Identifying Best Practices for Targeted Riparian Buffer Adoption and Outreach with Centre County CAP Stakeholders

Photo by USDA

FINAL REPORT

HDNRE 574 | Spring 2021

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EXECUTIVE SUMMARY

In 2020, following increased concern regarding water quality issues in the Chesapeake Bay Watershed and in accordance with a 2025 deadline for reducing nitrogen loads in local waterways (DEP, 2020), officials in Centre County Pennsylvania drafted a Countywide Action Plan (CAP) for water quality improvement. The CAP uses available data to create a roadmap for pollution reduction, in the Chesapeake Bay watershed using a variety of best management practices (BMPs), particularly in agricultural areas. Centre County, Pennsylvania was one of 43 Pennsylvania counties tasked with the creation of such a plan (Centre County Pennsylvania, 2021).

To better execute the CAP, plan organizers have requested the delivery of a communications toolkit—the development of which is detailed herein. This toolkit serves to inform outreach to local landowners regarding CAP approved agricultural BMPs and supplement the biophysical "Centre County toolbox" provided by the Pennsylvania Department of Environmental Protection (PADEP). The communications toolkit aims to marry biophysical and social science data to provide detailed direction for relationship building, information on rhetorical and design theory, and examples of success from prior outreach. Furthermore, the toolkit enables the use of demographic data to identify landowners who may be amenable to adopting agricultural BMPs (namely riparian buffers) in key implementation zones.

Utilizing a transdisciplinary, mixed methods approach, researchers analyzed archival information, conducted semi-structured interviews, and mapped geospatial data to create guidelines for landowner outreach as it pertains to the Chesapeake Bay watershed. The following is a summary of themes and findings further elucidated within this integrated toolkit:

- A review of archival literature was conducted using bibliometric analysis to identify prominent themes in BMP outreach and landowner engagement. Primary themes fit into three categories with a variety of subcategories:
    1. Perception/Values: landowner concern regarding i) *aesthetics*, ii) *identity*, & iii) *land value*
    2. Implementation Support: availability of i) *financial resources* & ii) *educational resources*
    3. Stakeholder Information: knowledge of i) *landowner characteristics* & ii) *non-landowner involvement*

- A series of semi-structured interviews lasting an average of 43 minutes were conducted with local professionals who have experience in landowner engagement and BMP adoption. Primary themes were identified using framework coding and fit into five categories:
    - i) *Need for programmatic flexibility and strategic use of resource*s, ii) *importance of building trust and relationships*, iii) *investment of time*, iv) *importance of community involvement, co-learning, and co-benefits,* & v) *need for multi-method, reflexive approach to stakeholder engagement*

- To integrate biophysical and sociodemographic data, researchers used prior literature and block group census data to create an equation allowing GIS mapping of the county watershed. Maps detailing areas that have high willingness for landowner adoption of riparian buffers *and* high ecological need for buffers were produced using factors of tenure, sex, age, and population. These landowners are identified as prime candidates for outreach using the toolkit's communication recommendations.

For further information regarding the integration of these themes and findings into the communication toolkit's landowner engagement roadmap and GIS pipeline, see pages 12-13.

PROJECT INTRODUCTION

Background

Centre County set a planning goal to reduce nitrogen loads delivered to local waterways by ~1.8 million pounds by 2025 (DEP, 2020). Achieving these water quality goals requires increased adoption of agricultural best management practices (BMPs), such as riparian buffers—a vegetated zone adjacent to streams or wetlands (Mayer et al., 2005). The Centre County Clean Water Technical Toolbox, the toolkit that describes the local planning process to meet Phase 3 of the Chesapeake Bay Watershed Implementation Plan, provides a wealth of biophysical information to target, quantify, and track water quality improvements from BMP adoption. However, the technical toolbox lacks details on a vital component of the Centre County Action Plan (CAP): *how* to begin a conversation with landowners that culminates in changed behaviors which improve water quality. In fact, the words "communication", "engage[ment]", and "discuss/talk" do not appear at all in the document.

Our project leverages a diverse team of graduate students, representing both the biophysical and social sciences, to add a communications best practices "tool" to the current Technical Toolbox. This tool supports three actions in Centre County's CAP Priority Initiative 1: to plan a prioritization deliverable with steps toward implementation (Action 1.6A), to lay the foundation for the next iteration of LandscapeU students to engage in impactful landowner outreach (Action 1.6B), and to start crafting targeted messages for riparian buffer adoption at a spatially refined audience (Action 1.7). To attain these actions, we begin with a simple communication model: Purpose + Audience = Message. A key purpose of our stakeholders is to increase riparian buffer adoption to meet Centre County's water quality goals. Yet we are left to discover the values of their target audience (riparian landowners), as well as methods to craft and disseminate a message that conveys this purpose in ways which recognize and respect landowners' values.

We furthered this process of discovery through transdisciplinary, mixed methods approaches. First, our Literature Review team connected existing knowledge on barriers and incentives to buffer adoption. This offered a broad understanding of the needs of Centre County's riparian landowners. At the same time, our Interview team spoke with key informants who have firsthand experience working with landowners on buffer adoption and implementation. These practical, local anecdotes refined themes from the general literature. Together, these teams provided the foundation for methods to achieve our stakeholders' purpose: creating impactful communication that resonates with landowners and, ultimately, meets CAP goals on time. We summarize these best communication practices in Deliverables 1 and 2. Finally, our GIS team created a pipeline for targeting prime parcel-level opportunities to first disseminate materials that embody our best communication practices. Using Spruce Creek HUC-12 Beaver Branch as a case study, we overlaid fine-scale biophysical, sociodemographic, and consumer data to determine intersections of high ecological need for buffers and high indicators of willingness to adopt buffers. Overall, our efforts represent a critical first step in both creating and dispersing materials that accomplish Centre County's water quality goals.

Team Members

Marissa Kopp - Ecology & LandscapeU Trainee

Background/experience in ecological sciences and in professional writing. She integrated the Chesapeake Conservancy's GIS output with landowner sociodemographic variables to spatially prioritize buffer outreach in Centre County. She also performed bibliometric analysis for the literature review team, provided literature from communication theory, and led crafting the GIS and communication deliverables.

Rosemary Aviste - Social Psychology

Background/experience with quantitative social psychology research and has conducted research on environmental behavior adoption and motivation. Rosemary was responsible for coordinating and carrying out the review of academic and practitioner literature on best practices for communicating with landowners about BMP adoption and supporting them through the implementation process.

Julia Traub - Landscape Architecture

Background/experience with landscape architecture and geography; currently working on a project evaluating the role of green-spaces in student success and the optimization of installing these spaces. She worked with Rosemary to coordinate and carry out this project's literature review, as well as supporting the interview portion of this project. She was responsible for finalizing the production of the physical deliverables, utilizing her graphic design knowledge.

Aubrey Tallon - Recreation, Parks, and Tourism Management (HDNRE dual-title)

Background/experience with exploratory and qualitative interviews, qualitative data analysis, and working with sensitive and marginalized populations as stakeholders and subjects. Aubrey assisted in analyzing ethical considerations of the project, as well as designing and conducting a portion of key informant interviews. She worked alongside Ryan and Hannah to transcribe and code conducted interviews, to be used in conjunction with archival and literary sources.

Ryan Naylor - Recreation, Parks, and Tourism Management & LandscapeU Trainee

Background/experience with qualitative interviews, document gathering and content analysis, and qualitative thematic analysis. Ryan will work with Marissa to provide Census data to include on the spatial prioritization of the project. Ryan will work with Marissa, and Rosemary to define an equation for weighting sociodemographic variables that connect to landowner willingness to adopt riparian buffers using an Analytic Hierarchy Process. Ryan will work with Aubrey and Hannah to design and conduct semi-structured interviews with practitioners who have firsthand experience working with landowners on BMP adoption and implementation. Aubrey will work with Ryan and Hannah to code these interviews. Findings will inform data included in the communications plan.

Hannah Whitley - Rural Sociology (HDNRE dual-title)

Hannah has six years' experience with qualitative social science research and for the last three years has been working with the Water for Agriculture project which has been coordinating the CAP program in Mifflin, Potter, and Tioga Counties. Hannah co-led and designed the interview portion of this project. She wrote the majority of the team's IRB application and worked with Ryan and Aubrey to identify and contact potential interviewees. Hannah conducted, transcribed, and coded three interviews and participated in the summation and analysis process. She supported the acquisition of academic studies for the literature review effort and contributed to the creation of the requested communication plan for CAP stakeholders.
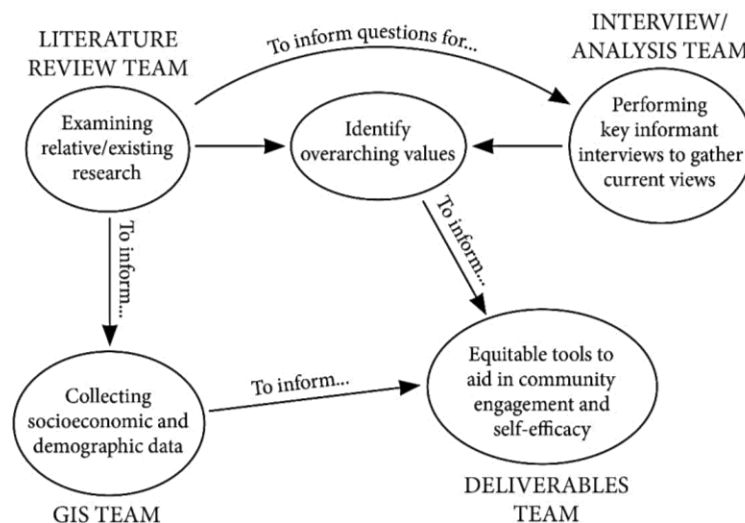
Team Breakdown

Literature Review Team	**Rosemary**, Julia, Marissa
GIS Team	**Marissa**, Ryan, Aubrey
Interview Team	**Aubrey**, Ryan, Hannah, Julia, Rosemary
Interview Analysis Team	**Hannah**, Ryan, Aubrey
Deliverables Team	**Julia**, Rosemary, Marissa

**bold indicates team leader
***member participation is not exclusive to listed teams

Conceptual Diagram

Goals & Objectives

Main Goal: Create a communication toolkit on how to effectively engage with agricultural landowners regarding riparian buffer adoption.

Literature Review Team
Objective 1: Review key literature on (1) landowner willingness to adoption buffers, (2) best practices to engage with landowners, and (3) rhetorical strategies.

Interview/Interview Analysis Team
Objective 2: Interview key informants who have firsthand experience with implementing CAPs for further recommendations.

GIS Team
Objective 3: Identify prioritized parcels in Centre County as opportunities to first target engagement that embodies our best communication practices.

Deliverables Team
Objective 4: Produce communication framework tools that encourage equal and effective conversations between stakeholders, landowners, and other concerned parties.

LandscapeU Goals

We designed our overarching project Goals and Objectives to benefit our stakeholders. Yet an ancillary goal to our overall project is to practice core competencies that align with the LandscapeU mission and our graduate teams' professional development (see **Table 1**).

Table 1. Alignment of project outcomes with LandscapeU core competencies

Core Competency	Our Outcomes
Design thinking	Literature Review and Deliverables Teams leveraged visual and social marketing theory to design intentional and impactful outreach materials All students contributed to the design of a semester-long project that meets stakeholders' needs using multiple methods from at least 5 disciplines Iterative approach to identify key themes: literature, interview, then combined
Systems thinking	All students contributed to deliverables that improve the sustainability of Centre County's socio-ecological system and critically considered variables relevant to this system Interview team considered Pennsylvania's broader network of key informants GIS Team discussed mismatch in system boundaries between biophysical and sociodemographic data
Communication	All students used cross-platform strategies for virtual communication All team leaders communicated updates to our group, class, professors, stakeholders, and LandscapeU faculty using accessible language All students practiced "cold emailing" professionals outside of their network (e.g., to request an interview, data, software help, etc.)
Team facilitation	All students developed group agency in virtual weekly team meetings Students initiated cross-team meetings with the Built Infrastructure group
Ethical dimensions	Interview Team completed an IRB process (first time for one student); and all students discussed ethics of the Non-Human Research designation GIS Team discussed ethics of sharing consumer and digital data with professionals from University of Minnesota and PA DCNR
Innovation	Merged previously disconnected biophysical, sociodemographic, and consumer data into a single spatial framework Connected literature from disciplinary silos into a transdisciplinary review
Interdisciplinary proficiency	Four students worked with ArcGIS and R software for the first time Two students experienced key informant interviews for the first time All students participated in a team outside of their expertise

Deliverables Team | Overview

The **goal** of the Deliverables team is to produce a framework of effective and equitable communication tools to be used among stakeholders, landowners and other involved parties. This content is important because of the common miscommunications presented through the earlier produced literature review. We met this goal by combining all found knowledge of GIS spatial analysis, literature review and key informant interviews as well as general research on rhetoric theory, social psychology and graphic design.

Our **objectives** to meet this goal were as follows:
- Understand the tools that are missing for effective and equitable communication.
- Locate targeted BMP areas.
- Cross-reference work completed by the other teams to create tools that promote agricultural BMPs to a diverse audience.
- Provide various types of tools to improve the self-efficacy of landowners and stakeholders in communicating and implementing BMPs.

Outputs
- Communications Table: Information from persuasive rhetoric theory and other literature review data composes a table of conversation tactics to level the communication field between landowners and stakeholders.
- Engagement Roadmap: Graphic design tactics produce an understandable roadmap that provides necessary information to various types of audiences for best chance of proper education.
- GIS Pipeline: A workflow process to identify priority parcels for outreach using biophysical, consumer, and census data for any county in the Chesapeake Bay watershed
- Case Study Map: Proof of concept from GIS pipeline for Spruce Creek HUC12 Beaver Branch

Key Takeaways
- Social science research is under-utilized in conversations of communication tactics and agricultural BMPs among diverse groups.
- Many tools exist in the realm of BMP education, but there are not many amenities that explain how these tools can be applied in a way that promotes self-efficacy.
- Managers and planners can identify priority parcels for riparian buffer outreach using freely available data from the US Census and Chesapeake Conservancy.

Challenges
- Small sampling size makes these deliverables narrow in their ability to be applicable to other spatial/social regions.

Future Directions
- The produced deliverables will be rightfully tailored to be implemented in the CAP - making them actively available for use.
- These items may always be tailored to various demographics, geographic locations and sample sizes. Social science encourages consistent adaptation in order to get the most out of these kinds of interventions.

Communications Table

This communication tool is informed by themes from a transdisciplinary literature review and key information interviews. The tool includes two sections: (1) a table of best communications practices and (2) specific, local ideas for implementing these practices.

Table I. Communication Best Practices for Effective Riparian Buffer Outreach

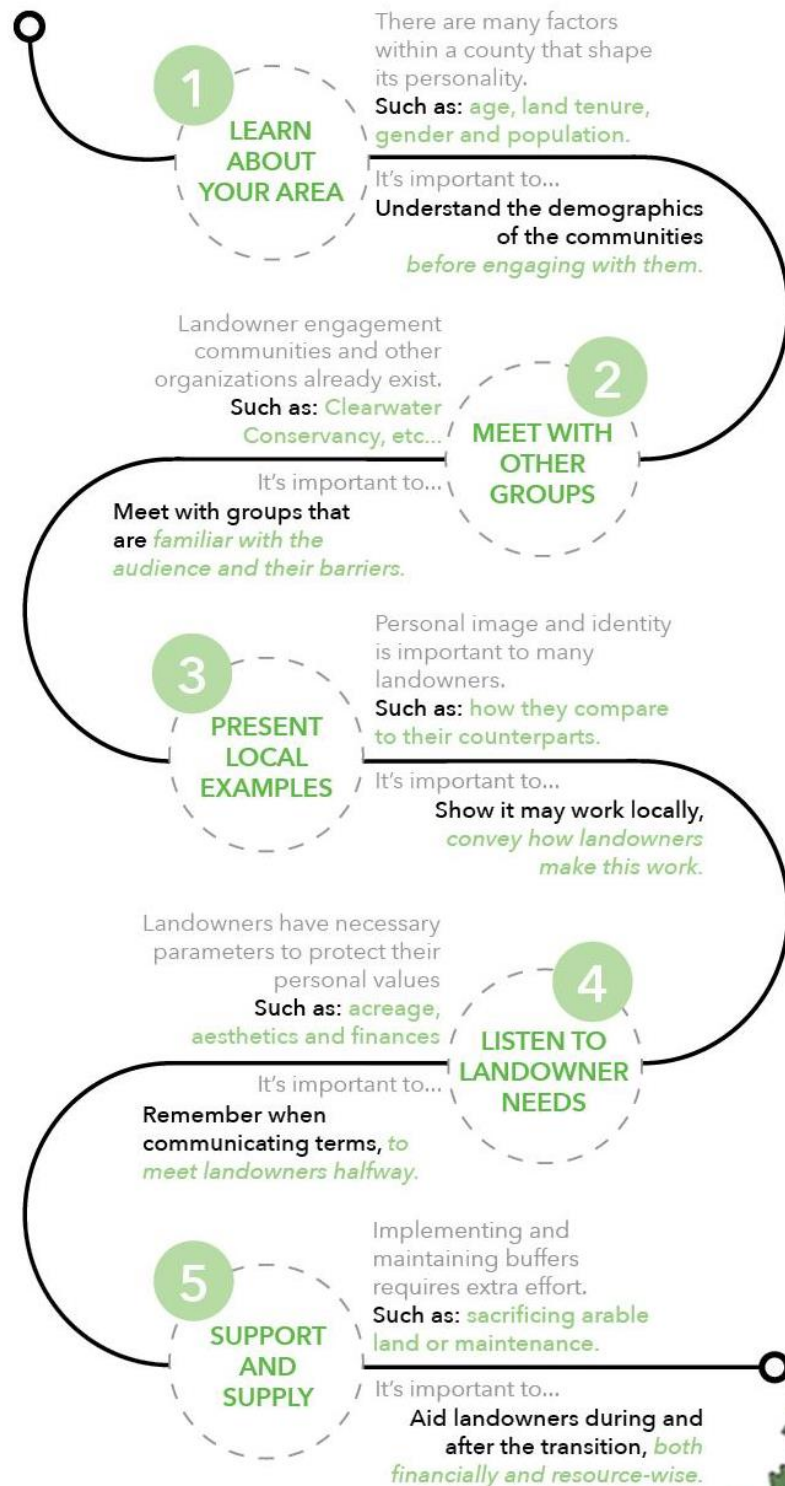| Best Practice	Rationale	Example Strategies
Listen	When we want to convey a message, staying quiet seems counter to our goal. However, educational experts who engage with landowners stress that we must shift from "telling" to "listening". To practice active listening, turn statements into questions and repeat back core ideas. This opens up space for landowners' voices and reaffirms that we hear them.	<u>Strong Message:</u> *What issues **are you concerned about** on your land?* [Listen.] *I'm hearing that **you're concerned about X, Y, and Z, is that right?** Let's match those concerns to some of our programs.*
Use concrete, local examples	Farmers often hold intrinsic motivations for conservation, such as love for their land (Ryan et al. 2003). As such, outreach programs should connect to local values (Chapman et al. 2019). Link broad "awareness" of issues to real, concrete experiences at the scale of local watersheds (Druschke 2013; DiCaglio et al. 2018).	<u>Weak Message:</u> *Riparian buffers help to **prevent eutrophication** in the **Chesapeake Bay**.* <u>Strong Message:</u> *Riparian buffers help **keep streams cool for fish** in **Spring Creek**.*
Highlight existing positives and knowledge	Many landowners already know and use best practices, some of which may not fit into credit systems in current water quality models. However, some riparian buffer educational resources rely on an antiquated "deficit" communication model, which assumes that our audience is an empty vessel waiting for our knowledge (Druschke & McGreavy 2016). Instead, outreach should be proactive in recognizing the knowledge farmers already bring to the table (Chapman et al. 2019).	<u>Strong Strategy:</u> Host a **P**eople **L**earning **A**bout **C**ommunity and **E**nvironment **(PLACE) mapping session** with farmers, educators, scientists, and policymakers (Primozich 2001; Smith et al. 2002). PLACE mapping asks participants to collaboratively draw a systems diagram of a local watershed to spark a conversation on sustainable, mutually acceptable riparian action plans.

Address farmer concerns	Although some barriers to riparian buffer adoption are "practical" (e.g., financial or logistical), other barriers hinge on farmers' emotions: fear of risks and concern for their reputation. As one extension key informant notes: "Every farmer on the planet is sensitive in one way or another to his reputation among other farmers." One communication strategy attuned to farmers' reputations is a normative appeal (Metcalf et al. 2018). Craft a message that frames adopting riparian buffers as a social norm, part of a shared behavioral standard in the farming community.	Strong Message: *"Most landowners like you invest in riparian buffers"* (Metcalf et al. 2018) *"Planting a streamside buffer to protect your land shows your neighbors that you are a good steward of your land and how much you value your community"* (Metcalf et al. 2018)
Send a trusted messenger	As one of our educational key informants says: "You can only move as fast as the speed of trust." Two ways to build landowner trust are (1) to form a sustained, long-term relationship, or (2) to leverage existing trusted relationships. The later strategy can be particularly effective. Landowners tend to trust local non-governmental and university scientists over county, state, or federal government (Weaver & Cole 2019). However, farmers are most influenced by word-of-mouth referrals from peers (Boone 2019). Use contacts from Clearwater Conservancy to identify respected local farmers that will recommend riparian buffers to their neighbors.	Strong Strategy: Include **testimonials** and names of trusted allies (e.g., local farmers) on fliers or other outreach materials
Emphasize farmer's right to choose	Landowners want to control what happens on their land (Smith et al. 2002). As such, outreach must emphasize a landowner's control over not only the adoption but the design of riparian buffers. For example, interviews show that many farmers are concerned about buffer aesthetics and whether buffers will make their farm look well managed. For these farmers, grass buffers may be a more visually appealing choice (Ryan et al. 2003; Chapman et al. 2019). However, other farmers may be more interested in a profitable buffer design (Commender 2016). These farmers may prefer to choose buffer designs with fruit or nut bearing trees, ornamentals, or other marketable products.	Strong Strategy: Take a **"menu" approach** to buffer types (e.g., grass, forested, multifunctional) with pros, cons, cost, and assistance programs associated with each Key Resource: For farmers interested in profitable buffer design, share the free online book *Planting Tree Crops: Designing & Installing Farm-Scale Edible Agroforestry* (Wilson et al. 2018)

Table II. Local ideas for implementing communication best practices

| Strategy	Local Opportunities	Connect With...
Site Demonstration	Research suggests that riparian outreach is most effective through interactive activities (Smith et al. 2002; Strong & Jacobson 2005; Boone 2019). Leverage an upcoming buffer planting at the Deibler Track near PSU's Ag Progress Days. This buffer will be a prime opportunity to demonstrate best practices and start a sustained conversation with farmers.	Penn State (Tyler Groh or Stephanie Herbstritt)
Outreach Follow-Ups	Local organizations, including several through Penn State, already allocate time and money to hosting riparian buffer outreach opportunities. Research finds that landowners who recently engaged with a buffer installation outreach program showed a 66% increase in response to riparian restoration surveys (Metcalf et al. 2018). Target participants in events, like Penn State's 2021 Stream Health and Riparian Buffer Walks, for a continued conversation on buffer adoption.	Penn State Agriculture & Environment Center (Matt Royer or Sarah Xenophon) Penn State Extension (Jennifer Fetter)
Targeted Mailers	Landowners that join informal organizations related to land management are often interested in agroforestry adoption, including forested riparian buffers (Strong & Jacobson 2005). Consider connecting with local organizations to forward mailers to their members.	Pennsylvania Association for Sustainable Agriculture (PASA) Center for Private Forests (Allyson Muth)

Engagement Roadmap

  During preliminary research for the project, including readings from the Centre County Action Plan, it seemed there was a generous amount of tools available for current stakeholders or practitioners to utilize, but no proper instructions on how to do so. Many of these tools addressed water quality, nutrient management, soil readings and other physical science information on the landscape itself. This exposed the lack of social science perspective being integrated alongside this physical science information in the CAP, which led us to pursue an Engagement Roadmap. This deliverable combines the important research and values determined by the Literature Review team and the Interview team; combining previous research with existing informant perspectives. The main focus of the steps suggested in this Engagement Roadmap is to help stakeholders understand the priorities and perspectives of the landowners they will be working with. To aid with this goal, graphic design skill was used to create a handout that organizes key information in a way that highlights important steps in a hierarchical matter. The visual engagement quality of the roadmap itself makes it easy to read and brings the reader's attention to various important key phrases, which reflect the work put forward in the communication table exhibited above.

1

LEARN ABOUT YOUR AREA

There are many factors within a county that shape its personality.
Such as: age, land tenure, gender and population.

It's important to...
Understand the demographics of the communities *before engaging with them.*

2

MEET WITH OTHER GROUPS

Landowner engagement communities and other organizations already exist.
Such as: Clearwater Conservancy, etc...

It's important to...
Meet with groups that are *familiar with the audience and their barriers.*

3

PRESENT LOCAL EXAMPLES

Personal image and identity is important to many landowners.
Such as: how they compare to their counterparts.

It's important to...
Show it may work locally, *convey how landowners make this work.*

4

LISTEN TO LANDOWNER NEEDS

Landowners have necessary parameters to protect their personal values
Such as: acreage, aesthetics and finances

It's important to...
Remember when communicating terms, *to meet landowners halfway.*

5

SUPPORT AND SUPPLY

Implementing and maintaining buffers requires extra effort.
Such as: sacrificing arable land or maintenance.

It's important to...
Aid landowners during and after the transition, *both financially and resource-wise.*

LANDOWNER ENGAGEMENT ROADMAP

RIPARIAN BUFFERS

Image Source: University of Kentucky College of Agriculture

GIS Pipeline
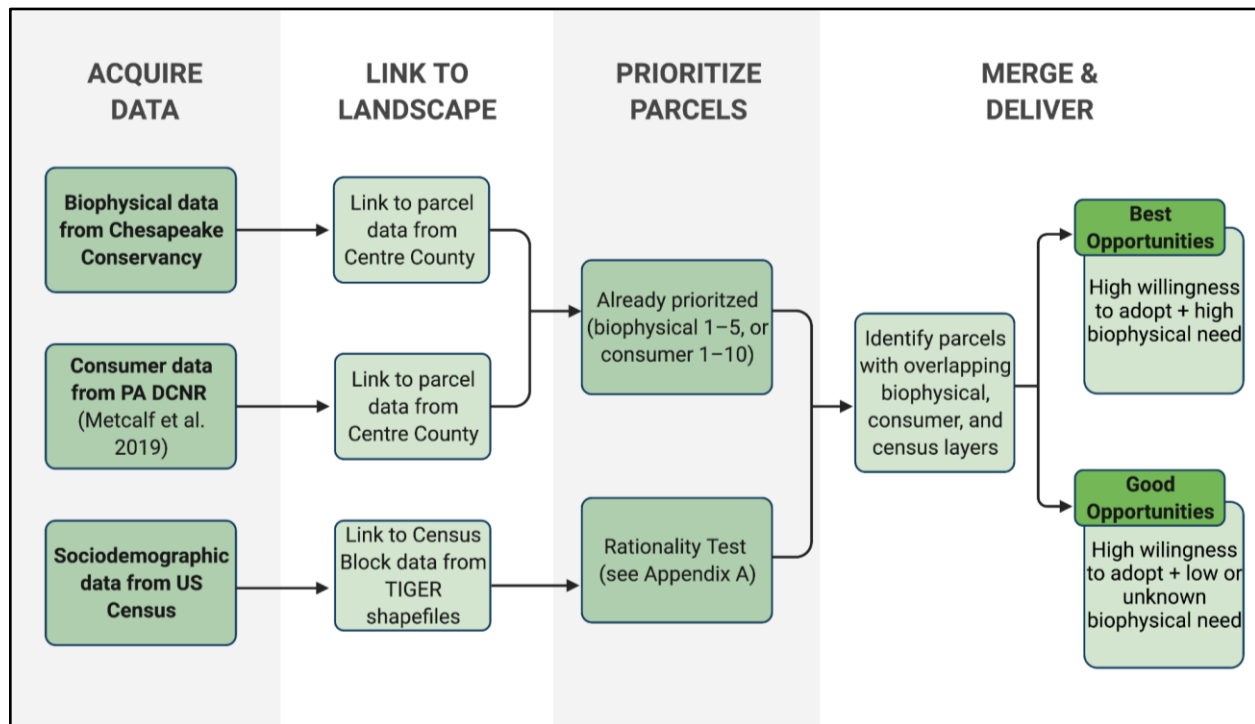
The workflow process reviewed here can be used to replicate our methods for any county in Pennsylvania needing to identify priority parcels necessary to reach their CAP goals. This data includes 1) biophysical data freely available via the Chesapeake Conservancy, 2) consumer data predicting the likelihood of landowners responses to conservation outreach from the Department of Conservation and Natural Resources (DCNR), and 3) freely available Census demographic data of Tenure, Sex, Age, and Population deemed necessary through our literature review to influence landowner willingness to adopt buffers.To further fitler parcels identified by the biophysical and consumer data, Census data should be gathered at the smallest available resolution available, the block scale.

Once gathered, data should be linked to the county of interest. Biophysical and consumer data are at parcel scale resolution and can be linked to any freely available parcel level data (e.g. tax information) available through the county of interest. As Census data is not available at the parcel scale, TIGER shapefiles available through the Census should be used to link demographic data to the county via geographic entity codes (GEOIDs).

Once linked, the prioritization of parcels begins. Luckily, the biophysical and consumer data is already prioritized, however, the census data is not. To do so, an Analytical Hierarchy Process (AHP) otherwise known as a 'rationality test' can be used to produce a 'priority' number for each block within the county. However, numbers then need to be categorized based on priority. To do so, use the geometrical interval classification scheme within ArcGIS to categorize on a one-to-five scale to prioritized blocks into the top twenty percent best opportunities within

the county.To promote replicability efforts, the process and methods needed to run the AHP are outlined within the GIS section and Appendix of this document.

The final step is to prioritize the best parcels to target for communication outreach. Once each data set is overlaid, the highest priority parcels will emerge. For example, this workflow was implemented for the Beaver Branch watershed seen below. Via this methodology, parcels were narrowed to eight key opportunities seen in red. It is important to note that this workflow process is enhanced but does not require the data from DCNR. When solely using Census and biophysical data, the AHP captured 83% of the parcel identified by Metcalf et al. (2019). Thus, this GIS pipeline can be used within the entirety of the Chesapeake Bay Watershed. These parcels represent where target outreach should occur using the engagement roadmap and communication best practices outlined above.

Case Study Map
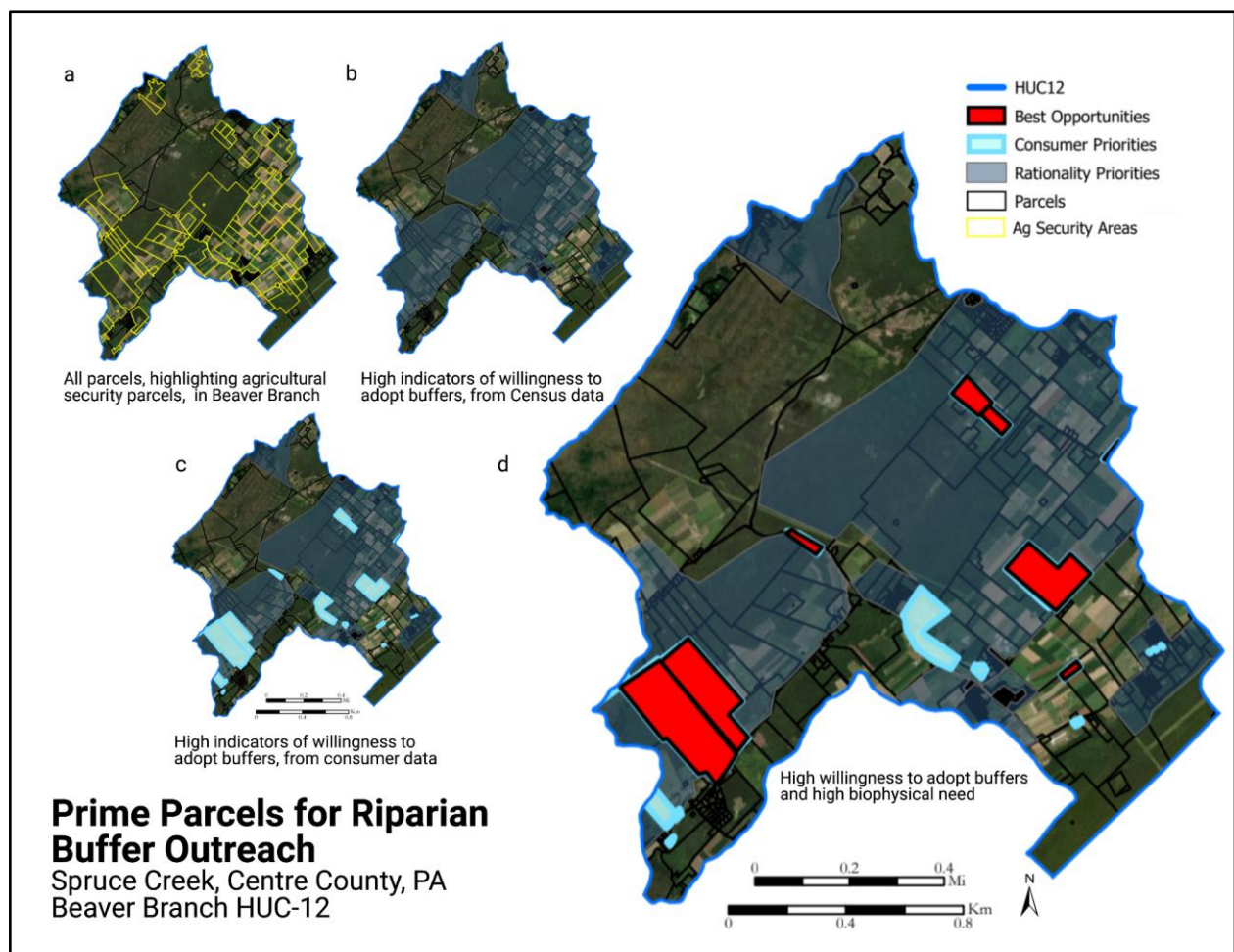
This case study map is a "proof of concept" output from the GIS pipeline.

Literature Review Team | Overview

The **goal** of the Literature review team was to conduct a review of academic and practitioner literature on best practices for communicating with landowners about BMP adoption. We looked at literature from a range of disciplines to inform both the demographic work being done by the GIS team and to lend support to the findings of the Interview team. We met this goal by searching literature specific to riparian buffer adoption in the Chesapeake Bay Watershed and more broadly in the fields of environmental and motivational psychology, rhetoric, and graphic design.

Our **objectives** to meet this goal were as follows:
- Conduct a bibliometric analysis to visualize key themes and connections within the field of riparian buffer adoption literature
- Review key literature on (1) landowner willingness to adoption buffers, (2) best practices to engage with landowners, and (3) rhetorical strategies for engagement.

Outputs
- An organized summary of themes identified across the literature review, which were integrated with the themes from the interviews to create a well-rounded theory supported deliverable
- A table of specific communication tactics and key phrases, which was informed by the themes identified in the literature review and interviews.

Professional Development
- New software skills: Zotero, R Code Language, VosViewer
- Gained trans-disciplinary perspectives from outside of our own academic fields

Key Takeaways
- We identified eight themes, organized into three categories: Perception/Values (aesthetics, identity, and land stewardship), Implementation Support (financial concerns and educational/ financial resources), and Stakeholders (landowner demographics, non-landowner involvement).

Challenges
- We found it difficult to find literature that was applicable to central PA or the Chesapeake region.
- There is a lot of research about the biophysical aspects of riparian buffers, but there is less research on social aspects including adoption and communication practices.

Future Directions
- From the literature, key stakeholders have been identified as being important in communication strategies. A future direction could be following up with these key stakeholders.
- The themes and recommendations we identified are based on past studies, which are largely non-specific to our target population. Future teams should work on building relationships with landowners in Centre County to gain specific insights.

Methods

Goal

The goal of the Literature Review Team was to collect and synthesize literature relating to riparian buffer adoption and communication as an archival proxy for field research. Themes identified through this review were integrated with the key informant interviews to lend support to their findings and important demographic variables identified through this review were integrated with the geospatial analysis conducted by the GIS Team.

Objectives

To meet this goal, our first objective was to collect all literature relevant to riparian adoption and communication. First, we identified Armstrong & Stedman (2012) as a key text because (1) their research targets the conditions under which willingness to implement riparian buffers might increase, and this aligns with our stakeholders' goal of increased riparian buffer adoption; (2) their research is based in the Spring Creek watershed, the top prioritized HUC-12 watershed in the Centre County CAP's corridor of opportunity; and (3) the work is relatively recent. As such, we used Armstrong & Stedman (2012) as the springboard for a bibliometric analysis to expedite the literature review process.

Initial Bibliometric Analysis

We used the "Connected Papers" online tool to visualize similar papers (Fig. 1), where each node represents a paper connected by lines representing a "similarity" metric based upon *co-citation coupling* (shared citations; i.e., Do two papers cite each other?) and *bibliographic coupling* (shared references; i.e., Do two papers cite a common reference?). The size of the node is relative to the number of citations, and the color of the node relates to publication year. The tool analyzes this network to compile two outputs: *prior works* and *derivative works.* Prior works are the 10 papers that were most commonly cited in the network, and this suggests that they may be foundational or seminal works in the field. Derivative works are the 10 papers that cited most other papers in the network (i.e., have the most connections between nodes), and this suggests that they may be either surveys of the field or recent related research. We began our literature review with these 20 papers and refined them to relevant articles (n = 14).
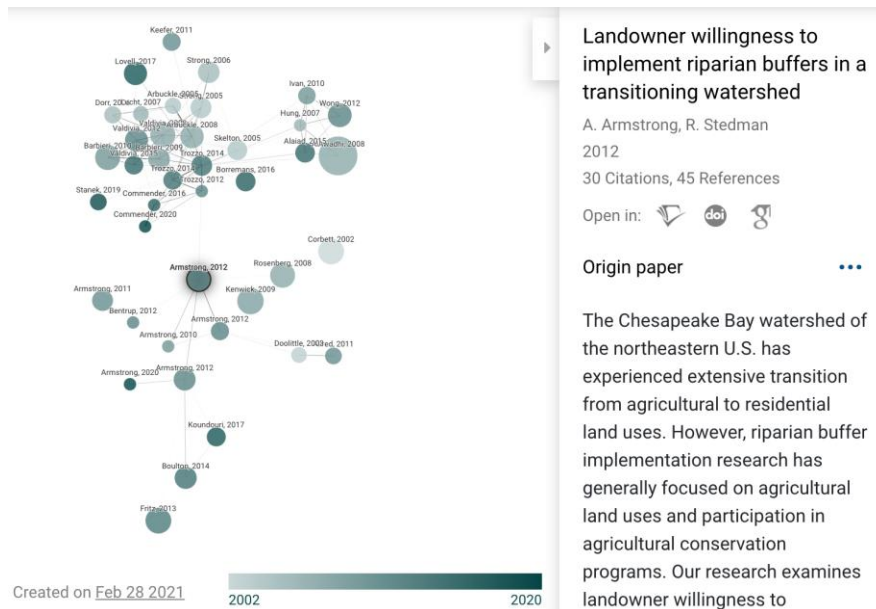
Figure 1. A citation analysis of a key place-based text from Armstrong & Stedman (created with Connected Paper). Nodes represent a paper, and lines represent a "similarity metric" based upon shared citations and references. The size of the node is relative to the number of citations, and the color of the node relates to publication year.

Discipline-based Literature

In addition to the prior and derivative works, each team member found key literature by conducting an independent search within their own disciplines: motivational and environmental psychology (n = 5), rhetorical theory (n = 4), and design principles (n = 4). The purpose of approaching the search from different disciplines was to gain multiple and diverse perspectives on riparian buffer and agricultural BMP adoption and communication and to best use the expertise of our team members.

To conduct this search team members used a variety of methods including keyword searches in Google Scholar and the Web of Science database (for examples see Table 2). To narrow the search, team members first looked for research completed specifically on riparian buffers in Central Pennsylvania within the past ten years. Once this most relevant literature was found the search was broadened to include areas generally in the mid-Atlantic area, then broadened to include the United States and Southern Canada. The search was also broadened to include agricultural BMP adoption in general and papers written outside of the last ten years.

Table 2. Examples of Keyword Searches

Riparian buffers or Agricultural BMPs *and*
    Rhetoric
    Motivation
    Community Social marketing
    Communication
    Social psychology
    Self Determination Theory
    Demographics
    and
        Centre County, PA
        Central Pennsylvania
        Pennsylvania
        Mid-atlantic
        East Coast
Ecology *and*
    Landowner outreach

Secondary Bibliometric Analysis

Once the literature from the prior works, derivative works, and individual searches was collected we began summarizing and organizing the literature. We conducted a basic bibliometric analysis, a statistical analysis of publications, on most of the literature (21 out of a total of 27 documents) using the bibliometrix package in R (Aria & Cuccurullo 2021).[1] We found that our literature arose primarily from the journal *Agroforestry Systems* (n = 7); however, our sources included a wide variety of disciplines (e.g., communication, economics, management, policy, and human behavior) spanning from 1991 to 2020. We created a final bibliographic coupling network using the VosViewer software (van Eck & Waltman 2020). We found that at least four sources (Matthews 1993, Baumgart-Getz 2012, DiCaglio 2018, and Metcalf 2019) had been previously "disconnected" from the citation network, in that these papers did not share a single common reference with any other source in our review. This is evidence of transdisciplinary innovation: we successfully connected siloed disciplinary knowledge into one review.

Theme Identification

To pull key themes from this literature, we first created a table to compile the papers and quick summaries of main findings from the papers. For each entry the field or discipline of the paper was noted along with the citation and a summary of key findings. From this table we organized the literature in two ways: spatially and thematically. We began by organizing the papers according to spatial relevance with research in Centre County and Central Pennsylvania being the most relevant and research occurring in the greater U.S. and Canada being the least relevant. We attempted to spatially organize the papers under the assumption that land-owner values may change by region. Part of this is driven by value differences in general, but also different types of agriculture, which may produce different land values. Next, we identified seven main themes, which were further organized into three categories: Perception/Values (aesthetics, identity, and land values), Implementation Support (financial resources and educational resources), and Stakeholders (landowner characteristics, non-landowner involvement). See Supplemental Table 1 in the Appendix for an organized table of key takeaways.

Integration with GIS Team

Part of our team's goal was to use findings from the literature review to help inform the GIS Team's spatial prioritization work. The first step in reaching this goal was searching for literature that addressed the relationships between farmer demographic variables and willingness to adopt riparian buffers or agricultural BMPs in general. The second step was working with the GIS team to use our findings (for example, one meta-analysis showed that sex was a better predictor of

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[1] Our bibliometrix output and code (as an R Notebook file) are available upon request. Theses/dissertations and non-digitized books did not have compatible metadata for a bibliometric analysis.

willingness to adopt than age) to provide relative importance weightings of each demographic variable, which were then used to create a formula to determine spatial blocks that should be prioritized.

Integration with Interview Team

Once the interviews were completed, transcribed, and coded, we integrated the findings from the literature review with those from the interviews. Preliminary themes from the interviews largely mimic the themes found in the literature. For example, both the literature review and interviews highlighted the importance of building strong interpersonal relationships with landowners and using trusted social networks to gain trust and build those relationships. The final deliverable highlights the themes from the key informant interviews and used the corresponding literature to add support and perhaps depth to those emergent themes. See Supplemental Table 2 in the Appendix for theme integration.

Interview Team | Overview

The **goal** of the Interview team is to conduct a series of semi-structured, in-depth interviews with key informants who specialize in landowner and producer engagement, both as practitioners and researchers. We analyzed emergent themes and concepts from the literature review to establish a structured series of questions for participants, with the goal of using key informants to broaden our understanding of agricultural engagement in the Chesapeake Bay region. We met this goal by successfully conducting a series of interviews (n=8) with informants from academic, extension, and similar backgrounds. Using emergent framework coding we have established themes to be integrated with our literature review for a holistic view of stakeholder and landowner engagement practices.

Our **objectives** to meet this goal were as follows:
- Establish a series of structured questions for researcher and practitioner informants using a thorough review of agricultural BMP adoption literature
- Conduct a series (n=8) of in-depth interviews with key informants who frequently work with landowners or are involved in research surrounding landowner engagement
- Establish themes by using inductive framework coding to compare responses between informants
- Employ emergent interview themes to frame recommendations for CAP communication plan

Outputs
- A formal protocol created and submitted to Penn State's Institutional Review Board
- Recruitment materials to share with potential key informant interviewees
- A framework coding guide and template for streamlining the transcription, coding, and analysis process
- Eight framework coding templates with main themes and accompanying transcript sections
- A document with communication best practices identified during interviews; shared with the Literature Review and Deliverables teams to compile the integration of findings from Interviews and Literature Review (see Table 2)

Professional Development
- Qualitative methodological skills: Interview development and execution, transcription, and inductive coding
- Interpersonal skills: Effective interviewing, key informant communication, and ethical considerations

Key Takeaways
- Our framework coding process identified five themes that summarize interviewee recommendations for effective outreach and communication to landowners: (1) Need for programmatic flexibility and strategic use of resources; (2) Importance of building trust and building relationships; (3) Investment of time; (4) Importance of community involvement, co-learning, and co-benefits; and (5) Need for a multi-method, reflexive approach to stakeholder engagement.

- These overarching themes are presented in tandem with the recommendations for best communication practices outlined in Table 4, which was created in partnership with the Literature Review and Deliverables teams.
- Themes identified during interview analysis support what we've read in the literature and contribute a number of best communication practices not identified in our review

Challenges
- Due to COVID-19, interviews were conducted via Zoom, which reduces researcher ability to observe and record non-verbal facets of communication (i.e. body language) of informants
- The number of interviews our team was able to conduct were limited by our truncated timeline

Future Directions
- Interviews were conducted with researchers and practitioners due to the short timeline of the project. Future iterations would benefit from discussing these themes with landowners and producers directly, but would require significant lead-in time for building rapport and trust within agricultural communities.

Methods
Overview. To reach the established objectives, the Interview team conducted a series (n=8) of semi-structured, in-depth interviews with key informants. Informants were selected via a combination of purposive and snowball sampling methods and were selected due to their participation in known organizations and programs as well as geographic location relevant to the Chesapeake Bay. Interviews were conducted with the intended duration of 30-45 minutes, with the option for extended time as required.

Question Development
Our interview questions were adopted from the Armstrong and Stedman piece (2012) which the Literature Review team identified as being a leading protocol for research on best practices for riparian adoption. With this in mind, our interview protocol was framed by the following research questions:
1. How, if at all, have past policies affected current landowner willingness to shift agricultural practices?
2. What are some best practices that project facilitators need to take into consideration when working with landowners to implement BMPs?
3. What is the best way to reconcile divergent policymaker expectations with landowner expectations?

Research Sample
The sample for the interviews portion of this study included two categories of participants: education and/or extension experts and representatives from semi-local environment and natural resource organizations. All interviewees had extensive experience related to stakeholder engagement with agriculturalists and landowners. To participate, subjects had to identify as having some connection to natural resource stakeholder engagement, be older than 18 years, and reside in Pennsylvania. In total, 8 key informants participated in this research via an individual interview (N=8).

Recruitment

Interview recruitment took place during the second week of April 2021. Interview team member's pre-existing relationships with members of the Penn State Extension program Water for Agriculture helped build connections with the study's initial participants. With Water for Agriculture leadership in support of this project's objectives, we obtained access to several key informants whom we would not have previously own. With the support of our Water for Agriculture gatekeeper, this study benefited from a combination of convenience and snowball sampling that was utilized during this project.

We first contacted individuals whose names were provided by our gatekeeper. These individuals were contacted via email using information publicly available online or provided through snowball sampling. Ultimately, this study's sampling was sourced from a pool of individuals who were both convenient in their proximity and their (predicted) willingness to participate (Robinson 2014). A total of 8 interviews were conducted with 8 respondents. These respondents represent 16 coalitions, universities, representative councils, and community organizations.

Data Collection

Before data collection began, an interview protocol was developed, framed by this study's research questions and objectives. The semi-structured interview guide included a question at the end for the respondent to add anything additional and allowed room for follow-up questions from the interviewer.

The Interview team submitted an application to the Pennsylvania State University Institutional Review Board (IRB) for expedited, exempt review. It was later determined that due to the scope and audience of this research, our application received a classification of "Not Human Research." Semi-structured interviews began on April 9, 2020, and concluded on April 19, 2020. All eight interviews were conducted via Zoom. Though not required, verbal consent was obtained before all interviews. Interviews ranged from 26 minutes to 57 minutes, with an average length of 45 minutes. All interviews were audio-recorded and transcribed verbatim using Otter.ai, an automated transcription service. All personally identifiable information has been redacted from each transcript.

Semi-structured Interview Methodology

This project utilized a semi-structured interview instrument which consisted of ten open-ended questions organized into five categories: introduction, perspectives on working with stakeholders on BMP adoption, perspectives on communicating socio-behavioral research findings, and closing. Follow-up and probing question examples are included on the same instrument, though not all questions were asked of each participant. The five categories were arranged thematically to aid in interview structure and flow and were designed so that the participants could take breaks, ask questions, or move to a different topic if desired.

Data Analysis

This project utilized the framework analysis method to examine all qualitative data. All data were hand coded in GoogleDocs by the Interview team.

Ritchie and Spencer (1994) outline five stages for conducting a framework analysis: familiarization, identifying a framework, indexing, charting, and interpretation. During stage 1 ("familiarization"), researchers "get to know" the data to assess its overall "feel." By reading interview and reflection meeting transcripts, reviewing field notes, and recording emerging issues in the data, researchers get a sense of

what data they're working with. Stage 2 ("identifying a framework") asks the researcher to develop framework (coding) categories informed by a priori concerns as well as emergent issues that arose during the familiarization stage. During this stage, the researcher creates a matrix output of rows and columns (often called "thematic categories") that organize the data. Rows represent cases (different participants or different interviews) and columns represent different themes and/or concepts identified in the raw data (Barker 2016). In each cell, the researcher begins to summarize data and adds illustrative quotes from transcripts. Gale et al. (2013) describe how this presentation of data allows for themes to be interpreted across a data set while still being connected to the individual participant or focus group. This way, you can see similarities and differences between participants and within the themes that have been identified.

Stage 3 ("indexing") involves systematically applying the framework to each interview transcript. As the researcher works through each transcript, they highlight a chunk of text they think applies to a certain category (or categories) from the framework; the highlighted text is then "dragged and dropped" into its corresponding category. During our coding process, the Interview team coded for all themes while reading through individual transcripts and photo captions. Though this process was very time-intensive, it allowed us to focus on one single case at a time.

Once indexing was complete for all captions, notes, and transcripts, we began to chart the data into a more manageable format (stage 4). The end product from this stage was a spreadsheet where all interviews were summarized and organized by the framework categories. This stage was very helpful to prep for stage 5: interpretation. During this stage, the team was tasked with finding patterns in the framework and "articulating one's own sense-making of the data in the light of one's research questions" (Parkinson et al. 2015: 27). During this stage, we read through the framework spreadsheet, took notes on broad findings, and began to develop a set of themes that applied to each research question.

Outcomes

Our framework coding process identified five themes that summarize interviewee recommendations for effective outreach and communication to landowners. These themes include: (1) Need for programmatic flexibility and strategic use of resources; (2) Importance of building trust and building relationships; (3) Investment of time; (4) Importance of community involvement, co-learning, and co-benefits; and (5) Need for a multi-method, reflexive approach to stakeholder engagement. These overarching themes are presented in tandem with the recommendations for best communication practices outlined in Table 4, which was created in partnership with the Literature Review and Deliverables teams.

Need for programmatic flexibility and strategic use of resources

The need for programmatic flexibility and strategic use of agency resources was a large part of our discussions with the eight key informants. In large part, this flexibility was needed due to landowner and agency financial limitations and the uniqueness of landowner property structure and willingness to participate in "cookie cutter" programs. Our third interviewee, an education/extension expert, reflected:

> *Some farmers don't fit well into agency boxes… Many programs have abstract technical prescriptions [i.e., buffers] that aren't applicable to everyone… So [the farmers] are trying to take these abstract technical prescriptions, which are not flexible, and they're based on federal programs that don't have flexibility. They get frustrated with the whole process. - 003*

This reality of farmers not fitting well into agency boxes is directly in line with literature recommendations to address farmer concerns (aesthetics, program inflexibility, and implementation and maintenance assistance). One way agency representatives can help ease landowners into the process of considering BMP adoption is by framing their communication approach to match landowners' needs and values and eliciting feedback to brainstorm how agency needs and landowner desires might converge. Even if a landowner's needs are not directly in line with a program's call for applicants or target audience and their timeline does not abide by agency deadlines, listening to and brainstorming with landowners can help expand programmatic flexibility and be more strategic about the use of resources.

Importance of building trust and building relationships

The importance of building trust and building relationships between agency service providers, Extension educators, and the local community was stressed by all interviewees. Particular emphasis was placed on the amount of time and persistence that goes into establishing a reputation as a dependable community member. Our first interviewee, an education/extension expert, summarized the amount of work that goes into gaining trust from farmers and landowners:

> *In terms of building trust, building the relationships, it's that slow, methodical work, of just building those connections. And sometimes it's as soft and almost seemingly tangential as getting to know people and not necessarily coming right to 'Hey, I have a message to convey to you.' It's that building relationship.* - 001

For agencies working in areas that do not have an established agency representative or education/extension expert, some interviewees suggested hiring well-known and liked farmers as subcontractors to conduct farm visits and elicit farmer/landowner perspectives on available programs. Our second interviewee, an education/extension expert, provided an example of how hiring trusted community members as subcontractors has worked well for the agency's work in BMP programs:

> *We're actually using some of our grant money to hire a farmer who has a lot of local contacts, and is kind of transitioning out of, he's still full time in the operation, it's a dairy but is transitioning a lot more of the day-to-day farming work to the next generation. He's now kind of working as a kind of a subcontractor with us, to go and visit other farmers, where he already has those established relationships and a lot of clout in the community. He happens to be elected township supervisor as well as an all around good guy and well known for his leadership in the ag community.* – 002

Simple communication tactics like careful listening, hearing, and repeating what farmers and landowners are excited about and concerned for are other ways to practice gain trust in a community. Respecting farmer's specialized and local knowledge is imperative for this practice, even if this knowledge conflicts with science-based rules. Three of the eight interviewees identified farmer/landowner sensitivity as being something to remain vigilant, especially in reference to past experience with BMP adoption. Some farmers, for example, may have never formally participated in agency BMP adoption programs. They, however, may have made conscious efforts to incorporate best management practices into their operation. Sometimes this may manifest in perceptions where farmers think agency representatives are over-thinking the process, and agency representatives think farmers are cutting corners. Our fourth interviewee, an education/extension expert, explained why it is important to remain vigilant of farmer sensitivity, as ignoring feelings and efforts to engage with BMP adoption outside of formal programming may be alienating to some landowners:

One of the common comments that I heard out was that, "I'm the farmer and you're trying to [ignore what I've been doing all this time], and I've gotten a little bit of expertise in this, but you have over engineered this project to a point where it's not cost effective anymore." And it's not just not necessarily cost effective to me because you're perhaps subsidizing my costs. But why should every resident pay for this over engineering? And there's a little bit of a looking out for my fellow community person as well, who's paying taxes to support this project? And you have gone way beyond what most common people would think needed to be done for this. - 004

Investment of time

The investment of time it takes to build relationships, trust, and work with farmers and landowners to participate in agency best management practice programs was brought up by all eight of our interviewees. Time came up for a variety of situations: the time it takes to build a genuine relationship, the time it takes to build trust, and the disconnect of farmer/landowner timelines and agency/policy deadlines. The latter of these is a particular concern for strategizing how to advertise BMP programs with active deadlines to farmers and landowners. One environmental and natural resource organization representative explained:

You really need to line [your timeline] up well and know how to do the upfront outreach, engagement, technical assistance, to spend the dollars. And that is something that for the CAP, that would be very I think important to recommend… [The Department of Environmental Protections] is providing those implementation dollars for shovel-ready project. They want to see that money spent in a one year period. So the partnership has to line up. They got to do the engagement and then some of the technical assistance, at least to get everything lined up on the front end. Because a project just doesn't happen in a year. Having the initial conversation to the project is done, closing the books, is usually a fairly lengthy process. - 006

Another issue raised concerned working with the Amish, Mennonite, and broader Plain Sect population which does have representation in Centre County. The majority of Plain Sect communities do not accept financial incentives for participating in agency programming efforts. As a result, without the threat of financial loss or legal action, it is very difficult to advertise and engage the Plain Sect population in BMP programs. The time required to build relationships with local Bishops and find creative solutions that do not resolve around financial compensation is something to consider in implementation processes, as one education/extension expert interviewee explained:

When you're working with Amish farmers, you really don't have incentives, or it's much harder to do financial incentives because they can't take money from the government. So you've already had sort of one hand tied behind your back, not to say there are workarounds and people don't figure this out. But it depends on the Bishop. And it's how variable they are, small community and parish and all that sort of thing. - 001

Importance of community involvement, co-learning, and co-benefits

The importance of community involvement, co-learning, and identifying co-benefits is a theme highlighted by our Literature Review team and something that was also echoed by all eight of our interviewees. This theme is in large part related to the themes of building trust and relationships and investing time, but we've identified it as an independent theme here because of its connection to strategic engagement and relationship to best communication processes.

Again, the importance of a project coordinator/agency representative being someone who lives and works in the community and has a good reputation is not to be underestimated. Success stories of community involvement and co-learning from our interviewees had much to do with representative personality and their ability to make individualized connections with landowners and bring these people together in a broader effort. Describing the work his co-worker has put in to connect with the community, one education/extension expert remarked:

> *I watched [name of colleague] who lives there, and her friends and she conducts meetings with these folks all the time. And I see the relationship she has and how they respond to her, compared to those responding to me. And I give her credit for all of that because she's developed that relationship and trust. And so when she talks about some of the things that we're talking about here, they listen to her. - 002*

An equally important aspect of this is to approach agriculture and natural resource issues as allies. What does this mean? One education/extension expert explained:

> *Instead of me going out and saying, "Okay, this is what it is, you know, you got to do this, this and this," you need to turn it around and say, "This is what we're up against. What are your ideas? What would you be willing to do?" Because that's how you build trust and get people thinking about coming up and brainstorming and maybe getting some unconventional ideas, but they solve the problem. I mean, it may not be cookie cutter, like the policymakers want it to be, but what it is. – 003*

The communication practice of approaching issues as allies, framing rhetoric to match landowner needs and values, and simply not trying to "convince" landowners is a novel finding of this research. As our Literature Review team has shown, behavioral adoption is a long process of shifting perceptions, values, and beliefs, which emerges out of reciprocal engagement. Allowing landowners to approach issues from a common standpoint, providing more information about financial or other benefits, and inviting farmers/landowners to ask questions and make their own educated answers is just one step for best BMP adoption communication practices.

Need for a multi-method, reflexive approach to stakeholder engagement

Finally, five of our eight interviewees discussed the need for multi-method, reflexive approaches to stakeholder engagement when communicating the benefits of BMP adoption. The need to move away from the "expert" model of education was an important highlight for all of the education/extension representatives included in our sample. Explaining the harm of the expert model, one interviewee shared:

> *I'm also thinking of that extension in northern Pennsylvania, what my colleague there calls the "expert model," which is when someone from Penn State comes up to visit a farmer, and they just tell the farmer all the things they're doing wrong and tell them how they should actually do other things. If they have that knowledge, and that's important to have that technical knowledge, I'm not disregarding that. It's when you fail to have a dialogue, and have the farmer share and invite those kinds of critiques or questions. – 003*

When asked about advice they had for the Centre County CAP team, all eight interviewees stated the importance of putting farmers and landowner needs first in the process, as these relationships are what will build trust and willingness to engage in BMP projects. Our first interviewee, an education/extension expert, summed the advice quite poignantly:

If they want true success, it's really an all of the above approach. It's putting people first; it's giving people the time and latitude to work with farmers individually, and engage on very personal levels, whether it's workshops on the farms, or whatever, but the time and commitment to do that, and the latitude to do that. And then, of course, all the other sort of standard ways of workshops and field days, which takes time and money. Right. But if you're serious about it, you'll also find a lot of the reason we're in the pickle that we are is we've taken, you know, we've been pennywise and a pound foolish sort of; we want the quick, easy, cheapest solution in the short term. But it costs long, it costs us, you know, diminished success, or all these other, you know, external costs that we don't think about or budget for in the long run. – 001

Conclusions

In sum, our framework coding process identified five themes that summarize interviewee recommendations for effective outreach and communication to landowners: (1) Need for programmatic flexibility and strategic use of resources; (2) Importance of building trust and building relationships; (3) Investment of time; (4) Importance of community involvement, co-learning, and co-benefits; and (5) Need for a multi-method, reflexive approach to stakeholder engagement. These themes support what we've read in the literature and contribute to a number of best communication practices that were not identified in our review. These novel findings include insights on working with Amish, Mennonite, and Plain Sect communities, the importance of remaining vigilant of farmer sensitivity and reputations, the importance of eliciting farmer feedback, and the best practice of working with farmers/landowners as allies rather than trying to simply convince them to take part in BMP programs.

GIS Team | Overview

The GIS Team's **goal** was to refine parcel-level prioritization for targeted buffer outreach that uses best communication practices from the Deliverables Team. To meet this goal, we identified socio-demographic indicators of willingness to adopt buffers on prioritized land in Centre County.

Our **objectives** to meet this goal were as follows:
- Integrate biophysical variables pertinent to buffer placement onto Centre County parcels
- Link sociodemographic variables to spatially explicit boundaries on the landscape
- Define an equation for weighting sociodemographic variables that connect to willingness to adopt riparian buffers using an Analytical Hierarchy Process with the Literature Review Team
- Overlay weighted sociodemographic block data onto biophysical variables to create a refined parcel-level prioritization for riparian buffer outreach

Outputs
- Map of priority parcels with high ecological need for and likelihood of adopting buffers
- Document of key stakeholders in the network, current projects, and contact information

Professional Development
- Networking: We gained contacts from professionals at Chesapeake Conservancy, PA Department of Conservation and Natural Resources, and University of Montana
- Interdisciplinary proficiency: We gained our first experience with 1) Census data and TIGER shapefiles, 2) GIS data management, and 3) Analytic Hierarchy Processes (or Rationality Test)

Key Takeaways
- Tenure, age, sex, and population are important sociodemographic indicators of willingness to adopt riparian buffers.
- In a case study of Beaver Branch, we captured 83% of the targeted parcels from consumer data models (that considers over 800 individual and property-specific variables, see Metcalf et al. 2018) using just four variables from freely available Census data
- Stakeholder networks are being under-utilized.

Challenges
- Mismatch in spatial resolution of biophysical and sociodemographic data
- Tradeoff of spatial resolution and recency of sociodemographic data
- Barriers in accessing identifiable sociodemographic data at the census block scale

Future Directions
- Integrate 2020 Census data (available by the end of 2021) into our framework
- Verify our equation weighting for sociodemographic variables
- Consider integrating data sources beyond Census[2] and immediate stakeholder network

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[2] E.g., participation in external professional organizations, such as PASA. See **Literature Review Team**: Strong & Jacobson (2005), Valdivia et al. (2005), Baumgart-Getz et al. (2012), Metcalf et al. (2019), Boone (2019), and Weaver & Cole (2019)

Methods

Goal

The goal of the GIS Team was to integrate biophysical and sociodemographic or consumer data into a single spatial framework in order to prioritize parcels for targeted buffer outreach. To meet this goal, our first objective was to overlay existing biophysical data onto a parcel map of Centre County. This objective aligned with Action 1.1E-1 of Centre County's CAP: to advance local comprehensive planning efforts by using Chesapeake Conservancy's existing dataset to identify buffer gaps.

Biophysical Objectives

Specifically, we leveraged the Chesapeake Conservancy's 1-meter resolution "Precision Conservation" data on the land use 35' around each stream in Centre County.[3] In addition to land use (which allows us to "see" the gaps in streamside vegetation), the Chesapeake Conservancy data creates a heatmap of low to high priority parcels for filling these gaps using methods described in Gemberling et al. 2020.[4] Briefly, each parcel receives a Site Score using the following equation:

$$(1.00 * Ag/Imp/Turf \ in \ DA) + (0.09 * DA) \qquad \text{Eq. 1}$$
$$+ \frac{(1.10 * Ag/Imp/Turf \ in \ DA)}{Gap \ Area}$$

where *DA* is drainage area (acres); *Ag/Imp/Turf in DA* is the total land area in each drainage area considered to be agriculture, impervious, or turf from high-resolution land use data; and *Gap Area* is the size of the flow path restoration opportunity (acres). The product of Eq. 1 is then added to a Designation Score, which uses the 2017 Integrated List of Non-Attaining streams and 2017 Total Maximum Daily Load streams to place higher priority on (1) agriculturally impaired streams, (2) exceptional value/high quality streams, and (3) upstream proximity to an impaired stream. These Total Scores (Site Score + Designation Score) are tiered from 1 (low priority) to 5 (high priority) for each parcel in a county. In short, these data create a parcel-level prioritization map where the greatest need exists for buffer adoption.

Sociodemographic Objectives

While this biophysical heatmap indicates locations of great ecological need for buffers, the Chesapeake Conservancy's framework lacks indicators of landowner likelihood to adopt buffers from sociodemographic and consumer data. To fulfill this need, our second objective was to link

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[3] We thank Emily Mills, Geospatial Technology Manager at Chesapeake Conservancy, for sharing these data.

[4] Specifically, see Section 4. Precision Conservation Mapping Methods

sociodemographic variables to spatially explicit boundaries on the landscape. To complete this objective, the methodology needed must be able to 1) determine the appropriate resolution of the sociodemographic variables relative to resolution of biophysical variables to further filter parcels, 2) determine the appropriate variables to gather at this scale, and 3) determine the nature of the relationships between these variables as it relates to prioritization. To answer these questions, we chose an analytic hierarchy process (AHP), which is effective in natural resource management decisions regarding site suitability, in this case, determining the best parcels for communication outreach (Banai-Kashani, 1989; Mighty, 2015; Saaty, 2002). The outcome of this process is an equation that addresses subjectivity (Banai-Kashani, 1989), or how qualitative and quantitative factors are weighed in determining the prioritization of parcels. The methods used within this process are outlined below.

Census Data were gathered from https://data.census.gov using the advanced search option. This search option allows for the filtering of variables through table codes, surveys or sources of data, years collected, geography, and topics. Data were first differentiated by geography to access data at the smallest available scale: the block scale. Although a greater diversity of data exists at the coarser block group scale (e.g., education), we decided to use the smallest scale available to best match the parcel-level scale of biophysical data. Furthermore, where the Block Group constitutes a Census Tract containing between 600–3,000 people, the block is delineated by visual (e.g., streams) and non-visual features (e.g., Property lines). Thus, blocks correspond closer to parcel-level data due to these attributes. Available data at the block group scale covers topics ranging from 1) Family and living arrangements, 2) Housing, 3) Populations and People, and 4) Race and Ethnicity. Based on iterative meetings with the literature review team, it was determined that variables of Tenure, Sex, Age, and Population influence the adoption of riparian buffers. These data were then prioritized based on recency of collection, the 2010 decennial census. Data were cleaned for the purposes of transferability into ArcGIS.

AHP Equation Development

Collaboration with the literature review team and the built environment group was integral for completing the analytic hierarchy process (AHP). The utility of the AHP lies in its ability to deal with uncertainty in decision-making processes that have both qualitative and quantitative factors by providing a methodology to examine and correct the inconsistencies in judging the relative importance of variables via expert input (Banai-Kashani, 1989). The experts used within this process were the literature review team, whose knowledge was used to inform the 1) relative importance of the variables described above (Tenure, Sex, Age, and Population) in relation to one another, and 2) determine the priority of the categories within each variable. (For example, tenure is nine times more important than age, tenure is five time more importance than sex, and so on.) Further, because census data contains multiple categories within each variable, an AHP had to be repeated for each variable. For instance, blocks with individuals who have no mortgage

are five times more important than blocks with loans, and nine times more important than blocks with individuals who rent. Stated otherwise, an AHP was used to understand the relationship between the four variables and an AHP was used within each variable of interest (for more details see Saaty, 2002). In total, five AHPs were utilized in consultation with the literature review team. The product of each AHP is an equation that states the relationship between variables. Thus, five equations were created. For more details see Supplemental data.

Once the relationship between and within variables was determined, an output equation of the AHP determined the block suitability for riparian buffer implementation as follows:

$$Site\ Suitability\ Score\ =\ Tenure\ +\ Sex\ +\ Age\ +\ Population \qquad \text{Eq. 2}$$

where each variable is defined by Eq. 3–6.

$$Tenure\ =\ .5368[(No\_Mortgage * .7606) + (Mortgage * .1576) + (Rent \\ * .0816)] \qquad \text{Eq. 3}$$

where *No_Mortgage* is the number of people "free and clear" of their mortgage in a census block, *Mortgage* is the number of mortgage holders in a census block, and *Rent* is the number of renters in a census block.

$$Sex\ =\ .1053[(Male * .8333) + (Female * .1667)] \qquad \text{Eq. 4}$$

where *Male* is the number of males in a census block and *Female* is the number of females in a census block.

$$Age\ =\ .0541[(Young * .1000) + (Mid1 * .2000) + (Mid2 * .3000) + (Older \\ * .4000)] \qquad \text{Eq. 5}$$

where *Young* includes individuals aged 15–35, *Mid1* includes individuals aged 35–54, *Mid2* includes individuals aged 55–74, and *Older* includes individuals aged 75–84.

$$Pop. = .3027[(Low * .5971) + (Mod1 * .2238) + (Mod2 * .1171) + (High \\ * .0601)] \qquad \text{Eq. 6}$$

where *Pop.* is the population in a census block, *Low* is census blocks with ≤ 49 people, *Mod1* is census blocks with 50–99 people, *Mod2* is census blocks with 100–149 people, and *High* is census blocks with ≥150 people.

Within Eq. 3–6, the first value represents the weighting criterion for the relationship between the variables from Eq. 2 (i.e., Tenure, Sex, Age, and Population). Values nested within Eq. 3–6 are the weighting criterion for the factors that exist within each variable (e.g., for Eq. 4, the two

nested values represent the relative weighting criterion between "Male" and "Female"). The higher the criterion weight, the more relative importance it has compared to the other variables. To determine the 'correctness' or validity of the equation, a consistency ratio determined by the inconsistency in judgement is included within each AHP. This must be a value of less than 10%. This value is due to the underlying assumption of the AHP, where inconsistency is expected and all expert judgement must continue to be adjusted with experience (Banai-Kashani, 1989). The highest consistency ratio was 6.22%, therefore demonstrating good consistency in judgment. We applied these equations to each of the 4583 blocks within Centre County (see Supplemental Figure 1 in the Appendix).

Biophysical and Sociodemographic Integration

Our fourth objective was to overlay weighted sociodemographic block data onto biophysical variables to create a refined parcel-level prioritization for riparian buffer outreach. To meet this objective, we performed a case study on Beaver Branch watershed, one of the three prioritized watersheds identified by our stakeholders. First, we classified the Site Suitability Scores from Eq. 2 into tiers (where 1 is low willingness to adopt and 5 is high willingness to adopt) using the geometric interval classification scheme in ArcGIS. Next, the PDF output of the consumer data acquired through the Centre County Conservation District was overlaid on blocks which received the highest willingness to adopt tier. The parcels that emerged represent high consumer willingness for conservation outreach and high willingness to adopt buffers, which were then outlined by hand. Finally, we aligned this map with the biophysical heatmap from Chesapeake Conservancy. This map is provided in our **Deliverables** section. All data layers are summarized in Supplemental Table 3.

Conclusions and Future Directions
The outcome of this GIS pipeline is expected to be the first of many iterations. First, future iterations of this class could duplicate this research to add a temporal dimension. The 2020 census data will be available by Spring 2022, which if repeated, could showcase demographic trends in Centre County. Second, although prior literature and the formal AHP model inform our weighting of census variables, these weightings need validation. This presents an opportunity for future classes to talk with farmers about these variables and their willingness to adopt riparian buffers.

Additionally, through these novel methods, new relationships were formed with stakeholders working to further the sustainability of the Chesapeake Bay, including in the realm of spatial analysis. For example, it was discovered that high quality data at the parcel scale is available to Chesapeake Bay stakeholders that cannot be accessed by this research team due to ethical concerns. However, this inaccessibility may not be representative of non-Penn State affiliated stakeholders working within Centre County (e.g., Allyson Ulsh, Erin Letavich). This research

process has led to the belief that quality of stakeholder connections must increase as data were currently siloed within individual projects that, when integrated, can provide a vital tool to validate the prioritization deliverable (see Supplemental Table 4).

Finally, beyond the scope of LandscapeU, we feel that this GIS pipeline offers a model for future integrative watershed research. A recent critical review of best management practices (BMPs) for diffuse nutrient pollution specifically highlight (1) spatial optimization of BMP locations, and (2) integration of "biophysical data on BMP performance [...] with social and economic survey data on those implementing BMPs and impacted by BMPs" as key known knowledge gaps which warrant future research (Lintern et al. 2020). Our pipeline offers methods for other research groups to attempt this integration through long-term, funded projects.

PROJECT CONCLUSION

In this report we have provided a detailed, in-depth look at the transdisciplinary, iterative mixed-methods approach used by our team to elucidate key intersections of social and biophysical data in the context of Centre County CAP implementation. It is our hope that these data can be used to help CAP organizers build and positive relationships with landowners, as well as provide insights into message crafting and design theory for doing so. Additionally, the creation of the GIS mapping examples and equations provide a long-term, easily updated solution to locating parcels which are likely to have both a high willingness to adopt agricultural BMPs, *and* a high ecological need for doing so.

Taken together, these facets of research have been integrated into a roadmap for improved communication with landowners (see p. 12). Using this tool, CAP organizers can execute GIS mapping to identify key areas for outreach, then utilize included guidelines for communication and messaging to improve likelihood of agricultural BMP adoption in these areas.

Future Directions

While our work here provided significant insight into the process of landowner engagement for BMP adoption, there were a number of limitations that provide opportunity for future directions of research in the area. Limited time, lack of built relationships with landowners/producers, and lack of outside funding restricted aspects of the project, and these areas would benefit from future attention by LandscapeU students and CAP organizers. The following is a short summary of future directions we envision for this communications toolkit:

Deliverables: Future iterations of the CAP communications toolkit deliverables will allow for further tailoring based on demographic information and will incorporate messaging for ideological variance.

Literature: Themes and recommendations identified herein were largely non-specific to the target population of landowners in Centre County, PA. As it is produced, further work regarding this population should be identified to integrate into the review and keep CAP knowledge of BMP adoption in Central Pennsylvania up to date.

Interviews: Interviews herein were done with practitioners and researchers due to time constraints. This allowed us to view a greater depth and breadth of farmer experiences (due to the number of landowners each had engaged with), but risks viewing the agricultural experience through the lens of those from outside the target population. Future iterations of this work will use recommendations of relationship-building, time investment, and provision of services to landowners to allow direct discussion with landowners regarding their thoughts and concerns.

GIS: Future iterations of the GIS/geospatial portion of this project will incorporate updated 2020 Census data (available Q4 of 2021) into the framework. Additionally, data sources beyond the Census and immediate network of stakeholders should be considered.

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Supplemental Table 1. Thematic and Spatial Organization of Key Takeaways from the Literature Review

Category	Themes	Spatial Relevance	Key Takeaways
Perception/ Values	*Aesthetics*	Chesapeake Bay/ Pennsylvania	• Many farmers reported not liking the unkempt look of buffers; many farmers did not mind working with government agencies; most were unaware/uneducated about water resource effects. • Important values for promoting conservation on private property include: aesthetics, trust, and barriers and personal values. "Findings included that most landowners prefer natural looking riparian areas, prefer to work with local nongovernmental and university scientists, and are less trusting of county, state, or federal government" (Weaver & Cole, 2019)
		USA and Canada	• In depth interviews show that farmers are concerned about the visual quality of riparian buffers and whether or not it will make their farm look well managed. Grassy buffers are considered more visually appealing than woody buffers. (Ryan, Erickson & Young, 2003; Chapman, Satterfield & Chan, 2019)

	Identity	Mid-Atlantic/ East Coast	• Assumption: landowners in headwater areas do not perceive their influence on downstream water quality.
			  ○ Landowners with perennial streams seem to hold their own land to higher regard than those with intermittent streams.
			  ○ Landowners with forest/wetland primary cover had more riparian buffer coverage than others.
			  ○ Landowners with weaker perceived efficacy also had more riparian buffer coverage (Armstrong & Stedman, 2020)
			• Attributing personal responsibility to self and others, motivational and resource barriers and influence landowner behavior towards implementation and maintenance of a riparian buffer.
			  ○ Flood risk perception does not have a notable impact on riparian buffer implementation (Allred & Gary, 2019)

		USA and Canada	• Farmers with a 'Conventional farming identity' are found to be less interested in

			implementing agroforestry practices (Arbuckle et. al., 2008)

	Land Values	Mid-Atlantic/ East Coast	• Typical buffer designs often reduce arable land percentage.
			  ○ MCB (multifunctional conservation buffers) offer solutions that support arable land instead of replacing it.
			  ○ There was positive reaction from landowners to MCBs because it reduces soil loss
			  ○ These individuals had supportive peers and higher expectations of MCB performance
			  ○ Landowners also preferred MCBs with fruit or nut bearing trees that grew naturally (Commender, 2016).

		USA and Canada	• It is important to ground conservation programs in locally salient values in order to identify value conflicts between farmers and conservationists (Chapman, Satterfield & Chan, 2019)
			• Riparian buffers are less likely to be adopted if landowners:
			  ○ Have unfavorable attitudes toward trees
			  ○ Are motivated by economic factors
			  ○ Have negative perceptions of the current design of government payment programs for establishing trees in riparian areas
			  (Rhodes, Aguilar, Jose & Gold, 2016)
			• Farmers are motivated by intrinsic motivations such as love for the land and conservation values. Some farmers may also be motivated by a concern for their neighbors and the effect of polluted streams/ soil erosion on others (Ryan, Erickson & Young, 2003)

Implementation Support	*Financial/ Technical Resources*	Chesapeake Bay/ Pennsylvania	• Landowners need to know that a practice is profitable (e.g., information on how to access markets for agroforestry products from multifunctional riparian buffers) • Landowners need financial incentives (e.g., many landowners were interested in buffers but could not "afford to experiment"). Consider providing mini-grants to create demonstration sites on farms that are used for tours (Strong & Jacobson, 2005)

		Mid-Atlantic/ East Coast	• Most influential drivers of the program were cost-share assistance and water quality
			  ○ 251 members of study were sent a survey, 54% response rate
			    1. 23.4%: discontented or doubtful about buffer integration; experienced financial and maintenance issues previously [doubtful as well of environmental benefits]
			    2. 28.2%: contented and confident respondents; experienced minimal financial and maintenance issues, and were confident of environmental benefits
			    3. 22.6%: burdened but benefitted; lots of environmental benefit but lots of maintenance challenges as well
			    4. 25.8%: not convinced their buffer provides environmental benefits, but no problems with cost and maintenance
			  ○ 1, 3 & 4 are less likely to keep buffers after contract as compared to 2
			  ○ 1 & 3 had larger full-time parcels, 2 & 4 had smaller part-time parcels (Commender, et al., 2020)

		USA and Canada	• Farmers want financial assistance to implement buffers, but aren't always aware of existing programs or there may be too many land use restrictions. They also want technical implementing and maintaining the buffers, keeping in mind they are full time farmers without time to put into tree care (Rhodes, Aguilar, Jose & Gold, 2016) • Farmers are also concerned about the profitability of buffers and how they may harm profitability of their land or impact existing practices (e.g., trees negatively impacting crops or being obstacles for farm equipment) (Valdivia et al., 2012)
		Meta-analysis	• In a review of 46 studies, it was found that financial factors including capital and % income from farming have significant impacts on BMP adoption (Baumgart-Getz, Prokopy, & Floress, 2012)
	Educational Resources	USA and Canada	• Educational resources do not always take into consideration local community knowledge, which sometimes conflicts with science-based rules. It is important to recognize the knowledge farmers bring to the table (Chapman, Satterfield & Chan, 2019) • Knowledge of riparian buffers is a significant variable in willingness to adopt

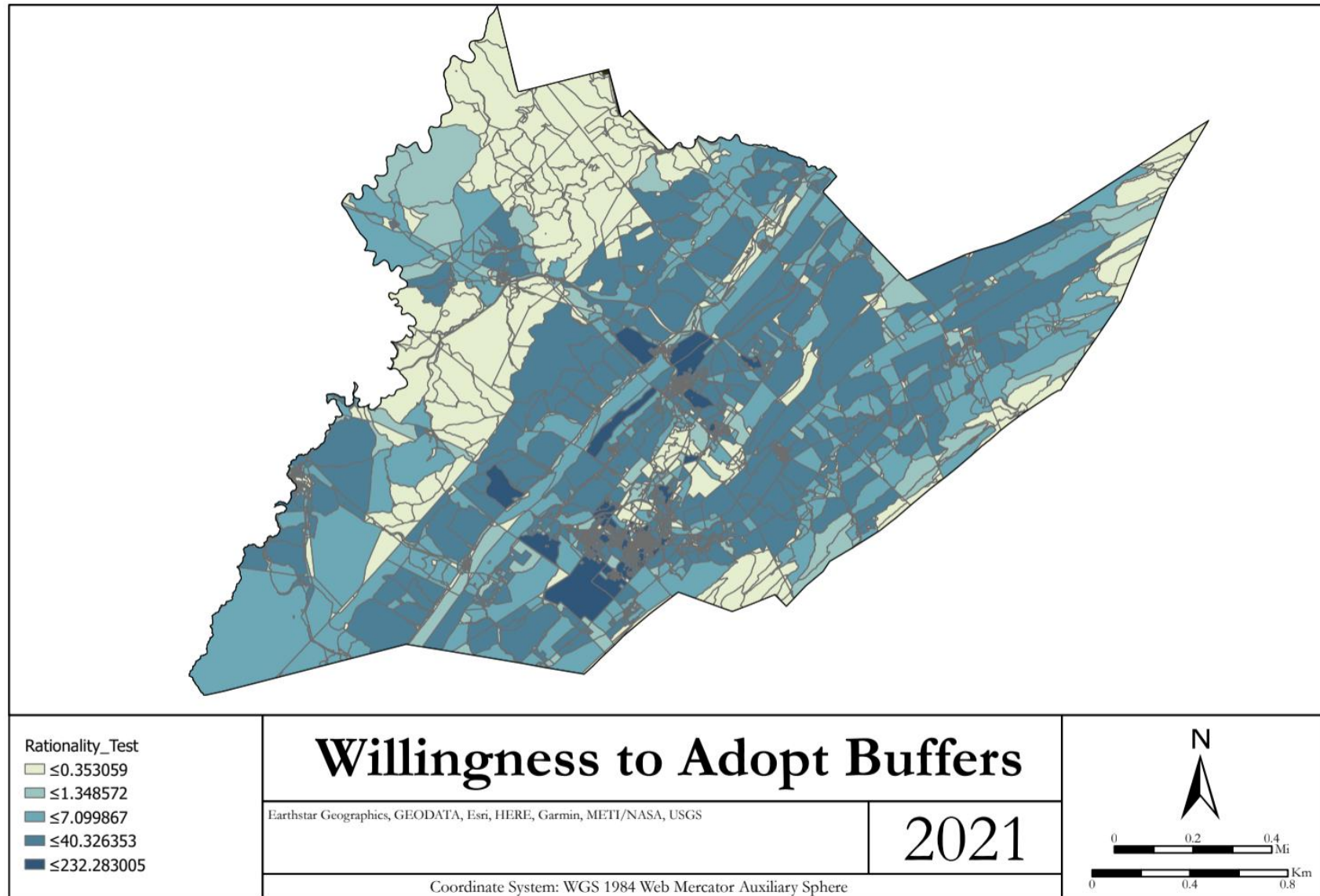| Stakeholder Information	Landowner Characteristics		
			• buffers (Valdivia et al., 2005) • Riparian plantations had lower respondency on behalf of landowners because of the lack of information on them (Matthews et al., 2004)
		Meta-analysis	• In a review of 46 studies, it was found that both access to and quality of information about BMPs had significant impacts on BMP adoption. Further, they found it more effective to communicate the farmer's individual impacts on water quality rather than general farm impacts (Baumgart-Getz, Prokopy, & Floress, 2012)
Stakeholder Information	*Landowner Characteristics*	Chesapeake Bay	• Landowner who recently engaged with buffer installation outreach programs showed a 66% increase in response to a riparian restoration survey compared to a control group (Metcalf, Angle, Phelan, Muth, & Finley, 2019) • Landowners that are members of informal organizations (e.g., PASA and WOA) are generally interested in agroforestry adoption, including forested riparian buffers (Strong & Jacobson, 2005)
		USA and Canada	• Older farmers were less interested in adopting riparian buffers (Valdivia et al., 2005) • Age, gender, farm operation and farm size were not correlated to the adoption of agroforestry systems (Matthews et al., 2004)

		Meta-analysis	• Across 32 studies from 21 different countries:
			  ○ Average education of a household was only significant in 40% of the studies
			  ○ Average age of household members or age of head of the household was only significant in 24% of the studies
			  ○ Gender, measured by proportion of males in the household was significant in 60% of the studies, although this could be reflecting the availability of financial resources
			  ○ Membership in a community org. Or cooperative positively predicted adoption in 40% of the studies (Pattanayak, Mercer, Sills, & Yang, 2004)
			• In a review of 46 studies, it was found that

			○ Older farmers are more likely to adopt BMPs ○ Overall education is not a significant predictor of adoption, but participation in BMP education programs is ○ Greater % Income from farming has a positive impact on adoption (Baumgart-Getz, Prokopy, & Floress, 2012)

	Non-landowner Involvement	Mid-Atlantic/ East Coast	• From 19 interviews conducted in the upper potomac watershed, it was concluded that:
			  ○ Riparian forest outreach needs to include face-to-face interpersonal connections between landowners and practitioners
			  ○ Communicating through networks of partner organizations can facilitate the personal element by leveraging trusted networks
			  ○ Word-of-mouth referrals from peers are very important to farmers
			  ○ One-on-one conversations are the most important communication channel followed by peer learning events, tours of forest buffers, workshops, and written content (Boone, 2019)

Supplemental Table 2. Integration of findings from Interviews and Literature Review

Recommendations Based on Interviews	Recommendations Based on Both	Recommendations Based on Literature Review
Don't Try to 'Convince' Landowners • Behavioral adoption is a long process of shifting perceptions, values, and beliefs, which emerges out of reciprocal engagement • Providing more information about financial or other benefits is only a small part of behavior change • Ask questions and listen to farmers, don't tell **Illicit Farmer Feedback** • Pitch your program to farmers for feedback on your program and engagement approach	**Address Farmer Concerns** • Aesthetics • Farmer Reputation • Program Inflexibility • Implementation and Maintenance Assistance **Frame Approach to Match Landowner's Needs and Values** • Identify converging interests between landowners and conservationists • Identify and address value conflicts between landowners and conservationists • Never assume landowner values – always ask and engage in a conversation about them • Consider and understand the landowner's perspective **Actively Reach Out to Farmers** • Face-to-face interpersonal connections are key • Meet farmers where they are; meet them on their farm and in their fields • Go to meetings in the farming community, create your own communities or meetings • Be present and available, but not overbearing • Don't just jump in with an aggressive sales pitch, make room for conversations and relationship building	**Target Farmers with previous engagement** • Landowners who recently engaged with buffer installation outreach programs are much more likely to respond to outreach regarding implementation • Target landowners who are part of organization (e.g., as PASA, WOA, or other sustainable ag. Organizations) **Demographics** • Age: Older farmers are generally less interested in adopting buffers, although this is only somewhat associated with buffer adoption

Change Messages Based on Ownership vs. Renters
- Recognize that landowners vs. renters may have different priorities or values
- Among renters, how much they are willing to invest in the land will change depending on the length of the lease

Working with the Amish
- Much harder to work with financial incentives
- Find creative solutions, won't take direct money, but might take supplies to implement the BMPs

Direct Mailers
- Mailers can be useful to get your foot in the door, but should be followed up with face-to-face engagement
- Mailers should not be the most important part of your engagement strategy

Identify 'Trusted Messengers'
- Communicate through networks of partner organizations to facilitate trust and relationship building
- Utilize word-of-mouth referrals from farmers' peers
- Have trusted allies put their name on advertising materials
- Be aware of who is reaching out, if there is a lack of trust in government organizations, don't have those organizations be the point of contact

Respect Farmer's Specialized and Local Knowledge
- Recognize the knowledge farmers bring to the table, even if it conflicts with science-based rules
- Don't assume farmers are uneducated about BMPs
- Don't go in with an "I'm going to teach you what's best" approach
- Recognize and incorporate what farmers are already doing on their land

- Average level of Education: only moderately associated with buffer adoption
- Greater % income from farming has a positive impact on adoption

Supplemental Figure 1. Output of GIS Rationality Test for all Census Blocks in Centre County, PA

Rationality_Test
☐ ≤0.353059
☐ ≤1.348572
☐ ≤7.099867
☐ ≤40.326353
☐ ≤232.283005

Willingness to Adopt Buffers

Earthstar Geographics, GEODATA, Esri, HERE, Garmin, METI/NASA, USGS

2021

Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere

N

0   0.2   0.4
Mi

0   0.4   0.8
Km

Supplemental Table 3. GIS data layers and sources

Data Category	Data	Source
Boundary	County	https://gisdata-centrecountygov.opendata.arcgis.com/
	Municipality	https://gisdata-centrecountygov.opendata.arcgis.com/
	Watershed	https://gisdata-centrecountygov.opendata.arcgis.com/
	Census Block Groups	https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html
	Census Blocks	https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html
	Parcels	https://gisdata-centrecountygov.opendata.arcgis.com/
Biophysical	SSURGO Soils	https://gisdata-centrecountygov.opendata.arcgis.com/
	Hydrography	https://gisdata-centrecountygov.opendata.arcgis.com/
	Impaired Streams	https://gisdata-centrecountygov.opendata.arcgis.com/

	Land Use	https://gisdata-centrecountygov.opendata.arcgis.com/
	Ag. Security Parcels	https://gisdata-centrecountygov.opendata.arcgis.com/
Sociodemographic	Age	https://data.census.gov/cedsci/
	Population	https://data.census.gov/cedsci/
	Sex	https://data.census.gov/cedsci/
	Tenure	https://data.census.gov/cedsci/
	Urban and Rural	https://data.census.gov/cedsci/
Prioritization	Precision Conservation	Chesapeake Conservancy(See Table G2.)
	Consumer Marketing	University of Montana (See Table G2.)

Supplemental Table 4. Key "players" in current riparian work via Chesapeake Bay GIS Specialist networking

Name	Organization	Contact
Ryan Davis	Forests Program Manager, Alliance for the Chesapeake Bay	rdavis@allianceforthebay.org
Matt Ehrhart	Stroud Water Research Center	mehrhart@stroudcenter.org
Adrienne Gemberling	Senior Project Manager, Chesapeake Conservancy	agemberling@chesapeakeconservancy.org
Erin Letavic	Civil Engineer and Project Manager, Herbert, Rowland & Grubic, Inc.;	eletavic@hrg-inc.com
Alex Metcalf	University of Montana	alex.metcalf@umontana.edu
Brenda Sieglitz	Senior Manager, Keystone 10 Million Trees Partnership Chesapeake Bay Foundation	bsieglitz@cbf.org
Teddi Stark	Watershed Forestry Program	c-tstark@pa.gov

	Manager, PA DCNR Bureau of Forestry	
Alysha Trexler	Western PA Conservancy	water@paconserve.org
Dave Wise	Stroud Water Resource Center	dwise@stroudcenter.org