiguous cultural meanings” (Harkness 1990, 216). Nassauer echoes these ideas stating that appearance matters. Riparian landscape design should respond to public values and preferences and should exude a “familiar” appearance that “corresponds with cultural values.” Nassauer brings up cultural sustainability and defines it as “ecologically beneficial practices that elicit sustained human attention over time (Nassauer 2001, 1440).”

Geofferey Lilburne has examined some of the cultural significances of landscape and applied theology to the idea of land use. In sum, Lilburne realizes that we have a “clash of cultures” in the rural American communities. Inspired by the ideas from Wendell Berry’s the
unsettling of America, Lilburne uses Berry’s definition of two cultural groups the “exploiters” and the “nurturers” (Berry 1977). The “exploiters” are often driven by the desire for wealth and are often encouraged by theological interpretations that encourage the “dominance of man over nature.” The “nurturing” group sees the land as a gift and the love of place and their recognition of reliance on the land and rootedness leads them to live in harmony with the land (Lilburne 1986). Both groups find biblical grounding for their arguments. There are biblical passages, such as Genesis 1:28 that support the exploiters, “be fruitful and increase in number, fill the earth and subdue it,” other passages support nurturers such as Genesis 2:7 “God formed man from the dust of the ground”.

Humans are grounded in their environment. “Between the physical environment and human activity there is always a middle term, a collection of specific values, a body of knowledge and belief: in other words a cultural pattern” (Forde, 1963, 463 quoted in Nedding 1977, 4). As our culture and social interaction have been altered by the environment, and vice versa, culture and social groups have altered policy and agricultural practices. Henri Decamps established the importance of human perception and the interpretation of landscape in understanding cultural landscape relations in riparian areas (Decamps 2001, 169). Decamps argued that riparian systems are much more than patches of ecological process, but include culture (Decamps 2001, 170). Decamps also argued that ecological sustainability hinges on the peoples’ understanding of diversity and connectivity. Decamps concluded that sustainable landscapes are those where “ecological health interacts effectively with cultural preferences” and where ecological knowledge increases aesthetic pleasure and vice versa (Decamps 2001, 174).

Scientific disciplines are starting to recognize the importance of social and cultural influences in the sciences. The promotion of cross disciplinary studies is beginning to recognize the need to see people as part of ecology (subjects and objects) not as ecological agents. An agricultural ecologist in Lowe et al. “The actions of humans, whether intentional or not, will affect the other organisms surrounding us and therefore not to consider our behavior in studying the wider ecology would be a grave omission” (Lowe et al 2009, 302). Viewing people (and their culture) as part of ecology is proposed to be a solution to sustainability issues. The lack of progress in sustainability initiatives may be influenced by either a “perceived weakness of science to inform policy” or the “need for profound societal change…grounded on the basis that society and nature are not separate” (Lowe et al. 2009, 304). Natural resource managers are
realizing the importance of community and community involvement in policy, and implementation decisions. To consider riparian buffers without the farmer in mind would be a mistake. Aldo Leopold stated that, “the landscape of any farm is the farmer’s portrait of himself” (Leopold 1939). Similarly the stream is a reflection in many ways of its watershed.

**Culture in the Kish Valley**

The Kish Valley holds a large proportion of farmers and is home to an array of religious affiliations that shape individual farming behavior. The dominant Christian denominations in the valley are United Methodists, Mennonites, and Amish. With each religion comes a different set of traditions, theology, and world views. These differences define cultures and subsequently influence methods of farming in the valley, which range from traditional farms (dominated by horse-drawn implements) to modern farms (dominated by machinery).

It is important to recognize these groups, and their cultural differences, especially in natural resource management. A better understanding of culture will result in a better understanding of effective riparian buffer implementation strategies. What may encourage one group will most likely not encourage another.

While in depth knowledge of theologies and practices is not necessarily important, a certain familiarity with the residents of the area certainly helps when dealing with landowners. The Amish are a group that is often misunderstood and stereotyped, most likely due to their tendencies to reject influences of world outside of their communities (separatist) and their inclination to remain within certain geographic areas in small communities or “districts” (Hostetler 1968, 71). Often the Amish are considered synonymous with Mennonites, but this is incorrect. Although the two groups share a very similar Anabaptist history and ancestral origin, their beliefs and traditions have evolved to produce two very different communities. The Amish split from the Swiss Anabaptists (including the Mennonites, Brethren, and Hutterites) in Europe during 1693-1697 (Hostetler 1968, 27). Most of the Mennonite farmers in the Valley are probably from Amish ancestry, but at some point their ancestors decided to leave the Amish church. There is a possibility too, that some Mennonite farmers in the area have no Amish ancestry. Within the Amish group of farmers in the Kish Valley there are 5 affiliations-- the “Buggy Amish” (most traditional) consisting of White Top, Black Top, and Yellow Top
(distinguished by color of buggies), to the “Beachy Amish” (least traditional) (Hostetler 1968, 77).

METHODS

Description of Study Methods:

I conducted interviews with farmers, who own property intersected by a stream within Menno, Union, and Brown townships of the Kish Valley (Mifflin County, PA). A stream constitutes any perennial flowing water course that was classified within the Strahler stream order system. A farm was defined as any parcel containing an agricultural land use, based on the Mifflin County Geographic Information Systems (GIS) data. Since this study aims to identify barriers and incentives to stream conservation, I interviewed two groups. Group 1 included farmers that did not implement riparian buffers and group 2 consisted of farmers that did implement riparian buffers (in accordance with MCCD records and aerial photographs, confirmed by field investigations).

Interviewee selection was performed using GIS software with data sets provided by Pennsylvania Spatial Data Access (PASDA) and the Mifflin County GIS Department. Parcel data was compared to agricultural land use coverage and all parcels containing an agricultural land use were selected. From this selection, parcels with the presence of a perennial stream were selected to form the final interviewee list. From this final group of parcels the presence of stream buffers was determined by cross referencing parcels with a list provided by the MCCD and additionally from aerial photographs. The presence of a perennial stream and the presence of buffer were verified in the field prior to conducting interviews.

Interviewee parcels were then split into two groups, those with un-buffered streams, and those with buffered streams. Each group was assigned codes for their parcels, and random parcels were selected for interviews. There were a total of 120 parcels (farms) with un-buffered streams, and a total of 16 parcels with buffered streams. From the given populations of group 1 and 2, I drew random selections using Microsoft Excel.

Interviews were based on a semi-structured interview process delivered in a conversational context. Questions for the interview were developed from research, field
experience, and professional input. Professionals across Pennsylvania representing many state, government, and non-profit agencies were contacted to provide feedback in their professional capacities. These organizations and the respondents are listed in the Appendix along with the interview questionnaire. The questionnaire was then reviewed several times by advising department faculty and submitted with supporting information to the Penn State Internal Review Board (IRB). Upon project acceptance by the Penn State IRB with exemption status (IRB protocol ID 42127) I preformed mock interviews with several respondents in the Nittany Valley to test run the interview questions and process. After some minor notes and revisions, the interviews were conducted in the Kish Valley in March of 2013.

When a parcel was selected, the head of the household was consulted as the interviewee on each farm. Several interviewees were contacted by phone to schedule interviews, but a large number of landowners did not have listed phone number and required property visits.

Interviewees were informed about the project and asked for their voluntary participation. A project explanation addressing the purpose of the research, the expectations of the participant, and a statement about voluntary consent were delivered before conducting the interview. In addition, interviewees were asked permission to take notes about their answers and were notified that by answering the interview questions they gave implied consent. The participants were asked to expand on questions via prompts, and to give as much detail as possible for every question that was asked. Participants were reminded that if they were made uncomfortable by any of the questions, they were not required to answer and they could stop the interview at any point.

Interviewee responses were analyzed subjectively to find common issues or themes within current conservation methods and designs. Coding and other analysis software was avoided in order to uncover landowner perspectives and opinions. Responses were then used to inspire design alternatives for riparian buffers and implementation processes in Part II.

Projected Outcomes:

An overall concern was the willingness of farmers to participate in this study, but my connections and presence in the community helped to alleviate hesitancy. I expected that there would be great diversity across respondents, even within the landowners with and without
buffers. Many different traditions and practices appear in this study, each with a different “world view”. From this diversity, I expected that there would be common threads among all farmers regarding barrier and incentives to stream conservation.

From the group of farmers without buffers, I believed value systems and education were some of the strongest barriers to stream conservation. Additionally, I believed the loss of productive land for crops, grazing, and concerns about overall buffer appearance would be common.

From the group that installed buffers, I believed that monetary compensation or project funding would be one of the strongest incentives. I also expected to find some common issues with buffer design between interviewees, such as maintenance hassles and the *loss* of valuable land.

These responses should form several strong design issues which can be addressed through various alternatives designs and processes that involve the farmers input into stream conservation decisions.

**RESULTS**

**Descriptive Statistics**

The descriptive statistics of the landowners interviewed is summarized in Table 1. Nine farmers were interviewed out of 120 who did not have buffers (7.5%), and four farmers were interviewed out of 16 that did have riparian buffers (25%). Of those interviewed farm sizes ranged in scale from 30-110 acres. The majority of properties were dairy farms with 30-100 head of cattle, and whose streams were primarily bordered by cattle grazing. Most of the properties were located on first, second, and third order streams. Most of those interviewed were residents of the Kish Valley all their life and came from families who had been farming for multiple generations. Various farming methods were represented in the interview including traditional farms with horse drawn implements and modern mechanized farms.

Random sampling resulted in a good geographic distribution across the study area including several stream orders. Distribution was best in Menno and Union townships;
representation was limited in Brown Township due to the karst geology and the small amount of farms with perennial streams.

### Descriptive Statistics

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Table 1: Descriptive statistics of landowners interviewed

### Landowner Perspectives:

Among the interviewees several barriers and incentives to stream conservation were discovered. Information between those who did not implement buffers and those who did produced unexpectedly similar results. For cultural considerations, the results were further sorted into traditional and non-traditional cultural groups. This data is represented in tables 1-3.

1. **Barriers**

Many barriers were revealed by both groups. The most prominent barriers overall were riparian buffer appearance (aesthetics), limited awareness of regulations, no perceived need, time to implement buffer, and working with government agencies. Other barriers included limits to use, loss of land being farmed, buffer maintenance, and unknowns about riparian buffers (Figure 6). The traditional farmers were not aware of stream regulations and were concerned with buffer
appearance, followed by time to implement, working with agencies, and waste of ground (Figure 7,8). For the modern farmers the primary barriers were defined by buffer appearance, access limitations (for recreation and maintenance), and buffer maintenance (Figure 7,8)

Figure 6: Barriers stated by landowners (with and without buffers)
Figure 7: Barriers stated by landowners with stream buffers

Figure 8: Barriers stated by landowners without stream buffers
a. Appearance

Appearance was a prominent issue among all of the groups interviewed. Many did not prefer the unkempt look of the buffers, but some suggested local buffers that they thought looked “nice”. The majority of those who installed buffers admitted to mowing them periodically, and the majority of those without buffers also acknowledged that they would prefer to mow the buffer. The buffers mentioned as preferable are also mowed seasonally.

[Landowner] “I don’t want to look at dead weeds; I like to see green grass.”

[Landowner] “They planted lots of trees in my buffer, but they all died, and the buffer does not look as nice.”

[Landowner] “I don’t want to look out my window and see a jungle.”

b. Working with groups or government agencies

Most modern farmers did not mind working with government sponsored programs or conservation agencies; their concerns were limited to red tape, paper work, and “petty requirements”. Traditional farmers were hesitant to accept monetary compensation from or work with the government or other agencies all together. This was most likely due to cultural reasons, misunderstanding of programs, and trust issues with funding agencies. The unwillingness to work with agencies is then compounded by other barriers, such as cost to implement and time to implement. In general farmers simply did not want to be told what to do with their land. It is evident through these interviews that farmers have a strong connection with the land. They put their blood, sweat and tears into the land, and to have someone come and tell them how and what to do is in a sense insulting.

[Landowner] “If I give up some of my land they will want it all, plus I am not a communist”

[Landowner] “Our people do not do that kind of thing”

[Landowner] “If I take money from them, don’t they own my land?”
c. Education

Most of the farmers interviewed, across all groups, were unaware or minimally informed about regulations or policy affecting water resources. Several were familiar with initiatives for stream fencing and some familiar with Chesapeake Bay efforts, but overall there was a lack of understanding. Farmers knew little reason for stream conservation, nutrient management plans, and erosion and sediment control plans. Many interviewees were familiar with the enforcement side of the policies due to recent activities in the area from the PA DEP, but many still remain unaware.

Overall most interviewees see conservation practices as beneficial, but feel that there are limits to conservation. Many understood methods of soil conservation and mentioned no till methods, cover cropping, and stream fencing.

[Landowner] “Conservation practices make sense, but sometimes they get carried away”

[Landowner] “It makes sense to me as long as it does not make farming hectic, and stream buffers would make farming hectic”

[Landowner] “Conservation plays a huge role. I have seen how much sediment can wash away in a large storm, and that is only what I can see.”

2. Incentives

Incentives again varied greatly across interview groups. Main overall incentives included perceived benefits, no cost to implement, increasing wildlife habitat, increasing recreation (Figure 9). Again, splitting these responses into traditional and modern farming methods reveals more detailed trends (Figure 10, 11).
Figure 9: Incentives stated by landowners

Figure 10: Incentives stated by landowners with stream buffers
a. Wildlife Habitat and Recreation

Value for wildlife extended across all groups. Many enjoyed seeing birds and waterfowl, reptiles, and larger mammals such as fox and rabbit. Several farmers were especially motivated by the idea of improved fish populations, which also represents recreation. Recreation benefits were often for children or young teens rather than the adults or landowner. Some landowners enjoyed the overall setting of the stream and the sounds of the water.

[Landowner] “I wanted the stream to be like it was when I was a boy. I would like my grandchildren to be able to fish and play in the stream like I did.”

[Landowner] “Sometimes I like to just sit and watch the ducks in the stream, or listen to the sounds of the water.”

[Landowner] “My boys like to trap muskrats and catch crayfish in the creek.”

b. Stream and Cattle benefits

Stream benefits and cattle benefits of riparian buffers were incentives for several farmers. This idea was further supported by a large number of farmers who fenced small sections or parts of their stream off on their own, without the support of any local agencies. While the farmers did
not understand all the benefits and implications of riparian buffers, they recognized some improvements from riparian buffers.

[Landowner] “I know it is bad for the cows to be in the stream because it can cause mastitis.”

[Landowner] “The stream has improved a lot since they installed the buffer. I wish they would have done more to help the stream by bringing in heavy equipment to fix it.”

[Landowner] “The cows can really make a mess of the stream.”

c. Monetary Incentives

As mentioned in the barriers section, the majority of traditional farmers were not incentivized by a reduced cost or funding opportunities. Reimbursement, or no cost to implement, was a large incentive among modern farmers. For the traditional farmers there is some evidence that indirect monetary incentives are effective. Some traditional farmers were willing to install riparian buffers to be certified organic. Some traditional farmers also expressed a willingness to negotiate, but may not have completely understood their church’s opinion or ruling on the matter.

3. Other Trends

Other responses that are not directly linked to barriers or incentives are listed in Figure 12-14. Some responses to note are that farmers may want to design their own buffers. Some farmers were willing to install buffers but did not have the time to contact local agencies or they contacted agencies and have not heard back. Many farmers implemented fencing on their own. Finally some farmers are opposed to the idea of stream conservation all together, no specific reasons were stated, but surely multiple barriers mentions above are playing a role in this. A few did not feel the need to implement riparian buffers because they did not see a need for it and felt that the stream was in good health and the water quality was good.
Figure 12: Other concerns stated by landowners

Figure 13: Other concerns stated be landowners with stream buffers
Figure 14: Other concerns stated by landowners without stream buffers

**a. Water Quality**

Water quality was generally perceived as good on most farms. Some recognized that they would not drink the stream water; others said they did drink the stream water. One farmer reminisced about swimming in the stream during the summer. Some farmers did not see anything wrong with their current streams, but many acknowledged that the stream was being negatively impacted, mostly through erosion and unstable banks. Many thought that straightening the stream would be beneficial to both farming and the stream itself.

**b. Changing attitudes and Landowners Involvement**

A large amount of farmers implemented fencing on their own in both the buffered and un-buffered groups as well as the traditional and modern groups. This is a very encouraging trend strengthened by the small amount of farmers adamantly opposed to riparian buffers as well as the amount of farmers who saw a benefit in conservation practices. Farmers also expressed the desire to mow their buffer (if they had on or not), and a preference to design their own buffers. This demonstrates a willingness from the farmer to be involved in the planning and management of riparian buffers.
Discussion

Project findings greatly exceeded the projected outcomes. Many insights were gained through the interviews regarding stream conservation issues and farmer perceptions. Some general findings were the overall familiarity with stream buffers and generally positive attitudes towards stream buffers from landowners. Few landowners were adamantly opposed to buffers or their installation, and many farmers voluntarily fenced streams without program incentives or encouragement. These trends are encouraging and demonstrate that the idea of riparian buffers is becoming more common and more widely accepted in the area.

The overall findings are best discussed in terms of physical buffer issues (design), and implementation process issues. While many barriers and incentives were uncovered (listed in Figures 6-14) these physical buffer issues and implementation process issues are probably the most important for those involved in resource management. It is also important to note the different incentive structures and preferences among the cultural groups of the valley.

A. Physical Buffer Issues

Among the physical buffer issues are buffer design/access, buffer use, and buffer appearance.

1. Issues with buffer design/access

I want to start this section with a reminder about the cultural significance of landscape and the relationship between the landowner and the stream. In traditional buffer design, there is a preferred buffer configuration that dominates all riparian buffer models. While this model is optimally effective for the environment, it does not adequately balance the interests of the landowner and the environment. If those involved in natural resource management truly accept that humans and nature are part of one community, then design should equally account for both parties. To design a buffer with minimal emphasis on human use and activity is to design a failing buffer. Some farmers will learn the benefits and install extremely effective environmental buffers, but others will not value these practices and may always want to do the minimum or nothing. In all things learned from this project, the necessity of site-specific design and the need to incorporate landowner concerns into buffer design is of utmost importance.
Several interviewees expressed dissatisfaction with buffer design in the fact that there was minimal flexibility. Confusion also arose about buffer use and allowances. Several felt that they “no longer owned their stream”, and that they were not able to “use it”. Buffer design, while protecting water quality and stream stability, should also allow and promote landowner use and involvement with the stream. The idea of fencing itself is a barrier to buffer implementation because it limits connectivity with the stream. Unfortunately fences are one of the few effective ways to keep cattle out of the stream, and the dominant land use adjacent to the stream in the farms interviewed was grazing. While fencing keeps cattle and livestock out of the stream, it also seems to create a subconscious idea that people must stay out of the stream as well. This issue is explored further through several design alternatives demonstrated in Part II.

2. Buffer appearance

Buffer appearance was another concern with riparian buffers. Many interviewees did not prefer an “overgrown” look that many newly installed buffers exhibit (“new” signifying buffers approximately 1-10 years old). Owners felt that the tall grass looked unkempt, messy, and was a source of weeds for adjacent or nearby agriculture fields.

This common preference of “neat and tidy” was no surprise and is confirmed by other landowner studies (Dutcher 200, Nassauer 2001). Often the issue of aesthetics is quickly dismissed among educated professional and natural resource managers, but the amount of interviewees that shared this common opinion demonstrates the significance of appearance.

A common response to a preferred buffer appearance was a seasonally mowed “meadow”, or a buffer with tall trees and a short 6” grass understory, or no buffer at all. While these preferred outcomes may not be the best solution for water quality they are landowner preferences that can inform future riparian buffer designs. Several studies address these preferences and suggest some solutions such as mowed strips around buffers to illustrate Nassauers idea of “Messy Ecosystems Orderly Frames” (Nassauer 1995). This issue of aesthetics are explored more in Part II.
3. Buffer Use

Surprisingly the overall productivity of the buffer land was of minimal concern among most farmers. To fence the stream seemed acceptable to the majority; although many did feel that they needed to receive something in return for giving up crop land or grazing area.

Those that did not mind the land lost to fencing recognized that this ground is often inefficient due to damage from cattle or flood events anyway. Those that felt compensation for lost ground was important tended to be on smaller farms with dense land use. The Kish Valley is bordered by Jack’s Mountain to the southeast and Stone Mountain to the northwest. This geographic influence of the ridge and valley province of PA, creates isolation from neighboring valleys and also creates crowding and competition for land. Residents of the valley tend to want to stay in the valley (demonstrated by the amount of farmers interviewed who lived in the valley all their life), but as the number of families grows (especially Amish families) space becomes limited. The dense nature of these farms may lead to some concerns about “giving up” land for riparian buffers.

Other farmers found alternative ways to make their buffers useful. One farmer in particular was harvesting maple syrup from maple trees along the stream and also harvested timber from along the stream.

B. Implementation Process

Within the implementation process issues were defined pertaining to incentives/barriers and outreach/education.

1. Incentives

Incentives for stream buffers vary throughout the Kish Valley. Culture is a large factor for this, but education and understanding of the stream buffers is also a large factor. Often monetary compensation is an assumed incentive to buffers, and while it is successful in many cases the Kish Valley provides a different situation among its traditional farmers.

Traditional groups are unlikely to accept monetary compensation due to trust issues and uncertainties about government funding and agencies. Reasons for this include cultural traditions, but also may include misconceptions such as the idea that buffer compensation is in exchange for land and water ownership rights. Other reasons include the idea that once involved
in a buffer program they will have limited input in regard to buffer design, and that they need to abide by the requirements of the program which they often believe do more than is needed.

There are alternative value systems that can also be pursued. Some value the habitat and wildlife that a buffer produces. Some received benefits for having buffers from outside resources, such as organic certification. Others value buffers due to nostalgic purposes. In this case it is important to note that while monetary incentives are not readily accepted, willingness to implement stream buffers in some form is still present and through proper education and relationship building incentives may come to be accepted or agreed upon.

2. Outreach/Education

The overall acceptance and willingness of a broad range of landowners to talk about stream conservation was surprising and refreshing. The interview process was expected to receive more hesitancy and skepticism about the issue, but surprisingly did not. Most interviewees freely shared their ideas and opinions (once being assured that I was not employed by an enforcement agency).

One reason correspondents may have been open is that the principle investigator (PI) had strong connections in the area, and was also a local resident. Another reason could be that the interviewer did not represent a certain entity involved with the monitoring, enforcing, or implementation of stream buffers. Most farmers became more conversational when asked for their honest opinions and became more relaxed when assured that the interviewer was not advocating for buffers but instead was seeking “local knowledge.”

The role of the citizen and community member has long been discussed in planning and design education. It is important that natural resource managers realize that local knowledge is as valuable as their formal education. It is also important to realize that most natural resource managers value riparian buffers and similar practices because they have invested many years studying and learning about water quality issues and stream conservation benefits. If the same level of investment, knowledge, and valuation is expected from the farmer, the need for a long term relationship is evident between managers and landowners, much like the relationship between a professor and student. This stresses the importance of social skills and cultural understanding in natural resource management fields.
Landowner education must be a gradual process as demonstrated by the brevity of this study. This study only started what could be a learning process for landowners. Outreach and interest in landowners should come before education. A relationship must be established before teaching can happen.

**Study Limitations**

Limitations to this study include the quantity of interviews obtained. Ideally a higher percentage of the selected populations would have been achieved, but the repetition of many incentives/barriers from landowners helped to validate the responses. This project is better viewed as a pilot study and highlights many incentives and barriers for the particular local context.

Another limitation was the GIS data and processing which resulted in the selection of several parcels with little to no stream presence on their property. Selecting for parcels with a certain amount of stream present on the property may have been more appropriate. This error in selection was corrected by field verification before conducting interviews.

Additionally, ephemeral streams were not included in the selection criteria. Only perennial streams were used to select possible interviewees. Using both ephemeral and perennial stream data would have resulted in a larger interview population and would have followed TMDL policy more closely, but including ephemeral streams may have caused confusion among landowners in regard to what constitutes “a stream”. Landowners may not have responded to ephemeral streams and perennial streams in the same way.

**Future Efforts/Suggestions**

This study is merely a stepping stone to a vast array of topics for inquiry. With the complexities of conservation issues, this study scratches the surface, but leads to many possible future pursuits. While no hard quantitative analysis was performed, there are many important findings that can be applied to the professional field today and researched further through empirical studies.

Since aesthetics were an issue, a follow-up study using buffer visualization before and after installation and establishment may be beneficial to landowners. Providing visual representation of buffer progression will help them understand and critique buffer appearance.
This step may also aid in buffer design, helping the landowner to value the buffer as an asset to the farm instead of a loss.

Riparian buffers currently existing in the study area take on many shapes, sizes, and forms. As a result of the diverse landowner preferences revealed in this study, there are many different riparian buffers “styles”. Studies focusing on buffer “typologies” would be beneficial to compare to stated preferences from landowner interviews.

Finally, the need for outreach and education is evident and this study has inspired me to pursue the possibility of forming a watershed association in the valley. This would help to involve the community in local decisions and aid natural resource managers in landowner relations. A watershed association would also help to spread information to landowners and serve as another available resource for conservation issues and inquiries.

**Involvement of Landscape Architects?**

Many people were surprised that a Landscape Architect would pursue such a project. Water resources cross many political and cultural boundaries. In caring for water resources there is a great need for collaboration between many groups, especially when dealing with watershed management (Miller 2002). Design and implementation (development) “changes the elements of the physical landscape and the relationship between these elements” (Steiner 2000, 291). Whenever there is an alteration on the landscape, whether it is a farmer plowing a field, or the construction of a new strip mall, these activities alter the hydrologic cycle. Design and planning with natural systems in mind require the collaboration between many professional fields and stakeholder groups. Some typical parties involved are the landowner, local government, state government, federal government, watershed groups, scientists, and designers.

It is not uncommon for landscape architects to be seen as facilitators in large scale projects. Landscape architects not only possess a tool set that aids in visualization and facilitation, but they also have knowledge of analysis tools, cultural influences, social implications, the importance of history, knowledge of plants, and both human and natural systems.

In this specific area of Pennsylvania, agricultural practices and culture need to be addressed when considering stream conservation strategies. Well-designed landscapes can
provide both environmental and cultural benefits. Education through implementation and involvement in the design process can further achieve community advocacy and help communities to better help themselves. Collaboration between professionals and the community helps to minimize the gap between the “expert” knowledge and the public’s dependence upon it (Fisher 2010). As mentioned in the cultural significance of landscape by Decamps “ecological health must relate to cultural preferences” (Decamps, 2001). In many ways, landscape architects are in a perfect position to do this.

Several of the previous landowner studies also involved Landscape Architects or recommended their involvement. Lovell and Sullivan suggest that planners and landscape architects become involved in such design process stating that among limitations to buffer acceptance aesthetics and buffer design alternatives are a few solutions. Jackson also concludes in “Who designs the agricultural Landscape” that landscape architects should influence farm policy and public opinion in consideration of how the design of the landscape can benefit landowners and the larger community (Jackson 2008, 37).

Conclusions

This study demonstrates some of the complexities that culture and value systems add to stream conservation issues. The landowners in headwater areas such as the Kish Valley are key components to stream conservation success. Promoting a better understanding of the landowner values and representing landowners in riparian buffer design can help to promote stream conservation in headwater areas. Current riparian buffer designs and specifications deal primarily with water quality and stream degradation issues. Landowner use of these systems has been typically limited, and the connectivity between landowner and stream has been minimally represented. Designs that respond to landowner values will be a more successful implementation strategy but may sacrifice maximum environmental benefit.

Value systems are not only different across cultures but spatial scales as well. Landowners in the upper watersheds/headwaters do not value water quality in the same way that residents and organizations in the Chesapeake Bay area do. A reason for this is that landowners in the headwater areas do not see the cumulative negative effects and poor water quality evident in places downstream. Streams cross both political and cultural boundaries. Therefore,
landowner benefits and values must be addressed through education, incentives, and riparian buffer design.

Farmers are very close to their land. When natural resource managers step onto farm property and tell landowners what to do, it is not well received. Explaining existing policies and reasons for BMP’s and stream conservation will lead to a better relationship between landowners and regulators. Understanding cultures and recognizing local knowledge are important for natural resource managers. There must be a relationship between landowners and regulators. There also must be a relationship between the farmer and the stream.

Riparian buffer design can address many of the obstacles that come about in stream conservation. Promoting buffer use, access, and improving aesthetics will help to promote stream conservation. The farm is a portrait of the farmer himself (Leopold 1999, 24). Managers, designers, scientists, enforcement personnel, and other interested parties must consider this. In other similar rural farming communities it will be difficult to convert farmers to have the same values that the policies and natural resource managers promote. The existing landowner values and incentive structures will need to be utilized, and this can be done through various buffer designs.

Finally it will be important to focus efforts on improving and maintaining existing buffers. Many of the landowners interviewed referenced “successful buffers” and “unsuccessful buffers.” A large proportion of landowners in this study already fenced off streams on their own. Farmers notice other models of stream buffers throughout the study area. Familiarity brought about by others participating in buffer programs, encourages neighbors or at least gets them talking about the issues. The existing buffer models shape the local attitudes and once aesthetics are addressed, I feel that buffer implementation will be more popular. If others see desirable and successful riparian buffers they will be more likely to implement buffers themselves.

I would like to invite you to explore the buffer design issues that are examined and visualized in Part II of this project. The findings of this study are explored in more depth through landowner preference visualization, alternative buffer designs, and a future priority map for stream conservation efforts in the Kish Valley.
Part II

Barriers and Incentives to Stream Conservation: The Influence of Culture on Buffer Design and Implementation
Section 1
Valley Features and Study Methods

Section 1 consists of several maps representing important physiographic features of the Kish Valley. Understanding the existing conditions of the study area is important when considering any design. The following maps cover topics such as geology, soils, hydrology, and slope. These maps show many features used to make the section 4 priority map showing important areas for stream conservation. The selection methods discussed in the methods section of Part I are also represented through several maps in this section.
Hydrology: Perennial Streams

Streams in the Kishacoquillas Valley (Kish Valley) often originate from mountain springs that surface on the side slopes of the sandstone ridges. These streams often disappear and reappear throughout the valley due to the karst geology.
Hydrology: Sub-watersheds

There are eleven subwatersheds within the study area. Nine of these drain into the Kishacoquillas Creek sub watershed which then flows into the Juniata River in Lewistown south east of the study area.
Many of the streams in the Kish Valley have been designated as impaired in compliance with the EPA total maximum daily load pollution reductions. Most of these streams are impaired due to sedimentation.
The valley is bordered by sandstone ridges and a carbonate limestone/dolomite valley floor. The more easily dissolved carbonate rock leads to sinkholes and underground streams across the valley.
The soils in the valley range in texture from coarse to fine. Much like the geology, there is an evident gradient of soil texture from coarse textured soils on the ridges to fine textured soils on the valley floor.
The slopes displayed on this map were chosen to coordinate with slope allotments of the NRCS soil classifications. The slope in the valley shows a predictable transition from steep to shallow moving from the ridges to the valley floor. Some steep slopes are present in the valley where stream channels have cut into the valley floor.
**Methods: Agriculture Parcels**

The land use in the study area is dominated by agricultural and forest land uses. The patterned landscape reveals the relationship between soils and land use. Parcel data was intersected with landuse to define agriculture parcels for interviews.
**Methods:** Agriculture Parcels with Streams

Agricultural parcels were then intersected by perennial streams to define the populations of landowners to interview. The population was then subdivided into two groups; farms with stream buffers and farms without stream buffers.
From the two groups, parcels were randomly selected to produce a list of possible interviewees. The red dots represent the centroid of multiple interviews and display the approximate distribution of landowner interviews across the study area.
Section 2
Landowner Preferences

The following images are visualizations of landowner preferences expressed by landowners. Farmers were asked to describe the ideal stream buffer and these visualizations represent their preferences ranging from no change to the stream to a buffer composed of short grasses and tall canopy trees. Pictures accompany these visualizations to show some similar buffers that already exist in the valley.
Landowner Preferences: Visualization 1

Many landowners were concerned with the overall size (width) of stream buffers. Most preferred buffer widths between 5 and 15 feet. In addition to this, most landowners preferred a manicured buffer as opposed to a “jungle”. This visualization represents a small scale buffer with seasonally cut grasses.
Landowner Preferences: Visualization 2

Many landowners showed a strong desire to mow the stream buffers, but also expressed a desire to see mature canopy trees. This visualization shows a manicured short grass buffer with old growth trees.
Some landowners did not recognize any problems or negative impacts associated with the current condition of the stream. Some stated the preference to leave the stream exactly as it was, except for the addition of a few canopy trees.
Section 3
Alternative Buffer Designs

The following images combine landowner preferences with current buffer design guidelines examined in section 2. The USDA Conservation Buffer Design Guidelines (Bentrup, 2008) were used to establish appropriate buffer widths in response to physical conditions across the valley (slope, soils, land use, etc.). These designs address three key issues brought up in landowner interviews and previously discussed in Part 1. These issues are buffer use, access, and aesthetics.
The design matrix above shows the issues that the following designs address and the stream order that is focused on in each design. Ideally every combination would be addressed, but each stream order and landowner concern provide unique opportunities of varying importance.

**Why no 4th order stream designs?**

1. The majority of farms are located on 1, 2, and 3rd order streams in the study area.
2. Most of the water enters the watershed through low order streams.
3. Smaller order streams are more enticing for landowners to manipulate.
**Buffer Use: 1st Order Stream**

First order streams require wide buffers since the majority of water enters the watershed through low order streams (Bentrup 2008). Allowing some use of the buffer area will provide benefits to the farmer and the stream. In this buffer design, fencing keeps cows out of the stream, but allows farmers to harvest hay in the active zone. Both the active and passive zone filter runoff, achieving a 60% reduction in sediment entering the stream. This design represents aesthetic preferences described in alternative 1.
**Buffer Use: 1st Order Stream**

Active and passive buffer zones are again present in this model. Instead of harvesting in the active zone, this model proposes low intensity grazing. High tensile fence separates the different grazing areas and a single strand electric fence at the edge of a 3-5ft setback from the top of bank, keeps cows out of the stream. This design represents aesthetic preferences described in alternative 1.
Buffer Access: 2nd and 3rd Order Stream

Many landowners felt as if they “did not own” their stream or that they “were not allowed to access the stream”. **Access** should be strategically placed **perpendicular** and **parallel** to the stream channel. Access will promote activities such as fishing, bird watching, and walking that can be of value to the landowner. Appropriate access will also accommodate buffer uses described before.

**Stream Access**

Locating access points near existing circulation paths (driveways) or near living areas (houses) will provide ease of access. Buffer access should pertain to buffer use. Larger access can accommodate equipment for buffer maintenance and use while smaller access points can be used for recreation.

**Parameters**

<table>
<thead>
<tr>
<th>Stream Order</th>
<th>Efficiency (%)</th>
<th>Avg. Slope (%)</th>
<th>Runoff Coefficient</th>
<th>Soil Texture</th>
<th>Field Length</th>
<th>Buffer Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>2, 3</td>
<td>60</td>
<td>5.0</td>
<td>0.003</td>
<td>Silty Clay Loam</td>
<td>≈650</td>
<td>30 ft</td>
</tr>
</tbody>
</table>

**Benefits**

- Full
- Partial
- Little to None

**Sediment Reduction**

<table>
<thead>
<tr>
<th>Stream Access</th>
<th>Aesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive Zone</td>
<td>●</td>
</tr>
<tr>
<td>Stream</td>
<td>●</td>
</tr>
</tbody>
</table>

Locating access points near existing circulation paths (driveways) or near living areas (houses) will provide ease of access. Buffer access should pertain to buffer use. Larger access can accommodate equipment for buffer maintenance and use while smaller access points can be used for recreation.
Many landowners expressed a desire to increase fish populations for family recreation. Stream buffer design should go beyond fencing and consider landowner access to the stream and habitat structures for fish, birds, and small mammals. Structures can also stabilize banks in desired fishing spots. This design represents preferences from alternative 2.
Buffer Aesthetics: 2nd and 3rd Order Stream

Aesthetics were of great concern to most landowners. Preferences for a neat and clean buffer were evident. Designing buffers to incorporate native plants will benefit both the environment and farmer. Often just fencing off the stream results in an overgrown area dominated by invasive plants. With proper planning and planting, buffers can look much more desirable.

Parameters

<table>
<thead>
<tr>
<th>Stream Order</th>
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Benefits

- Sediment Reduction
- Habitat
- Access
- Use
- Aesthetics

Native Trees
- Sycamore
  - Platanus occidentalis
- Black willow
  - Salix nigra
- Red osier dogwood
  - Cornus sericea
- Arrow-wood viburnum
  - Viburnum recognitum
- Joe Pye weed
  - Eupatorium perfoliatum
- Marsh marigold
  - Caltha palustris
- Fowl blue grass
  - Poa palustris
- Pale meadow grass
  - Toneyochloa pallida
Suitability Analysis

The composite map below prioritizes stream conservation efforts within the study area by criteria established on the maps to the right. These maps display many physical properties important to stream conservation. Cultural influences and preferences were not included in this map, but are valuable to understand when talking with landowners.
References:


United States Environmental Protection Agency. 2010. “Chesapeake Bay TMDL Executive Summary”.
http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/BayTMDLExecutiveSummaryFINAL122910_final.pdf


Appendix A.

Professionals Contacted for Interview Question Development
Professionals Contacted for Interview Question Input:

Dan Dunmire  
District Manager  
Mifflin County Conservation District

James Finley  
Professor of Forest Resources  
The Pennsylvania State University

Justin Kozak  
Watershed Specialist  
Mifflin County Conservation District

Katie Ombalski  
Conservation Biologist  
ClearWater Conservancy

Kristen Saacke-Blunk  
Director Penn State Agriculture and Environment Center

Larry Brannaka  
Hydrologist  
U.S. Fish and Wildlife Service

Lysle Sherwin  
Director Penn State Center for Watershed Stewardship

Lamonte Garber  
Agriculture Program Manager  
Chesapeake Bay Foundation

Matt Royer  
Director Lower Susquehanna Initiative  
Penn State Extension
Professionals that Responded for Interview Question Input:

Dan Dunmire
District Manager
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Conservation Biologist
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Hydrologist
U.S. Fish and Wildlife Service

Lysle Sherwin
Director Penn State Center for Watershed Stewardship

Professionals that Responded for General Project Input:

James Finley
Professor of Forest Resources
The Pennsylvania State University

Kristen Saacke-Blunk
Director Penn State Agriculture and Environment Center

Lamonte Garber
Agriculture Program Manager
Chesapeake Bay Foundation

Matt Royer
Director Lower Susquehanna Initiative
Penn State Extension
Appendix B.

Landowner Interview Questions
My name is Trevor Weaver, I live nearby in Belleville and I have been living here for almost 3 years. I am also a student at Penn State University and I am conducting a project on streams in the Kish Valley. I am asking local farmers to share their perceptions and voice their opinions to see how people view streams in an agricultural setting.

1. I would like to talk about streams, but first I would like to begin by asking you to discuss the details of your farm?
   Prompts:
   What is the size of your farm?
   What amount and type of livestock do you raise on your farm?
   How much land do you plant with row crops, and what types of crops do you plant?

2. Please tell me more about your farming history?
   Prompts:
   How long have you been farming?
   What generation farmer are you?
   How long have you lived in the area?

3. How does conservation play a role on your farm?
   Prompts:
   Do you hope to keep farming or pass the farm on to family?
   Do you conserve resources: soil quality, wildlife/habitat, longevity of farm, water quality?
   Do you use any fertilizer, chemicals, or manure to maintain your farm?

4. What is the importance of water and water quality on your farm?
   Prompts:
   What is the source of water on your farm?
   Where does the water on your farm end up?

5. Is there a stream located on your property?
   Prompts:
   What do you refer to the stream as, or what do you call it?
   What type of farming activities happen adjacent to the stream?
   What does the stream provide for your farm/family?
   - aesthetics, habitat, wildlife

6. Are there regulations that affect your stream?
   Prompts:
   If YES: Can you explain them to me?

7. Are any portions of the stream on your property fenced off or buffered?
   Prompts:
   If YES: When did you implement the buffers?
   Why did you install the stream buffers?
   What is your current evaluation of the buffers?
   How do you evaluate the initial design of the stream buffer?
   If NO: What is your perception of stream buffers?
Can you explain your willingness to implement stream buffers? Is there anything that would encourage you to implement a stream buffer?

8. Are there any other issues that you would like to share/talk about?