FUNDING NATURE-BASED SOLUTIONS: FORESTLAND WATER QUALITY NEXUS

Developing a roadmap for an ecosystem services incentive program within the Upper Oconee River Watershed in Georgia, USA

by

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Abstract

Ecosystem services are being degraded in part due to their lack of inclusion in economic decision making. Payment for ecosystem service (PES) programs can be utilized to protect both forest land cover and its impact on water quality and flow. In the Upper Oconee River watershed in Georgia USA, such an incentive program would link forest landowner's supply of clean water to prevent increased expenditures for local water utilities who could then use these savings to fund forestland best management practices. This project was developed through four phases, 1) Literature and Case Study Review of water-based PES programs and ecosystem valuation 2) Interviews and surveys with Oconee stakeholders, 3) Stakeholder analysis using PMID framework, 4) Spatial analysis identifying HUC10 watersheds to prioritize in a pilot program. Key findings include a roadmap for the structure, pricing mechanism, legal instrument and stakeholder involvement design that fits the local context and ensures successful implementation.

Executive Summary

Ecosystem services are being degraded in part due to their lack of inclusion in economic decision making. Payment for ecosystem service (PES) programs can be utilized to protect both forest land cover and its impact on water quality and flow. In the Upper Oconee River watershed in Georgia USA, such an incentive program would link forest landowner's supply of clean water to prevent water utility expenditures which can fund forestland best management practices; the Georgia Forestry Foundation is interested in creating these forestland incentives.

The goal is to implement a PES program to maintain water quality and combat pressures from development by ensuring forest landowners generate enough income to "keep forests forests." Forests provide a variety of ecosystem services, with timber and water being the two most important ones that have a significant impact on the economy[1]. There is a clear link between deforestation and decreased water quality, as forest loss leads to increased soil erosion by up to 40 tons per hectare per year[2]. Eventually, the level of sedimentation going to the intake point of water-consuming companies could pass a threshold level and the accumulated external cost could render their operation too costly[3].

For the PES, it is necessary to determine what the sellers need to receive for the ecosystem service in order to change their behavior to conserve it. It's important to understand the costs that landowners are incurring for the behavior change, and how much they are willing to accept for it; if the payment is not sufficient to cover these additional costs, the scheme will likely not succeed.

[1] Mohd Shahwahid *et al* (1997)
[2] Arias *et al* (2011).
[3] Mohd Shahwahid *et al* (1997)

Research Question: What is the most appropriate way to design a PES program for the Upper Oconee watershed that ensures long term success in preventing forestland conversion by meeting stakeholder priorities? *Goals:* To leverage previous work and provide recommendations for the implementation of a PES program in the region, considering examples from other PES programs and Land Management Service Agreements, as well as regional context.

Methodology:

We designed the Oconee River Watershed PES roadmap through four phases: 1) Literature Review and Case Studies; 2) Willingness to Pay and Accept Surveys and Stakeholder Interviews; 3) Stakeholder Analysis; and 4) Spatial Analysis of HUC10. The first two phases consolidated background information, informed design choices, and evaluated local stakeholder interest. The last two phases analyzed stakeholder categories, influence and interest followed by identifying priority locations in the watershed.

Recommendations:

We propose implementing a PES program in the Oconee Watershed that covers participating landowner costs, and funds for these payments are supplied by future cost savings from water utilities and minimal increases to ratepayer bills. Our main recommendations are:

1) *Hire* a new PES coordinator who can revitalize work completed by the Oconee River Watershed Partnership (ORWP) and work together to complete a PES strategic plan.
2) *Plan & engage* stakeholders to develop and agree upon an initial framework for the PES program. This design could be most successful by utilizing LMSA's and consistent funding from small ratepayer increases. We recommend engaging all the stakeholder groups identified in the PMID analysis.
3) *Government cooperation* could be a critical source for both technical assistance and grant funding; this important stakeholder has not been sufficiently engaged.
4) *Water flow* is seen as a bigger issue by water utilities, and as such, a transition from discussions around water quality to water flow may be an easier way to engage them.
5) *Location* for a pilot PES program should be one of the priority HUC10's identified through the spatial analysis. We recommend starting with Athens-Clarke County Water administrators. This pilot can then be replicated and scaled up to cover more areas.
6) *Toolkits and Resources* were consolidated to be provided to the PES coordinator to orient them to the challenges and potential solutions in implementing a PES program within the Oconee. The stakeholder Step-by-Step guide and TNC water funds toolkit will be important roadmaps to follow. Consolidated literature resources can provide the scientific basis to engage policy makers and non-governmental collaborative organizations.
7) *Funding* will be important. Once the planning processes are completed and implementation begins, designing a PES system to allow for consistent funding will be critical. Many resources for watershed scale planning and collaboration exist at the federal level. The most successful PES case studies involved funding from government sources.

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Introduction

Contextualizing the Problem

According to the United Nations Millennium Assessment Report in 2005, human wellbeing is directly tied to ecosystems. However, human activities cause degradation to the natural environment and therefore limit wellbeing; as such, the UN emphasizes that they must be protected urgently. Ecosystem services are divided into four categories: provisioning, regulating, cultural and supporting. These include services such as food, fiber, air quality, climate regulation, spiritual and religious as well as soil formation and photosynthesis. Forests, for example, can provide timber, recreation, greenhouse gas capture, water quality and quantity and pollination. This project will focus on the protection and conservation of these ecosystem services in the forests of the state of Georgia, United States.

In terms of its land use, geology, precipitation and biodiversity, Georgia is very diverse, with up to 400 unique species of trees. Georgia's watersheds are extremely important for the state, as 60.5% of them are used for drinking water; as such, it can be implied that its forests play an extremely important role in the availability and quality of water for residents and visitors.[4] For this to continue, maintaining a forest cover is imperative and is an important factor on water.[5] Georgia has 36.6 million acres of land, of which around 60% is forest; it is the number one state in the country for forestry.[6] However, urban areas are rapidly growing and posing an important threat to forests; Bryan County, for example, is the 6th fastest growing county in the country[7]. Urban development in the state has increased by 2.35 million acres in a 30-year period, mostly taking over forested land. An additional 2-million-acre loss is projected to happen between 2030 and 2060 due mostly to urban development, with 55,5000 acres being lost annually already.[8] Economic signals have been extremely important in the degradation of forest and land use change, and in Georgia forestland conversion to developed land has been a strong trend. One of the main drivers are "the economics of land values and development costs" therefore, a key consideration for conservation and resource management efforts has to be how the market influences land use change based on the cost and benefit of different land uses.[9]

Of this forest, the vast majority is privately owned (22 million acres), making engagement with private landowners extremely important for the success of payment for ecosystem service (PES) program implementation.[10] One of the main challenges of the

[4] Fernholz and McFarland, 2021
[5] Fernholz and McFarland, 2021
[6] Nick DiLuzzio. (2023). Interview, Georgia Forestry Foundation
[7] Nick DiLuzzio. (2023). Interview, Georgia Forestry Foundation
[8] Greene et al 2018.
[9] Fernholz and McFarland, 2021
[10] USDA (2021).

implementation of a PES program in this context is aggregating the different interests of the landowners and the water utility companies. There are three main types of owners, with the majority being private individuals (55%), corporate owners (29%) and lastly forest industry (6%). However, it is alarming that the ownership by individuals and forest industry actors is decreasing, while corporate ownership is increasing, giving way to Real Estate entities.[11] This indicates that understanding costs and pressures private landowners face along with how best management practices can be incentivized will be critical to this project.

Payment for Ecosystem Services Programs as a Solution

The concept of PES programs has been evolving over the last 20 years, acknowledging the role of natural systems as providers of goods and services to humans. One of the first examples of this was a PES program in 1996 in Costa Rica, which had the objective of reforesting an important part of the country. Due to its success and longevity, this scheme has been studied, replicated and improved around the world.[12] PES programs can be used in conservation and natural resource management to reach environmental goals by using market-based mechanisms, thus placing an economic value on non-market goods and services. The United Nations Millennium Assessment Report (2005) states that "because many ecosystem services are not traded in markets, markets fail to provide appropriate signals that might otherwise contribute to the efficient allocation and sustainable use".[13] These mechanisms are important to protect natural resources, which are being depleted at alarming rates, leading to negative consequences for both the natural and the human environment.

The implementation of a PES program to protect water quality in this region is extremely important, considering the importance of ecosystem services provided by forests and the richness of these in Georgia. The Georgia Forestry Foundation (GFF) has the goal of helping landowners keep their forests as forests, and as such developed a report in 2021, carried out by Dovetail Partners, titled "Understanding Payment for Ecosystem Services: Opportunities for forests, water, and private landowners in Georgia and the Southeastern United States." This was aimed at broadening the understanding of PES programs in the region, identifying opportunities, and increasing engagement with landowners. The previous research is meant to inform the development of a roadmap to lead to the implementation of a PES program. This research identified that the first stage of implementing a PES program was to build momentum, the second one is the design of the program, and the third one is the implementation of the plan.[14] Five watersheds within Georgia were then analyzed to determine their readiness level, with the Upper Oconee watershed being the most ready to do so; the project, therefore, will focus solely on this one.

[11] USDA (2021).
[12] Fernholz and McFarland, 2021
[13] Fernholz and McFarland, 2021
[14] Fernholz and McFarland, 2021

Client background

The Georgia Forestry Foundation is the non-profit arm of the Georgia Forestry Association, a timberland trade and advocacy organization. GFF focuses on protecting the state's 22 million acres of working forest and ensuring their longevity. They do this through demonstrations of the working forests' importance, and connecting people to this. One of their programs is focused on the forest and water connection- highlighting the importance of forests to clean water as over 60% of Georgians rely on drinking water that flows through forests.[15]

GFF has been working for several years on a project highlighting the forest and water connection, with the ultimate goal of launching a payment for ecosystem services market around water in Georgia as a way to help landowners keep their forestland as forests. Last year, GFF completed a state-wide report looking at 5 watersheds across the state and the potential for a PES market. The report concluded that the Upper Oconee Watershed was the closest to getting a program up and running.[16] This project will build on existing work in the state by synthesizing work that has been done and specifically focusing on the Upper Oconee watershed.

Research Question: What is the most appropriate way to design a PES program for the Upper Oconee watershed that ensures long term success in preventing forestland conversion by meeting stakeholder priorities?

Goal: To leverage previous work and engage with the already active stakeholder group in the Upper Oconee watershed to provide recommendations for the implementation of a PES program in the region, considering examples from other PES programs and Land Management Service Agreements, as well as regional context.

Objectives

1. Determine what changes in water quality create or decrease value to water utility
2. Identify distinct Occone-specific forest management best practices for water quality
3. Adaptable to stakeholder priorities in a step-by-step implementation plan
4. Understand economic incentives and most appropriate market mechanism

Materials and Methods

We conducted a mixed method approach to address our project goals, which included 4 phases. The first two phases gathered background information and the second two applied that information to the Occone watershed context.

[15] Fernholz and McFarland, 2021
[16] Fernholz and McFarland, 2021

Phase 1) Organizing a literature review to consolidate existing research on PES systems generally, followed by an analysis of 16 case studies on PES and water quality markets.

Phase 2) Designing Willingness to Pay & Willingness to Accept Surveys, followed by remotely conducted interviews of Oconee River watershed stakeholders (including utilities, landowners, partnership coordinators, government administrators, etc.).

Phase 3) Performing a stakeholder analysis with Project D Pro: Project Management for Development Professionals Guide methodology to understand interest, influence, and inform a Step-by-Step PES Implementation Guide.

Phase 4) Evaluating locations for a pilot program through an ArcGIS analysis to determine priority areas within the watershed.

Phase I. Literature Review & Case Study Methodology

We reviewed over 35 academic works and 16 PES case study literature to understand what peer-reviewed research existed around sample pricing and governance structures for water quality PES systems. In addition to peer—reviewed research, we also reviewed consulting reports, watershed management and prioritization maps, the The Nature Conservancy (TNC) water funds toolbox, environmental agency websites - including the Georgia environmental protection division, and conservation-oriented nonprofit documentation. Through this research and literature review, we focused on understanding key takeaways and best practices that could inform development of an Oconee watershed program.

We gathered our literature review and case study research through searches for PES systems in google scholar, literature recommendations from stakeholder interviews, and the research library provided by the SE partnership for forests and water. Understanding that this information could prove valuable to future PES implementers in the area, we consolidated papers into a google folder and key websites into the references list in the appendix A.10.

Phase II. Stakeholder Interview & Survey Methodology

In order to understand the local context, existing water quality challenges, and forest landowner priorities, we conducted 13 virtual stakeholder interviews over the course of 6 months. Each interview was approximately 1 hour, and was structured in a way to understand each stakeholder's interest in and recommendations for a PES program. Stakeholders were identified through our literature review, conversations with our client, online research on water utilities and nonprofits, and recommendations from other interviewees.

Stakeholder interviews included: external subject matter experts, regional trade associations, landowner groups, regional environmental partnership associations, non-profit organizations, local consulting foresters, and local water utility managers. A full list of interviewees and key takeaways can be found in the appendix A.3

We designed a series of willingness to pay and willingness to accept surveys to understand attitudes around water quality ecosystem services. These surveys were designed for two key groups: 1) Willingness to pay for the 'payers' - which includes drinking water treatment plants, hydropower utilities, and large water using corporations 2) Willingness to accept for 'payees' - which includes forestland owners. Appendix A.5 has samples of the specific questions asked in the surveys.

We contacted 33 water utility contacts, 100 forest landowners, 1 landowner association and the Georgia Association of Water Professionals, who relayed the message to their participants. We received responses from 3 water utility stakeholders and 8 landowners. Unfortunately, due to this limited engagement we were unable to gather enough information to complete a comprehensive review of the watershed. However, information received through the surveys was supplemented with stakeholder interviews - with 2 water utility representatives (Barrow County and Oconee County administrator and wastewater plant supervisor) and 1 representative from Forest Resource Consultants who could speak to regional landowner timberland management costs.

For Payers: We designed 3 separate surveys - one each for drinking water utilities, hydropower utilities, and large water using corporations. All surveys included 19 questions to indicate their willingness to participate in a PES program to avoid cost increases as forestland converts to other land uses. Questions referenced possible damages or incurred costs from lower water quality, current maintenance costs, knowledge of the forestland-water connection, and sample incentive prices for such a program.

For Payees: We designed 2 separate surveys for forest landowners with A&B testing to understand if willingness to accept prices would differ if they were asked before a discussion on current costs or after. Both surveys included 32 questions to indicate their willingness to participate in a PES program to protect water quality and prevent forestland conversion to other land uses. We aimed to understand if participation in the PES program would need to ensure that their marginal benefit from the payment from ecosystem services is higher than their marginal cost. Survey questions referenced costs incurred to conserve water quality through management actions, forest composition type, average harvest rotations and income, preferences around land management service agreements, and sample prices for participation in a program.

Phase III. Stakeholder Analysis Methodology

The Project D Pro: Project Management for Development Professionals Guide was used to develop the stakeholder analysis. The first step was identifying and analyzing the stakeholders related to the program, through secondary research as well as interviews. The stakeholders were then divided into 6 categories (users, governance, providers, influencers, dependents, sustainers) to understand the level of engagement that should be used with each. Afterwards, a Stakeholder Matrix was created to identify and elaborate on the interests and capacity of those who will potentially participate. Then, a Stakeholder Venn Diagram was created to illustrate the nature of the relationship between stakeholders, through the perspective of a key group in the project (in this case, forest landowners). Forest landowners were chosen as a key stakeholder, as they are both the providers and the beneficiaries of the program. Using these two tools, an Interest/Influence matrix was created to visually map who are the stakeholders with the most influence and the most interest, and as such identify opportunities for engagement. Based on this matrix, the engagement strategies were categorized into four: keep satisfied, engage closely, monitor and keep informed.

Phase IV. Spatial Analysis Methodology

A place-based analysis was conducted to identify priority locations at the HUC10 scale for a pilot PES program. An index was created in ArcGIS utilizing 3 main components: 1) drinking water intake locations and reservoirs, hydropower plant locations, and sawmill locations 2) current landuse/landcover data for the Upper Oconee River watershed 3) water flow data. We began by mapping water flow and HUC (hydrologic unit code) boundaries at the HUC8 and HUC10 scale to define management boundaries. Since our PES system is focused on water quality, we mapped out intake locations for drinking water and hydropower. Although water quality and forest cover is important for stormwater management and regulating water flows, stormwater treatment plants were excluded from the analysis. Once management areas and intake locations were identified, land cover types were added as a proxy for forestland conversion risk. Forestland properties at higher risk of conversion were hypothesized to be closer to urbanized areas and farther away from timber-processing mills. Forest cover and developed cover types were used to determine if a HUC 10 was below the 60% forestland threshold or at risk of falling below that threshold.

An index was created to prioritize HUC10 locations though a ranking of 1-4 with 4 as most preferred and 1 as least preferred. Layers used for the index were analyzed at the HUC10 scale and included:

1. Percentage of developed land (USGS Codes: Developed Open Space, Developed Low Intensity, Developed Medium intensity, and Developed high intensity)

2. Percentage of forested land (USGS Codes: Deciduous Forest, Evergreen Forest, Mixed Forest, Woody Wetlands)
3. Number of drinking water intake locations (EPA FRS registered intakes and utility identified reservoirs)
4. Number of sawmills. Locations of sawmills were geo-referenced from an excel list of addresses.

These rankings were summarized to create a combined score. Once each HUC10 had a score, these scores were indexed from 0-3 with 0 as no priority, 1 as low priority, 2 as medium priority and 3 as high priority locations. Areas with a high percentage of protected forest cover as identified by the USGS were deprioritized. Data for this analysis was obtained from sources listed in the table below:

Source	Data
Georgia's Environmental Protection Division's Watershed protection branch	● Drinking water permit holders for surface and groundwater ● Wastewater permit holders ● Water supply watershed maps for the Upper Oconee ● Drinking water/public water system permit list ● Non-Farm surface water withdrawal permit list
Georgia Forest Commission's Wood-using industry directory	● Forest product manufacturer locations (including timber mills) form 2019 data ● Logging haul distances summary document as part of the Timber Product Output Survey
Georgia Power	● List of generating plant locations
US. EPA	● Safe Drinking Water Information System (SDWIS) filtering registrants for the 18 Oconee counties ● EPA Facility Registry Service (FRS) for the Upper Oconee River HUC8 filtering for 'drinking water programs'
U.S. Census Bureau TIGER	● GA State Boundaries ● GA County Boundaries
United States Geological Survey, USGS	● National Hydrography Dataset for HUC boundaries, streams and wetlands

	• National Land Cover Dataset (NLCD) to identify current land uses for developed and forested land cover types. • Protected Areas Database of the United States (PADUS) for locations already under forestland protection.

Findings

Literature Review Findings

People and communities depend on healthy ecosystems for the services they provide, such as clean water, clean air, food and timber, among others. However, these services are usually either undervalued or not valued at all, leading to their overexploitation and degradation. Market-based mechanisms can mediate the supply and demand of these services by assigning, or letting the market assign, a value to them. Many conservation programs aim to change the behavior of landowners so that they conserve, restore and manage the land in a sustainable manner so that these ecosystem services can continue to be provided[17]. To change their behavior, prescription, penalties, persuasion, property rights, or payments can be used. Of these, payments are the only mechanisms that "recognizes the situation for what it is" by placing a value on the provision of services that are clearly valued by the consumer through an explicit arrangement of payment for these[18]. A Payment for Ecosystem Services (PES) is one approach to payment schemes; there are a variety of structures to achieve this, but at its core, beneficiaries pay landowners to conserve the ecosystems. Typically, these focus on one single ecosystem service, but there can be "bundled services" such as water quality and biodiversity, although these are harder to quantify and therefore more challenging to implement and monitor. In the US, the most well-established PES are of carbon, endangered species, wetlands and watershed services; globally, however, "markets for watershed services compose the largest category of payments for ecosystem services in terms of annual transaction values"[19].

These programs can be organized in three different ways: market, project or site. A PES market facilitates transactions between multiple buyers and sellers, and the price is determined by the market itself, with multiple negotiations and actors working at the same time. On the other hand, a project is focused on a specific site with determined buyers and sellers (usually a single buyer and a single seller) and specific goals. Moreover, a voluntary market is one where buyers

[17] US EPA, O. (2015, February 10). *EnviroAtlas* [Collections and Lists].
[18] Salzman, J. (2005). Creating Markets for Ecosystem Services: Notes From the Field. New York University Law Review, *80*.
[19] US EPA, O. (2015, February 10). *EnviroAtlas* [Collections and Lists].

are not driven by regulation but rather seek to have best practices and more sustainable operations[20]. An example of this are voluntary carbon markets, where there are multiple protocols to create carbon credits, and a variety of projects to achieve this; the buyers and sellers agree on prices for the credits and there is an average price but the market simply facilitates the transactions.

Similarly, there are five mechanisms that can be used in these markets. Trading and offsets are used to standardize a credit of a unit of the service, for example a biodiversity credit, and can be bought or sold more easily. Bilateral agreements are when a single buyer signs contracts with one or more landowners and pays them directly for the ecosystem service; the terms of the agreement are negotiated between the two parties and do not necessarily involve valuing the service itself. With collective action funds, multiple actors come together and pool their resources to fund ecosystem conservation through the fund. On the other hand, governments can use public subsidies to pay landowners to conserve their land instead of producing a commodity such as crops or timber. And finally, environmental water markets are used where existing markets for water rights exist, and these are accessed to buy water that is not used and therefore left in nature[21]. Salzman (2005) further identifies two more mechanisms, which are reverse auctions where landowners provide sealed bids on their willingness to accept for changes in land use management through a publicized competition, and the government or buyer can decide on the best bid. The other is paying a third party, like a local non-governmental organization (NGO), to then distribute the funds to the landholders; this is similar to establishing a fund, but it is done by the buyers to ensure a proper distribution of the funds.

As can be seen, there are a variety of ways in which PES programs can be structured, and this flexibility allows for them to be adapted to the local context in a way that ensures their success. However, this amount of options can also make their implementation challenging. To further the success of nascent programs, some enabling conditions must be met; there must be a clear understanding of what the service is, how it is provided and who the providers and beneficiaries are. There must be a discrete number of consumers and providers of the service, with clarity on who they are and what their role in the program will be (as well as their willingness to participate). Moreover, there must be a clear understanding of the biophysical service that is being provided, and what the pathway for that supply would be. In line with this, the amount of service required needs to be determined, as well as an understanding of how this level of service will be provided in a sustainable and long-lasting way. In addition, it would be preferable to have a heterogeneous landscape in which discrete land use changes will clearly provide additional services[22]. On the policy side, it is clear that "the government has a critical role to play in ecosystem service provision,"[23] as they can support the development and

[20]An Atlas of Ecosystem Markets in the United States. (2017).
[21] An Atlas of Ecosystem Markets in the United States. (2017).
[22] Salzman, J. (2005)
[23] Salzman, J. (2005)

monitoring of ecosystem markets through policy. One example is using PES for regulated parties to meet environmental compliance, both through regulated and voluntary markets; such is the case for wetland mitigation credits to comply with the Clean Water Act. Moreover, governments can explicitly promote ecosystem markets through local, state or even federal policy. They could also provide guidance and issue recommendations for the implementation of PES markets; even if not binding, this sends a strong signal to sellers to invest in such programs[24]. Of course, there are many obstacles to implementing PES programs, including institutional block themselves, as bureaucracy to implement new markets can be extensive and more often than not, political jurisdictions are not aligned with ecological significant areas (for example, a watershed may span multiple counties or even states, and coordination between these different governments can often be difficult). Additionally, because ecosystems are public goods, it can be challenging to spur collective action and get all actors involved and actively participating[25]. One of the main challenges, however, is identifying the right price that buyers are willing to pay and sellers are willing to accept; it is important to consider that PES schemes, in order to be successful, need to generate payments that allow landowners to cover the expenses of managing the ecosystem. It is critical to understand a price that would ensure the suppliers of the service keep supplying it; this needs to be higher than their opportunity cost of not engaging in exploitation activities where they would get paid for commodities[26].

Key findings were also informed by previously commissioned work from GFF, regional watershed planning documents from the GA Environmental Protection Division, and conservation and restoration priorities from the University of GA. All of these works should be leveraged when designing the Oconee PES pilot program. Dovetail Partners through a GFF partnership conducted a series of landowner engagement workshops which highlighted interest and appetite for a water quality incentive program in the region however this appetite should be tempered by our interview response from water utilities who indicated an unwillingness to participate. This report also identified key PES enabling conditions such as an active coalition of partners, agreed upon challenges (water quality changes with increased sedimentation and nutrient loading due to conversion to development) and solutions (protecting forest cover).[27]

Other key enabling conditions for the Oconee were matched from the TNC water funds toolbox, including multi-stakeholder governance, clear objectives, science-based watershed priority identification, and initial funding through federal planning grants.[28] This toolkit also outlined a 5-phased project cycle to develop a water program that should be utilized by the new coordinator. This cycle included - Feasibility (for a water program to solve a water challenge), Design (a regional collective action platform), Creation (to formalize and publicly launch the

[24] An Atlas of Ecosystem Markets in the United States. (2017).
[25] Salzman, J. (2005)
[26] Arias *et al* (2011).
[27] Fernholz and McFarland, 2021
[28] The Nature Conservancy (2023) Water Funds Toolbox. Website. https://waterfundstoolbox.org/.

program), Operation (establish stability, activities, and evaluation), and Maturity (institute structures for long term viability).[29]

In the case of the Upper Oconee Watershed in Georgia, the goal is to implement a PES program to maintain water quality and combat pressures from development by ensuring forest landowners generate enough income to "keep forests forests." Forests provide a variety of ecosystem services, with timber and water, and their respective uses, being the two most important ones that have a significant impact on the economy[30]. There is a clear link between deforestation and decreased water quality, as forest loss leads to increased soil erosion by up to 40 tons per hectare per year[31]. Moreover, sedimentation not only occurs during the harvesting of the forest, but it can continue over many years if logging activities continue as logging roads contribute about 90% of the sediment yield. Eventually, the level of sedimentation going to the intake point of water-consuming companies such as utilities could pass a threshold level and the accumulated external cost could "engulf potential revenue" and render their operation too costly[32]. Based on a national survey of 37 water treatment utilities with watersheds averaging 60% forest cover, estimate that 1% reduction in forest area would increase turbidity by 3.9%-6.3% (which increases cost of treatment).[33]

Water quality and quantity is especially important to utilities, as sedimentation and nutrient levels can have important impacts on their treatment costs. In the case of hydropower in particular, excessive sediment build up could seriously impact the useful lifetime of the dams; this, in turn, could disrupt local and national energy systems, considering hydropower generates 19% of the world's electricity. Therefore, maintaining upstream forest cover can contribute to the lifespan of hydropower and drinking water utilities[34]. As such, a PES program where water and hydropower utilities pay forest landowners to conserve their land could be a way to ensure the provision of water quality through its valuation and economic remuneration.

Much of the stakeholder engagement work was managed through the Upper Oconee River Watershed Partnership. Unfortunately, the coordinator for the partnership transitioned to another role and this important community building work has been unable to move forward. Work completed by the partnership and their monthly meetings can be revived through hiring a new coordinator. We recommend hiring a coordinator and setting up internal structures within the partnership to withstand an individual leaving.

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[29] The Nature Conservancy (2023) Water Funds Toolbox. Website. https://waterfundstoolbox.org/.
[30] Mohd Shahwahid *et al* (1997)
[31] Arias *et al* (2011).
[32] Mohd Shahwahid *et al* (1997)
[33] Puneet Dwivedi, Fabio J. Benez-Secanho, Jonathan Skaggs, Duncan Elkins, Wesley L. Gerrin, Cassidy Lord. (2020). *Conservation and Restoration Priorities in the Upper Oconee River Basin.* Warnell School of Forestry and Natural Resources and River Basin Center, Odum School of Ecology. University of Georgia.
[34] Arias *et al* (2011).

The most clear tool to structure an Oconee PES program would involve Land Management Service Agreements (LMSA's) to address Best Management Practices (BMP's) that protect water quality practices but retain forest landowner independence, rights, and land protection. Initial information about LMSA's is included in the Dovetail report and were heavily utilized in the case study for Denver, CO. Additionally, most successful funding programs included source water protection fees on ratepayer bills. In other locations, these fees were used to purchase priority lands within the utilities source water areas, or put conservation easements on such lands.[35] These same ratepayer structures could instead be utilized to provide annual or monthly payments to landowners for BMPs. Additional funding could be provided by large water-using corporations identified through municipal bond disclosures and water withdrawal permits.

Case Studies Findings

Pricing Mechanisms

In addition to researching background information on PES and how water utilities could play a role in water conservation, case studies from around the world were analyzed to identify aspects of these that could be used in the water quality market in the Upper Oconee Watershed. One of the main takeaways was that the average price per hectare per year paid was $22.38 USD; while monthly fees per hectare may provide continuous income to landowners, case studies show that it is more efficient to do annual payments. On the other hand, these payments can be shared with users of electricity or water; the average fee when transferred to consumers was $10.41 USD per month. It is important to point out that many of the schemes are not based on a monthly fee for users, but rather a per unit fee, like per kWh or per gallon of water. When taking that into account, the average price paid by hydropower utilities was $2.58 USD per kWh generated; all these prices have been adjusted for inflation. There is one example of a modeling framework applied in Cambodia where the payment was divided between the hydropower company and the users, resulting in the users paying $0.0008 per kWh and the operator paying $326,416 USD per year[36]. An important takeaway with pricing is that it is not necessary to conduct a valuation of the ecosystem service itself (determining what the exact value of every gallon of water, or every unit of sedimentation), but rather what the sellers need to receive for it in order to change their behavior to conserve it. While some studies, like Arias et al, Mohd Shahwahid or Dwivedi, analyze the value of water quality in different contexts, it is not necessarily important to have that level of detail. What is important is understanding the costs that landowners are incurring for the behavior change, and how much they are willing to accept for it; if the payment is not sufficient to cover these additional costs, the scheme will likely not succeed. An example of a successful program is the case of La Esperanza Hydropower Project, who decided not to participate in Costa Rica's national PES scheme, but rather sign a bilateral agreement with a

[35] Fernholz and McFarland, 2021
[36] Arias *et al* (2011)

landowner in its vicinity. No valuation of the service was conducted, but rather a negotiation between both parties (with the mediation of a local NGO, Monteverde Conservation League), wherein a fair price was agreed on. There was no monitoring of how much water quality or quantity improved, simply an "intuitive" understanding that it would improve. This bilateral agreement was signed for 99 years and has been very successful[37].

Program Structure

In terms of the structure of programs, all the case studies included an organization or government body that acted as an intermediary between the buyers and the sellers, including managing the funds, monitoring progress and mediating relationships, among others. The great majority of the cases included only one buyer and one seller; the cases that had more than one seller still only had one buyer. In comparison to voluntary carbon markets where a project emits carbon credits and anyone can buy the credits, these PES programs are made specifically to fit the needs of the buyers, who require the provision of water quality. There are, however, some examples where each project is part of a larger program when managed by a government entity, as is the case with the national-level PES program in Costa Rica, managed by FONAFIFO. In 1996, a Forestry Law was passed in the country to establish that forest cover could be maintained through mechanisms that allowed beneficiaries to compensate landholders for these benefits. The government established a fee of $74.85 USD per ha per year, and there are multiple companies, mostly hydropower, who participate in the program. They pay a fee to FONAFIFO, and this government agency in turn pays these as incentives to forest owners. It is important to note that this scheme works because of the regulation to support it[38]. Structurally, long-term contracts are more conducive to the success of the programs, as they ensure that the ecosystem services are still provided; in the case of Costa Rica, the program agreement is signed into the property deed, therefore ensuring its continuity regardless of changes in property owners[39]. However, this is more difficult to achieve as forest landowners are not likely to enter into such long term contracts, especially with conservation easements as the majority of the case studies explored. On the other hand, Land Management Service Agreements are more flexible as they allow landowners to continue their economic activities, to a limit that allows for the provision of ecosystem services. For example, the water company Perrier Vittel bought land from farmers to conserve it, but gave it back for free to farmers who agreed to use less intensive dairy farming techniques and follow the necessary conservation practices to protect the watershed[40].

Stakeholder Engagement

As mentioned in the literature review, the government plays an important role in the implementation of these programs. Local, state and even national governments set the regulatory background necessary to enable these programs to start, and to be successful in the long term.

[37] Rojas, M. & Aylward, B. (2002)
[38] Rojas, M. & Aylward, B. (2002)
[39] Rojas, M. & Aylward, B. (2002)
[40] Salzman, J. (2005).

Moreover, in many cases, they provide funding and resources for the functioning and administration of the program itself. A higher-level governmental office can also bring various local governments to work together towards the implementation of the program, as well as pooling their resources. This was the case with the New York Catskills program, where the New York State Government created the Catskill Watershed Corporation and worked with New York City and over 60 towns, 10 villages and 7 counties to design and implement the PES program. Together, they were able to invest $3.97 billion in ecosystem restoration to avoid the construction of a new water filtration plant, which would have cost over four times that[41]. Additionally, governments, especially national ones, are a channel for supplementary funding when needed, as is the case with the Costa Rica national PES program, where they got grants from the World Bank and the Global Environmental Facility[42].

Lessons Learned

Not all aspects of the case studies were successful, and lessons can be learned from them. One key learning is that stakeholder engagement is extremely important, and without having the buy-in of both buyers and sellers, the program will likely fail. However, it can also be a costly and timely endeavor and should be accounted for; for example, in New York, the payment to landowners to change their behavior was actually the minority of the budget ($19.36 million), while most of it went to partnership programs ($535 million)[43]. Another important consideration is the flexibility of the program, to ensure more buyers and sellers can join throughout its lifetime, and can have flexible agreements to suit their needs. While it is paramount to have a structure, having certain flexibility can enable success. For example, in the Costa Rica PES national system, the rate is $74.85 per hectare, considering four ecosystem services (carbon, water, biodiversity and scenic beauty); while that worked for many companies, La Esperanza Hydropower decided not to participate in the national scheme and instead develop a bilateral agreement to only pay for water at a rate of $18.40 per hectare[44]. In this case, the hydropower company decided to create its own project, but it does show the possibility that there are other companies that decided not to participate at all. A complete summary of all the cases studies analyzed can be found in the Appendix A.2.

Survey Findings

Unfortunately we received a limited response to the willingness to pay and willingness to accept surveys, only 3 water utilities and 8 landowners replied. Furthermore, we discovered that a team at UGA is also working on an ecosystem valuation for water quality in the region. Due to these challenges, and in an effort to minimize duplicative work, we refocused our work on stakeholder interviews. However, in the survey responses we received, we identified a few key

[41] Salzman, J. (2005). .
[42] Rojas, M. & Aylward, B. (2002)
[43] Salzman, J. (2005).
[44] Rojas, M. & Aylward, B. (2002)

takeaways, the first being that engagement with local stakeholders can be difficult without established relationships in the region. This is why hiring a Oconee specific coordinator would be an important first step to build relationships and trust to run willingness to pay and accept surveys. We recommend carrying this work into the future to inform the PES program development and sample pricing in conjunction with the UGA work and Keeping Forest partnership.[45] In reviewing the survey responses we did receive, it became clear that water utilities are not very interested in participating in an incentive program and although landowners are interested, they are hesitant to sign LMSA agreements. Full responses can be viewed in appendix A.3.

For utilities, a few themes arose. Many utilities believe that a water quality incentive program would add unnecessary costs, and it is the responsibility of landowners to maintain BMP's for water quality. Some utility survey respondents indicated an understanding of the water-forest cover nexus but were not interested in a program as current water quality does not pose increased costs or maintenance issues. The survey respondents did not indicate a concern about future increased costs as forestland converts. Additionally one respondent indicated that it does not matter if upstream land cover is developed or forested due to regulations around stormwater retention and pollution management will protect water quality - and that at times of poor quality during rain events they simply do not pump out of the river. Utilities also indicated that average reservoir dredging happens every 30 years and filter media is replaced every 10+ years, so the cost savings seen would be small and gradual. One respondent even indicated that increased suburbanization in the watershed is not an issue and it would be unfair to rely on ratepayers to use their fees to support forest landowners.

For landowners, all indicated interest in an incentive program to protect forest cover with increased development pressure and recognized forest cover's importance on water quality. 62% of respondents indicated land use changes and development as an important issue in the area. Landowners ranged from 50 acres to 9,000 acres with at least 90% forested.[46] All landowners had loblolly pine areas with a few hardwood areas and general stand age classes were 6-10, 21-25, or 36+. Average harvest rotations ranged from 28-40 years.

All but one landowner had an active forest management plan, and indicated average monthly management costs from $0 - $500 - $2,500 carried out by the owner. All forest owners indicated BMP's and wide Streamside Management Zone (SMZ) zones (25+ ft minimum) as the primary ways to protect water quality but would be hesitant to sign a LMSA. 87% of respondents would be willing to accept payment from downstream water users to protect water quality, but indicated that the price would depend heavily on the activity conducted and cost of the

[45] Nick DiLuzzio. (2023). Interview, Georgia Forestry Foundation
[46] Tasha Griffiths, Ana Gargollo. (2023). Landowner A Survey.

management. Overall, landowners would want an ecosystem service to be paid well, 'as much as the market would bear' and '$50/acre would be very interesting.'[47]

Due to limited engagement from local landowners, we reviewed the National Woodland Owner Survey (NWOS) to better understand forest landowner composition in GA and the Oconee region. 89% of forests are privately owned and 69% of primary decision makers are male.[48] Property taxes and keeping the land intact were listed among the top 5 concerns and water protection was among the top 5 reasons for owning forestland property. This indicates that a PES incentive program that could provide enough revenue to cover forestland property taxes may be sufficient for protecting forestland and preventing subdivision and development conversion. Also in the past 5 years, only 22% of landowners cut trees for sale but 24% of landowners used management practices to improve wildlife habitat.[49]

Timber costs and income with data from FORISK and Timbermart South was helpful for understanding what kind of revenue current timberland owners are working with to inform a sample incentive payment. While the floor price of a sample incentive payment could be on par with annual taxes, a more powerful incentive would be similar to a discounted cash flow for timber revenue.

Interview Findings

13 stakeholder interviews were conducted with participants from the environmental non-profit space, research institutes, forest trade associations, independent consultants, government and water utility representatives, and universities. While each of these stakeholders had unique perspectives and preferences for a PES program, a few key takeaways arose. A full review and summary of each interview can be found in appendix A.3.

From researchers and university staff: all interviewees indicated there is a wealth of resources available to help plan and implement water management incentive programs and PES systems. A few of the most helpful resources for the Oconee program would be the TNC waterfund toolbox, EPA's Enviroatalas, InVEST, and the USGS Sparrow decision tool.

One UGA researcher indicated that although water quality will be important moving forward, many water utilities are focused around water flow challenges that impact them currently. Shifting the PES system and conversation from water quality to water flow maintenance may be a more direct way to get hesitant water utilities to participate in the incentive program. They also indicated working with USDA grants to incentivize farmers to shift

[47] Tasha Griffiths, Ana Gargollo. (2023). Landowner A Survey.
[48] USDA (2021).
[49] USDA (2021).

from cropland back into forestland as a way to meet PES 'additionality' concerns. They also highlighted the need for state government to be engaged to ensure more long-term success of PES programs through consistent funding and regulatory support.

Other interviewees indicated that developing a 5 year plan to implement the program with the aim to cover 80% of the land would be important and should focus on areas that utilities know are high-loading areas for sedimentation (hydropower) or water pollution (drinking water). They also hypothesized that larger water users like microbreweries and Coca Cola should be additional 'buyers' in a program along with the water utilities.

From water utilities and county government officials: interviewees stated that a significant way to currently manage water quality is through zoning control. By limiting development in more rural areas, and incentivizing density in urban cores, zoning codes can protect forestland conversion and ensure a lower percentage of impervious surfaces which affect water quality. Current wastewater treatment plants are relying on these zoning policies to regulate their water flows. They also indicated interest in using zoning, stormwater regulation, and tax incentives as the main tools to protect natural spaces and the ecosystem services they provide. Unfortunately, they indicated that each individual county in the Oconee has their own regulation and management plans that makes joint watershed planning and programming difficult. They highlighted a few regional governmental bodies for water resources that should be engaged when implementing a PES program.

From environmental advocacy and collaborative agency stakeholders: all interviewees indicated that plenty of research is being done on the forest-water connection and sample ecosystem service valuation, however there is a "lack of coordinated effort" which indicates that collaboration among these different research agencies will be important moving forward. Many interviewees were eager to connect our project to other regional contacts and stakeholders; this was consolidated into a master contact list for a future PES program coordinator to access. See appendix A.4.

Main water quality challenges in the region are from wastewater contamination and less so from sedimentation. This furthers the idea that many forest landowners are following best practices for water quality and additional management activities are not required. One interviewee also indicated that if landowners are not interested in LMSA agreements, another avenue could be to utilize Conservation Use Value Assessments (CUVA), which could allow for economic incentives but also retain landowner property rights and flexibility. These agreements should target landowners in ecologically sensitive areas that have already been identified through regional conservation and restoration mapping efforts with UGA.

Interviewees indicated that it is difficult to convince water utilities to participate in the program without a clear valuation of the market credit per unit of water. However, getting water utilities (the payers) to participate is critical. Currently, water quality is not an issue due to land cover practices. However, if forestland is converted to impervious surfaces (i.e. urbanized) water quality could decrease. This means that water utilities are participating in the PES program to prevent future cost increases, not to lower current costs. The water utilities would need to buy into this long-term view.

Interviewees also indicated that "local environmental ordinances have not been updated in 20 years."[50] Therefore there is a lot of room for "model" ordinances that could support the development of PES systems. Interviewees also indicated that Athens-Clarke County could be a 'champion' of PES programs due to a deep understanding of the forest-water connection and engaged environmental community. Additionally, the Bear Creek Reservoir (which serves 4 counties) is at risk of not meeting water demand in 10 years due to population growth; the Upper Oconee Regional Water Planning Council who is working on this issue could be more interested in supporting PES systems that help meet water demand challenges.

From forestry trade professionals: interviewees indicated that most, if not all, forest landowners are following BMP's for water quality already. Forest Resource Consultants indicated that almost all of their clients follow certified forest protocols for timber management and ecological function. They also indicated that LMSA's or other agreements might be difficult for landowners to agree to without an established relationship and trust with the other entity. Many landowners are concerned about government regulations limiting their ability to manage timberland effectively, however if a trade association or private entity was running the program they would be more willing to participate. Most practices would involve updates to larger SMZ zones, or stricter controls on road construction for lumber crews during timber harvests. They also indicated that most landowners would be more interested in an annual or 5 year agreement instead of a longer-term contract. Moreover, engaging logging crews will be critical along with landowners and consulting foresters to ensure that the BMP's outlined in contracts are followed. Training logging crews and rewarding loggers who maintain water quality would be a strong incentive for other companies to follow. Also, indicating a list of 'prefered' logging crews who use bridge matts vs. collapsible bridges and have never been fined for SMZ's would be helpful for landowners to make choices that better protect water quality.

Interviewees said that making a PES program more accessible to smaller-scale landowners through a simple contract with a checklist of activities and management strategies grouped into pre-harvest, harvest, and post-harvest categories. They also stated that many landowners receive non-timber income from hunting leases which can help cover land taxes at the end of the year. If a PES incentive was around the same pricing of a hunting lease, more

[50] Cassidy Lord and Katherne Hawes. (2023). Interview, Southeastern Partnership for Forests and Water.

landowners might be interested in participating. The high range of an incentive program would be matching stumpage prices for the region which were estimated around $300 an acre for a first thinning, $600 for a second thinning, and $3,000 / acre for final harvesting.

Analysis

Stakeholder Analysis

The following is a stakeholder matrix, showing the multiple parties involved in the program to any extent. This was done with the objective of better understanding who the stakeholders involved in the program would be, as well as what interest and influence they may have on it. Seventeen stakeholder groups were identified based on interviews and secondary research, and they were classified into 6 categories (Users, Providers, Dependents, Governance, Sustainers, and Influencers) according to the PMD Pro methodology.

Stakeholder Description	Category	Interest in Program	Influence in Program	Role in Program
Georgia Forestry Foundation: non-profit arm of the Georgia Forestry Association, focused on ensuring the long-term sustainability of Georgia's working forest	Governance Sustainer	To accomplish its goal of keeping forests, forests.	Non-profit arm of Georgia Forestry Association. Capable of involving landowners in the area	Coordinator Can continue running program
Drinking water utilities: provide drinking water to households. Example: Baldwin County Water Dept	User Influencer	Gain better water quality and quantity, thus reducing filter and dredging maintenance costs	Have the financial resources for the program and forest conservation.	Payers for ecosystem services
Power utilities: use hydropower to provide electricity to households and corporations. Example: Georgia Power	User Influencer	Increase water quantity, reducing purchasing costs. Gain better water quality, reducing turbine maintenance cost.	Have the financial resources for the program and forest conservation.	Payers for ecosystem services
Wastewater treatment facilities: process water to remove pollutants, making it usable again. Example: Walton County	User Influencer	Indirectly gain better water quality, through reduced urbanization. Reduce stress on the wastewater system, decreasing costs.	Have the financial resources for the program and forest conservation.	Payers for ecosystem services

Water and Sewage Authority				
Water consuming corporations: use water in their industrial and commercial processes. Example: Coca Cola, Terrapin Beer	User Influencer	Gain better water quality and quantity, thus reducing water treatment and purchase costs. Improve reputation as a green business.	Have the financial resources for the program and forest conservation. Can bring exposure to the program.	Payers for ecosystem services
Small forest landowners: landowners that have less than 4 ha, (or anywhere from 50 to 9K acres) usually are family owned[51]. They manage their forests, but are at most risk of development due to low profits from them	Provider Dependent	Gain financial resources for better conservation activities, and certifications. Get financial incentive to not sell land to developers.	Have land to maintain water quality, but not enough to make a difference. Low influence.	Providers of ecosystem services. Beneficiaries of payments
Medium forest landowners: mostly family owned forests. Implement best practices and are mostly certified. At medium risk of development.	Provider Dependent	Financing for ongoing conservation and water quality best practices. Incentive to maintain forests instead of selling to developers.	Own the land to maintain water quality and avoid further development.	Providers of ecosystem services. Beneficiaries of payments
Large forest landowners: mostly industrial timber companies, implement best management practices and are certified to maintain competitive levels in the market. At low risk of development. Example: Weyerhaeuser	Provider Dependent	Financing for ongoing conservation and water quality best practices.	Own the land to maintain water quality and avoid further development, in a way that would be very impactful.	Providers of ecosystem services. Beneficiaries of payments
Landowner associations: encourage and educate forest landowners in the management of their land. Example:	Sustainer Influencer	To ensure landowner members keep their lands and increase sources of income. Accomplish conservation and water	Can coordinate and incentivize many landowners to participate in the program.	Relation to GFF to keep landowner participation high. Possibly governance: program can be passed on to them.

[51] Snyder, Stephanie A.; Butler, Brett J.; Markowski-Lindsay, Marla. 2019.

Greene-Morgan Forest Landowners Association		quality goals and gain more recognition.		
Forestry trade associations: advocate for forest owners and promote healthy business and policies to protect them. Example: Georgia Forestry Association.	Sustainer Influencer	To ensure existence and production of forestry products through additional sources of income. Increase standing and market access through additional certifications.	Can coordinate and incentivize landowners to participate in the program.	Relation to GFF to keep landowner participation high. The program can be passed on to them.
Research institutions: establishments focused on research; in this case, water quality and environmental valuation. Example: Georgia University	Providers	Advancing knowledge in the field of water quality and ecosystem service valuation.	Possibly influencers, can influence design aspects.	Knowledge producers for program design.
Certification institutions: certify best practices in forest management and achieving environmental, social, and economic benefits. Example: FSC[52]	User	More landowners are implementing best practices and seeking additional certification.	Could provide recognition to stakeholders who participate.	Possible certification.
Local conservation groups/NGOs: aim to protect natural ecosystems at a local level. Example: Oconee River Land Trust[53]	Sustainer	Ensure conservation of natural ecosystems.	Capable of involving other landowners and relevant stakeholders.	Possible governance: can carry on with the program
National conservation groups/NGOs: aim to protect natural ecosystems at a national/international level. Example: The Nature Conservancy.	Sustainer	Ensure conservation of natural ecosystems.	Capable of involving stakeholders at a national level and getting more funding.	Possibly replicate the program in other states or at national level.
State Dept of Natural Resources and Water: responsible for the management and conservation of natural resources. Example: Georgia Department of	Influencer Sustainer	Ensure conservation of natural ecosystems. Increased funding for conservation. Increased collaboration with the private sector.	Could sponsor the project and scale it to a state or even national level.	Possible sustainer: can manage the program, replicate or scale it.

[52] *FSC: About Us*. (n.d.). Fsc.Org.
[53] *Oconee River Land Trust Conservation Easement*

Natural Resources, Environmental Protection Division[54]				
Developers: buy land to develop into commercial or residential use; with the growing population in the area, can incentivize forest landowners to sell to them. Example: Crow Holdings Industrial or Selig Enterprises[55]	Influencer	Low interest in program, as it would conflict with own development pursuit	Indirect influence, as they can continue to exert development pressure on forest landowners, leading to loss of forestland	N/A
State Energy Commissions: regulate public companies to ensure consumers receive reliable service and prices[56]. In Georgia, water companies are not regulated by the state[57]. Example: Georgia Public Service Commission	Governance	Ensuring consumers are receiving a safe and reliable service, and ensuring the proper functioning of utilities.	Can regulate whether or not utilities are allowed to participate in the program.	Regulators.

Figure 1. Stakeholder Matrix

An additional analysis was made to understand the assumptions of the stakeholder map and the participation of each of the parties. These assumptions can have risks associated with them, which could impact the program implementation. As such, a risk response strategy was included.

Stakeholder	**Assumption**	**Risk**	**Risk Response Strategy**
Georgia Forestry Foundation	They have the capacity and resources to oversee the program.	Not enough capacity and resources. Possible lack of knowledge to implement the program.	Capacity-building Hiring a program coordinator
Water utilities	They have the interest and financial means to participate in the program. Their governance structure allows for them to make such decisions. Their operation costs will	Utilities do not want to increase fees to users, and the decision does not depend solely on them.	Engage decision-makers Engagement to highlight importance of forest conservation

[54] *Department Of Natural Resources Division*. (n.d.).
[55] Galliher, A. (2023, February 16).
[56] *Georgia Public Commission*. (n.d.).
[57] Berahzer, S., Hughs, J., & Erin Riggs. (2017).

	decrease as a direct result of forest conservation.		
Water-consuming corporations	They have the interest to participate in the program, as do their shareholders. Their image will improve from participation. Their operation costs will decrease as a direct result of forest conservation.	Their shareholders do not see the benefit of participating. The program is not recognized enough to improve their brand image.	Engagement to highlight importance of forest conservation. Marketing and communication strategy.
Forest landowners	They have the capacity and interest to improve forest conservation and water quality activities. They do not have any pre-existing legal conditions that prevent them from participating in the program.	Not enough capacity or financial means to increase this. They are already implementing best practices and water quality will therefore not improve.	Research legal framework to ensure there are no barriers to their participation. Engagement strategy to highlight the importance of maintaining (rather than improving) water quality.
Landowner associations	They have the capacity to coordinate and incentivize landowners to participate in the program.	There is no clear leadership and capacity to coordinate such a program.	Capacity-building activities, as well as definition of clear roles.
Trade associations	They have the interest and capacity to engage landowners to participate in the program. They have the decision-making power to take that step.	There is no clear leadership to manage the program, and it is not within their scope.	Engagement strategy to highlight the importance of participation and their role in incentivizing it.
Research institutions	They have the capacity, resources, and time to carry out research. They have relationships with key stakeholders to obtain the information they need.	They are not well connected, and do not have capacity or resources to carry out research. There is a lack of continuity from one year to another.	Through GFF, connect them with key stakeholders. Analyze their capacity and fill gaps as needed.
Certification institutions	They benefit from having landowners implement additional best practices. Some landowners are not certified and will pursue certification through this program.	Most landowners are already certified, or do not have the means to get certified. The additional best practices do not add value to the certification institutions.	Accept risk
Conservation groups	The program will help them advance their conservation goals in a significant way. They have enough capacity and resources to participate and even lead.	While the program increases conservation in the area, it is not attributable to these groups. They do not have	Close engagement to have them participate.

		the resources to participate or coordinate.	
State Government	There are no legal or bureaucratic conditions that prevent this program from happening. The program will help advance state-level conservation and water quality efforts. There are no conflicting interests with other state programs.	Permits are required for such a program, delaying its implementation. The state has no conservation and water quality goals. The government has a conflict of interest.	Research legal and governmental framework for program implementation. Engagement strategy with GA Environmental Protection Division to highlight the importance of the program and get government participation.
Developers	They would not be willing to participate in the program.	Positive risk: they could become an important stakeholder if they decide to participate.	Accept risk Consider engaging with this stakeholder
Energy Commission	Their regulations of energy utilities do not pose a legal obstacle for the implementation of the program.	There are state statutes, federal statutes or legal mechanisms that prevent utilities from participating in this. Georgia has a "gift clause," limiting state entities from subsidizing corporations; therefore if the rate increases for users, there would be no subsidy[58].	Research legal and governmental framework for program implementation. Engagement strategy with Georgia Public Service Commission.

Figure 2. Stakeholder assumption and risk mapping

The following Venn Diagram better illustrates the relationships between all the participating stakeholders. Understanding how the stakeholders relate to each other, and who has more influence over the program, is crucial in order to design a program that plays on the strengths of these relationships. Moreover, by understanding who is connected to whom, program coordinators can understand who to approach with specific needs and how to better connect to them. The size of the circles depicts the level of influence the stakeholder has on the program, while the proximity to other circles shows the strength of relationships they hold. Overlapping circles indicate there is a very strong relationship, or an overlap in stakeholders.

[58] Berahzer, S., Hughs, J., & Erin Riggs. (2017).

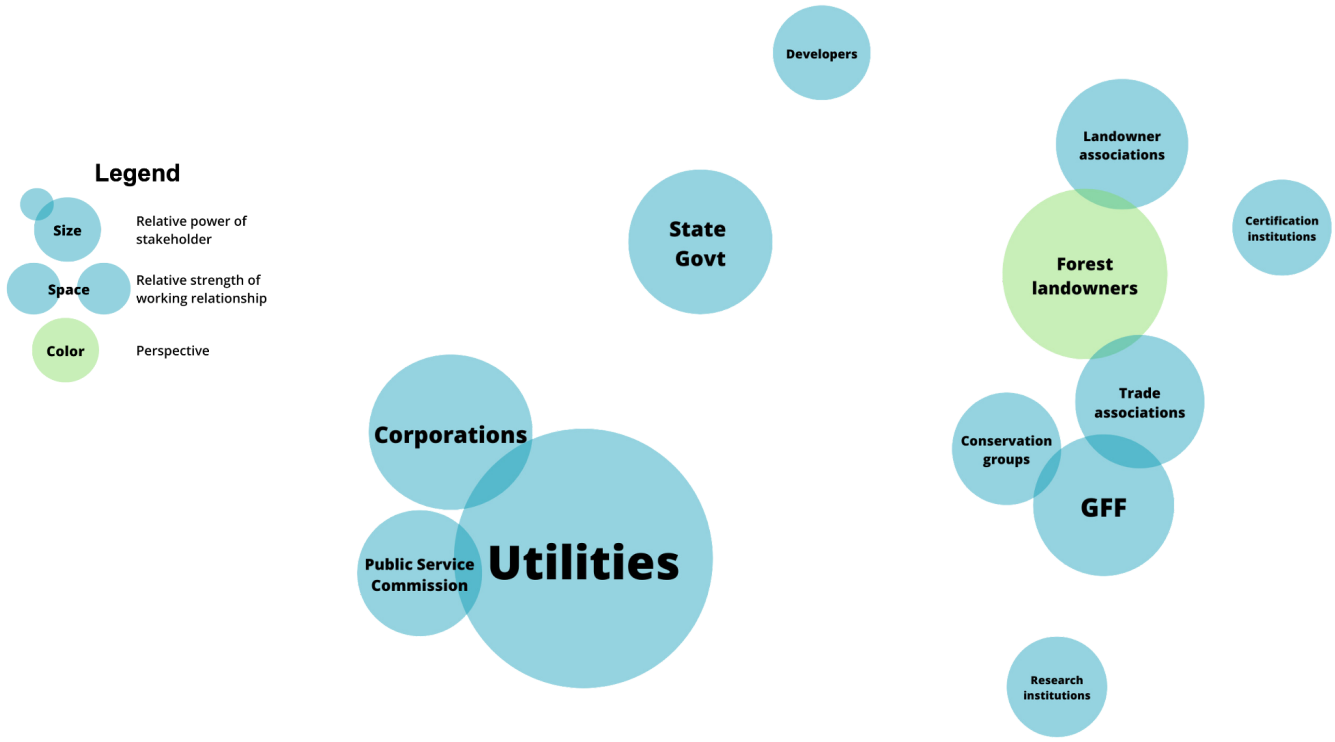

Figure 3. Stakeholder Venn Diagram from the perspective of forest landowners

As a final approach to understanding the stakeholders involved in the program, an Influence/Interest Matrix is shown below; this portrays the level of interest and influence that each stakeholder has. In turn, it indicates what level of engagement should be held with each. For example, stakeholders that have a high influence and high interest in the program should be kept satisfied and there should be constant communication during all the phases of the program. On the other hand, stakeholders with low interest and influence should not be prioritized and rather simply monitored to ensure they are engaged, and identify if their level of interest or influence changes over time.

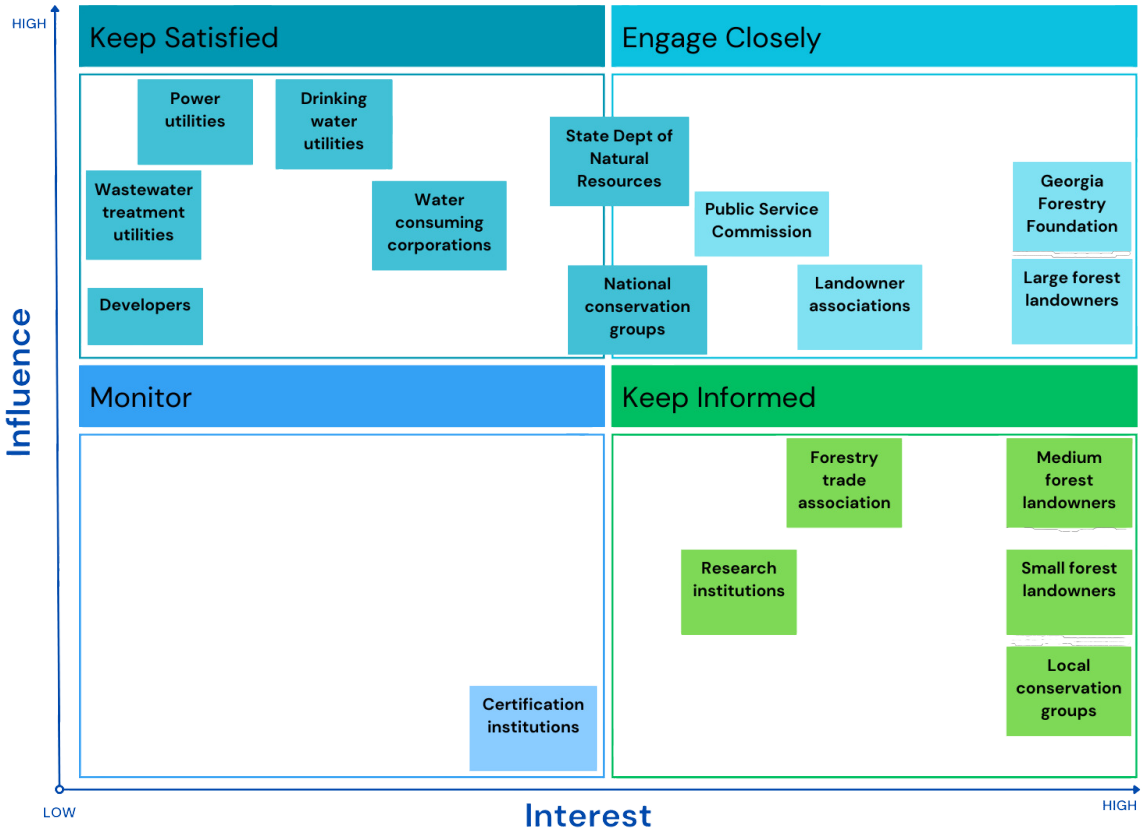

Figure 4. Influence/Interest Stakeholder Matrix

GIS Analysis Findings

A place-based analysis was conducted to identify priority locations at the HUC10 scale for a pilot PES program. An index was created in ArcGIS utilizing 3 main components: 1) Drinking water intake locations and reservoirs, hydropower plant locations, and sawmill locations 2) current landuse/landcover data for the Upper Oconee River watershed 3) Water flow data. We recognize that management at the HUC scale is clear from a water flow (see figure 5, Map 0) and ecological management perspective, however many of the HUC10 units cut across various county boundaries. This means that a pilot program in any particular HUC10 would involve collaboration and communication across multiple water government bodies. For easier implementation for a pilot program, once a water utility is interested in participating, their management boundaries could be used as the limit of the program initially, and then expand to the larger HUC 14 or HUC 10. These areas would have potential impacts for the PES 'buyers'.

Map 0: Basic water flow information and governance borders were layered into ArcGIS to provide context. Georgia's 159 counties and the Upper Oconee Region includes 18 counties that all have different water governance structures which may make collaboration more

complicated. It is also clear that water management boundaries will cross municipal, county, and and other governance boundaries.

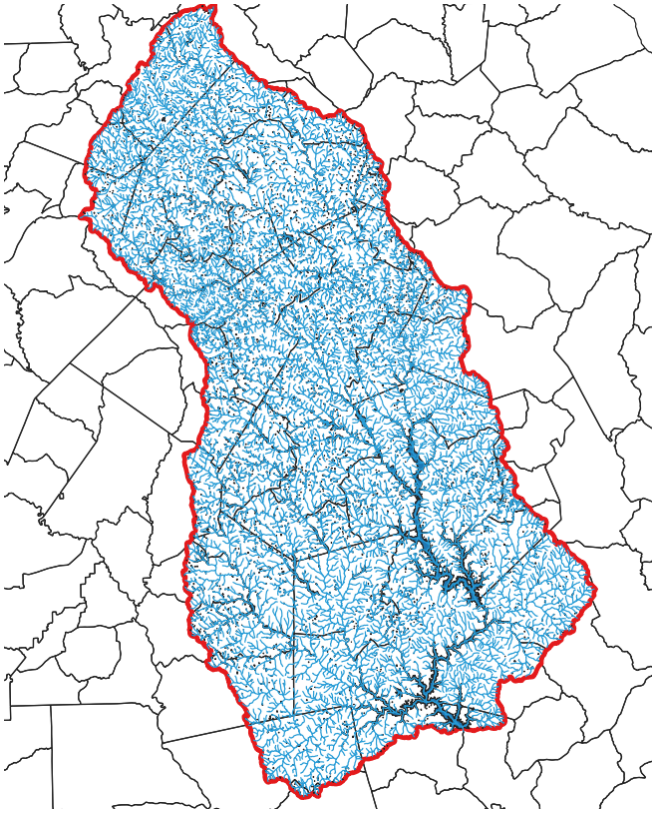

Figure 5. Map of waterways within the HUC 8 - Upper Occone

Map 1: Intake Locations and Sawmills (figure 6): our analysis was based on the HUC10 scale to indicate what water utilities are at the highest risk of seeing increased costs due to conversion pressures and could be targeted for the pilot programs. The first layer of our analysis identified main drinking water intake locations. Location information was pulled from a few different sources as many states are not transparent about this information due to security purposes. However, one important resource was the Waters of the Oconee River Basin webpage from the Georgia Water Planning & Policy Center at Albany State University.[59] These maps had Oconee water supply locations, wastewater discharge locations, water reclamation facilities, and hydroelectric locations. This was then cross referenced with Georgia's environmental protection division for non-farm water withdrawals within the 18 Oconee counties which listed 19 intake locations.[60] These locations were geo-coded based on provided addresses from an excel table.

Drinking water intake locations were also pulled from EPA resources. The first was SDWIS (safe drinking water information system) which was filtered for registrants within the 18

[59] Georgia Water Planning and Policy Center (2022).
[60] Watershed Protection Branch. (2022).

Oconee Watershed counties, but the list of 20 surface water systems did not include locations.[61] After searching for registrants online a few addresses were found. We then supplemented this information with data from the EPA's FRS (facility registry service) filtered for the Upper Oconee River HUC8 code which did have locations for 14 facilities registered as 'drinking water programs'.[62]

The last step to pull locations was reviewing water utility websites for the Oconee region and listing any drinking water reservoirs or source water locations that they referenced which produced 6 points. We also added in two hydropower plant locations in the bottom of the watershed pulled from the Georgia Power website. Adding all these layers together, 22 locations were identified as important water intake areas that would serve as the basis for the analysis.

Since we are also interested in forestland conversion, we added sawmill locations from Georgia Forest Commission's Wood Using industry directory.[63] These locations were provided via addresses in an excel document that were geo-referenced using python code and imported into arcGIS. 8 sawmills were found within the HUC8 boundaries for the Upper Oconee. This layer was added based on the understanding that landowners may be pushed to convert their timberland to other uses if traditional harvesting is not as profitable or management due to limited mill access or large hauling distances. Additionally, hauling distances were cross referenced from the USFS Forest inventory and analysis Timber products output database to get a sense of average hauling distances in Georgia. Average distances for the state included Sawmills-33, veneer-65, pulp 89. Composite-46, other (posts poles) 39 miles.[64]

[61] United States Environmental Protection Agency. (2023) *SDWIS Search. https://www.epa.gov/enviro/sdwis-search*.
[62] United States Environmental Protection Agency. (2023) *FRS Query. https://www.epa.gov/frs/frs-query*.
[63] Georgia Forestry Commission. (2023). *Georgia Wood-Using Industries Directory.* https://gatrees.org/directories/.
[64] U.S. Forest Service. (2023). *Timber Products Output Studies*. https://www.fia.fs.usda.gov/program-features/tpo/.

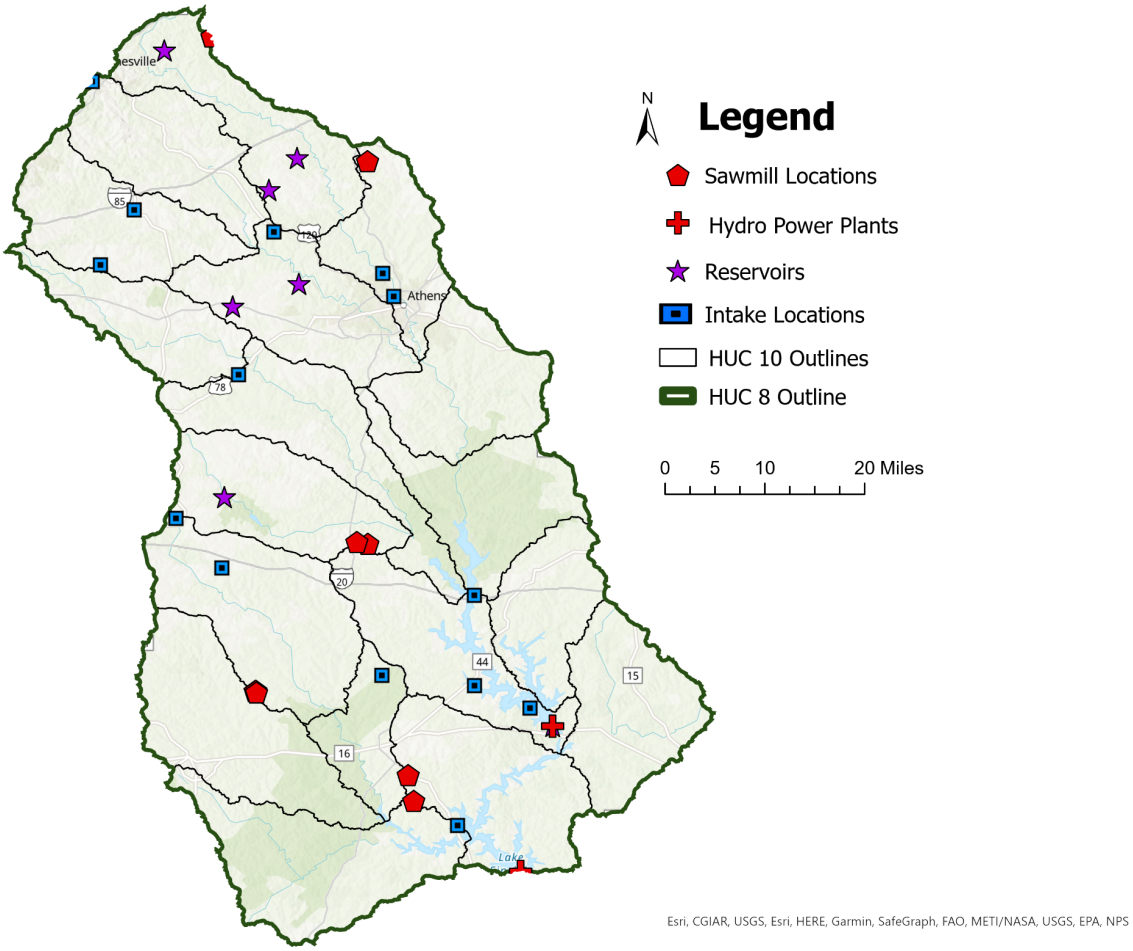

Figure 6. Map of county boundaries with water treatment plants and mills

Map 2: Landcover Types within the Upper Oconee Watershed (figure 7): to understand what was upstream of the key water intake areas, we used the USGS national landcover dataset to identify key forested and urbanized areas.[65] Based on findings from the literature review, 60% forest cover is an important metric to maintain to protect water quality and in interviews with landowners conversion to urban sprawl is a main pressure in the region. The NLCD uses 15 land cover types within the Upper Oconee HUC8. Forested areas were combined for a full percentage of areas that could potentially be protected through a PES system and developed land was combined to indicate 'urbanized' areas with higher proportions of impervious services.

Values of each landcover type were summarized and divided by the total to create percentages of total coverage per HUC10 code. See appendix A.7 for the full breakdown. Percentage of forested land was then summarized and included USGS Codes: Deciduous Forest, Evergreen Forest, Mixed Forest, Woody Wetlands. Percentage of developed land included USGS Codes: Developed Open Space, Developed Low Intensity, Developed Medium intensity, and

[65] U.S. Geological Service. (2019). *National Land Cover Database (NLCD).*

Developed high intensity. As expected, areas of highest development were surrounding Athens and Jefferson and as well as towards the NorthWest side of the watershed closest to main roadways to Atlanta.

We also used the USGS Protected Areas Database (PADUS) to identify areas that already had high percentages of natural landcover protection which primarily occurred around the lower parts of the basin around Lake Oconee.

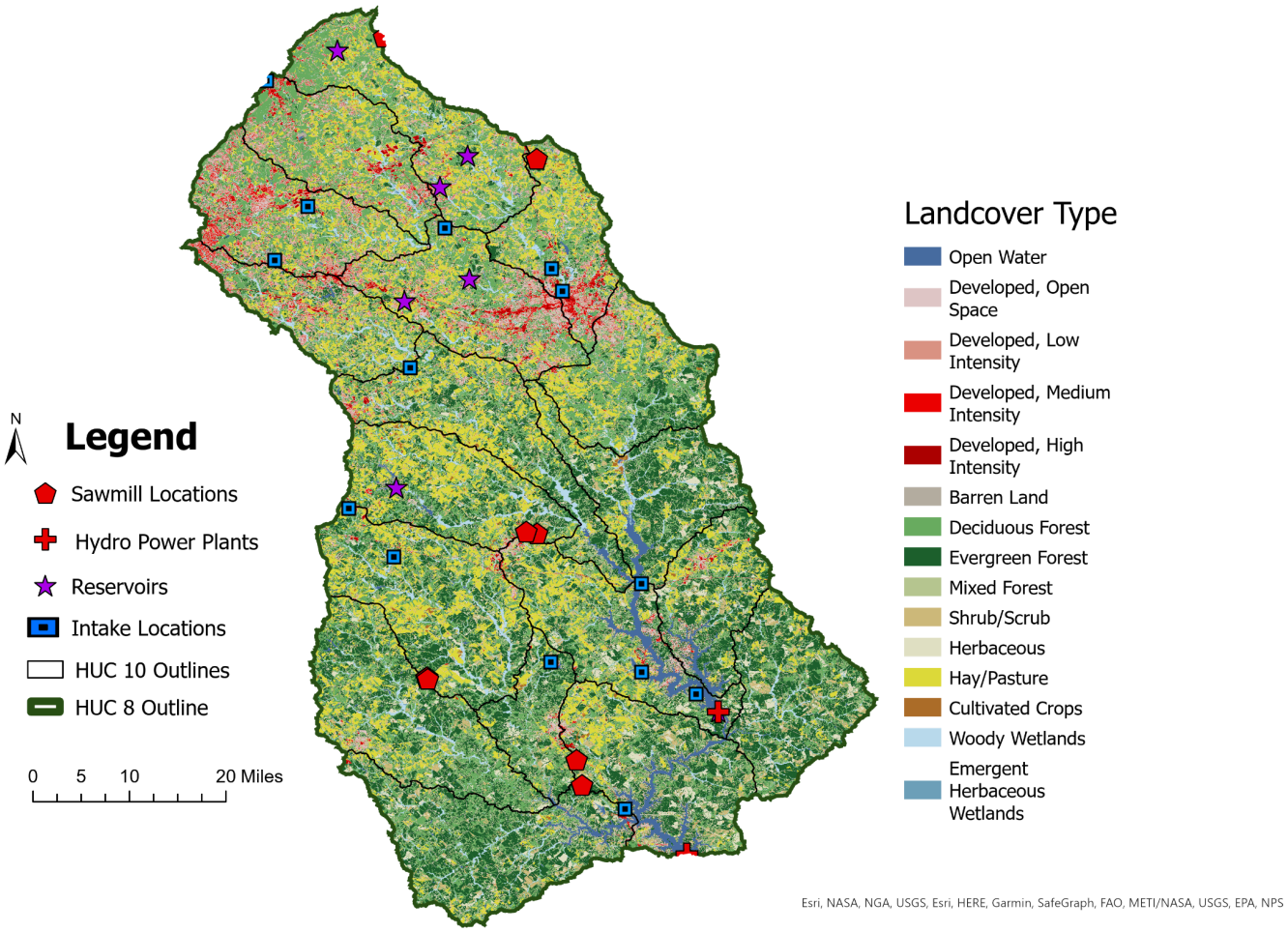

Figure 7. Map of landcover within the Upper Occone

Map 3: Priority HUC10s within the Upper Oconee Watershed (figure 8): utilizing all these data layers an index was created to prioritize locations for pilot programs. For the full index please see the methodology section. Results of this index indicated that the HUC10's that had a large number of intake locations and reservoirs, larger percentages of impervious surfaces, and low levels of protection are in the top part of the watershed. Indicated in dark green on Map

3. These priority HUC 10s are 307010105, 307010103, 307010102, and 307010108. The full ranking index table and summary calculations can be found in appendix A.7. These priority HUC10's are surrounding the Athens-Clarke County municipal areas which were indicated as an important location to start a program from the stakeholder interviews.

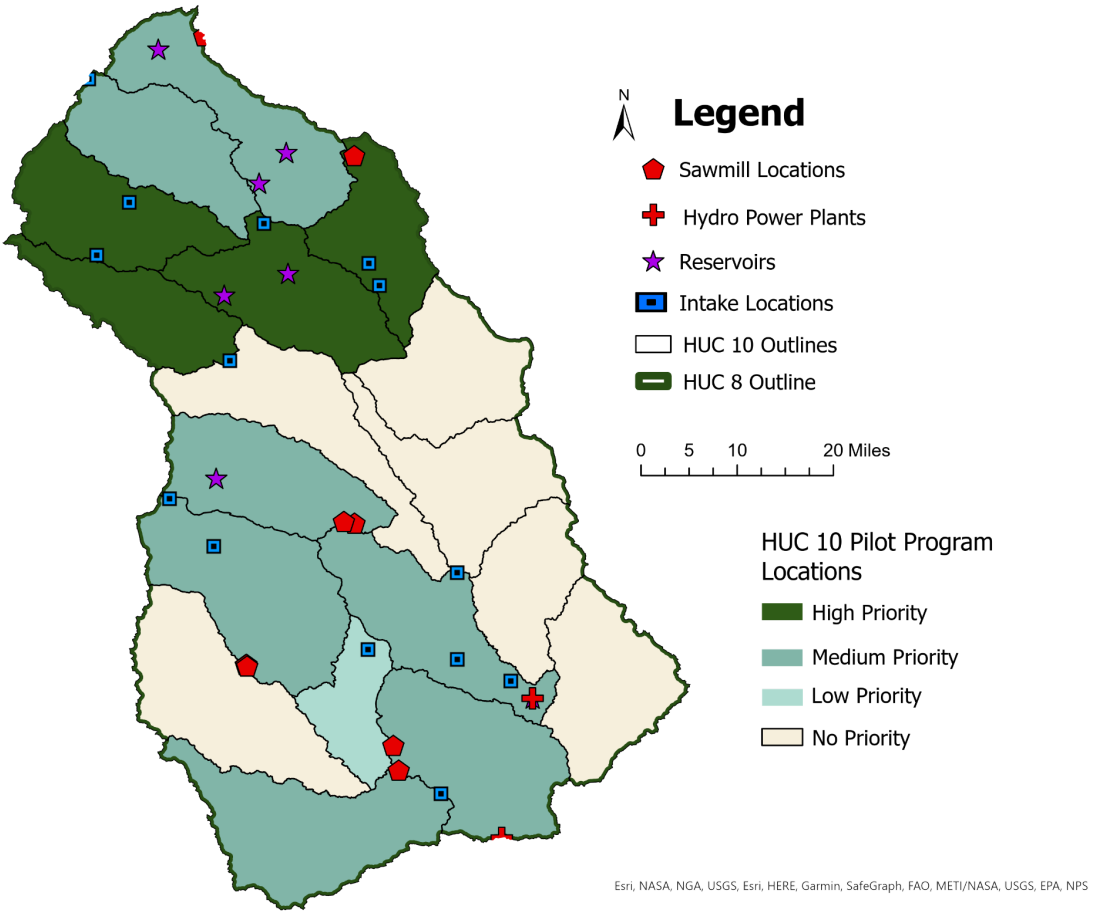

Figure 8. Map of priority HUC10s for pilot project

Discussion and Conclusion

Major Findings

With the recent drinking water crisis around the nation and growing development pressures, source water protection is becoming increasingly important. In many U.S. based PES source water systems, traditional conservation easements have been utilized, but their strict restrictions can limit landowner participation. Thus, new emerging markets and incentive programs for ecosystem services and their protection is critical. We propose implementing a PES incentive program in the Oconee Watershed that at minimum covers participating landowner annual taxes and funds for these payments is supplied by future cost savings from water utilities and minimal increases to ratepayer bills. Throughout each of the 4 phases of this project key findings and recommendations were identified. Our main recommendations have been summarized below:

1) *Hire:* in order to implement a PES system in the region, a new PES coordinator should be hired who can revitalize work completed by the Oconee River Watershed Partnership (ORWP). This coordinator and ORWP should work together to complete a PES strategic plan, identifying joint goals and preferences for the PES system that can integrate water management research completed already. Additionally, we recommend hiring a coordinator and setting up internal structures within the partnership to withstand an individual leaving.
2) *Plan & Engage:* once stakeholders have been gathered and initial framework for the PES program can be developed and agreed upon. We recommend following the planning steps and guidelines outlined in TNC's waterfunds toolkit. The design of the program could be most successful by utilizing LMSA's and consistent funding from small ratepayer increases. We recommend engaging each of the stakeholder groups identified in the PMID analysis and have provided key contacts in appendix A.4.
3) *Government Cooperation:* based on findings from our case study review an important stakeholder that has not been sufficiently engaged are government administrators. Georgia state water management regulators could be a critical source for both technical assistance and grant funding. Additionally, many water utilities are regulated at the County level and regional water administrator boards would be important stakeholders to engage.
4) *Water Flow vs. Water Quality:* most water utilities within the Oconee were not interested in participating in a PES system, primarily due to limited water quality challenges in the region. Convincing water utilities of the risks posed by forestland conversion will be important. However, a transition from discussions around water quality to water flow maintenance may be an easier way to engage water utilities. Water utilities do not indicate current quality challenges but do have flow management concerns. Regulating

water flow and flood prevention through forestland protection could be another way of structuring the PES system.

5) *Location:* a pilot PES program can be instituted in one of the priority HUC10's identified through the spatial analysis. We recommend starting engagement with Athens-Clarke County Water administrators identified in the appendix's contact list. This region will see more development and conversion pressure and has less forestland under protection than other areas. After implementing a pilot program, this can then be replicated and scaled up to cover more areas in the Upper Oconee.
6) *Toolkits and Resources:* In our appendix and shared google folders we consolidated hundreds of pages of resources for a PES program. These resources should be provided to the PES coordinator to orient them to the challenges and potential solutions in implementing a PES program within the Oconee. The stakeholder Step-by-Step guide (see Appendix A.1) and TNC water funds toolkit will be important roadmaps to follow. In addition, our consolidated literature resources provided by university staff and researchers can provide the scientific basis to engage policy makers and non-governmental collaborative organizations in the region.
7) *Funding:* Applying and securing funding for these regional planning efforts will be an important first step. Once the planning processes are completed and implementation begins, designing a PES system to allow for consistent funding will be critical. Many resources for watershed scale planning and collaboration exist at the federal level. The most successful PES case studies involved funding from government sources complimented by ratepayer increases. For more funding recommendations see appendix A.8.

Landowner Participation Challenges

Based on findings from landowner participation in carbon markets, landowners are generally unwilling to sign long-term contracts that limit their management objectives for their land. This is why it is critical to develop agreements that maintain a landowner's flexibility to conduct working forest practices on the property. However, these practices should follow state-wide BMP's and forest certification guidelines for water quality. Georgia specific BMP guidelines for water quality include: Streamside management zones; Vegetation management for sedimentation, erosion, and flash flooding; Non-point source pollution and fertilizer regimens; and hiring logging crews that follow BMPs and have not received citations in the last 5 years for SMZ activities.[66]

Initial survey responses from Oconee River landowners further indicate interest in short-term contracts (1 to 5 years).[67] Additionally, Georgia 52% of forestland owners are

[66] Georgia Forestry Commission. (2019). *Georgia Best Management Practices (BMP) Manual.*
[67] Fernholz and McFarland, 2021

participating in property tax programs that lower the taxable value of their land to the present use - i.e. timberland. Participation in this plan requires submitting documents to the country and having a forest management or stewardship plan. However, many small-scale landowners may not have active management plans and this could pose a barrier to participation in a PES incentive program. We thus recommend that any PES program structure provide support or recommendations for landowners who do not have active management plans to obtain them, either by working with consulting foresters or other trade associations.

Another layer that could make participation difficult could be limited ownership titles due to landowner heiress challenges. If ownership of timberland or forestland is uncertain, enrollment in a PES system would be limited. We recommend designing the program in a way to help landowners address these challenges – either directly with program coordinators or through partnerships with forest service programs that can address them.

Limitations and Suggestions for Future Work

The main limitation to this study was the time constraint, as an in-depth study on willingness to pay and willingness to accept could not be carried out. We did realize that a willingness to pay study was being carried out by another team at Georgia University, which then led to a pivot on the focus on the project and therefore less time to develop an in-depth analysis on this second workplan. That being said, the work on the economic valuation of ecosystem services is being continued, and should be included in the program design when finished. Ongoing conversations and engagement should be followed with that research team to ensure that their findings are taken into account.

Additionally, relationship-building in the region is a key first step in the implementation of a PES system; since we were not from within the region, understanding who the stakeholders were and what their relationships were with each other was very time consuming. Moreover, getting access to people's contacts for both interviews and surveys implied a lot of time and effort, because we were not known and many were not willing to share information. As such, we recommend additional stakeholder engagement as part of the future work, especially with utilities. It is critical to engage them, as they will be the buyers of the program and therefore a key to its success. For this engagement to proceed, a stakeholder management and communication strategy should be developed and implemented, both at the beginning and throughout the program.

As mentioned previously, government participation is crucial to the success of the program. An analysis of their specific role was outside the scope of this project, but should be carried out to further understand how they can be involved in a way that furthers the conservation and water quality goals set out. Moreover, engagement with these actors to involve them in the program design and decision-making is recommended; as was stated in the

stakeholder matrix, state and local government as well as the Georgia Public Service Commission could be part of the governance of the project.

Along the same lines, more research should be done on the legal mechanisms and framework for the program operation. While we suggest a Land Management Service Agreement be used, further research and consulting with lawyers for the specifics of these agreements should be made. Moreover, buyers and sellers should then be consulted on the agreements to ensure they understand what they entail and they consent to them. In terms of the legal framework, further research should be done to ensure that there are no obstacles to the program implementation in accordance to state and local laws; it is clear that Georgia has a "gift clause" that does not allow for subsidies, but a deeper understanding of what the statutes and laws surrounding this program would be. This can be explored in Phase II, step #2 of the implementation guide.

Finally, engagement with stakeholders should start as soon as possible and continue throughout the design and implementation, as this is crucial to a successful program. This can be done through more interviews to better understand the level of acceptance of the program, as well as willingness to accept not only economically but in terms of what activities are implemented. Additionally, there should be participatory workshops to further inform the stakeholder analysis, and the design of the program.

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Appendix

A.1 Step-by-Step Guide

The step by step guide to implement a PES system can be accessed here: Step by Step Guide

A.2 Case Study Summaries

9 case studies on PES programs for water quality were analyzed, the summaries can be found here: Case Study Summary.

A.3 Stakeholder Interview Summaries

13 stakeholders were interviewed to inform the content of this report, and understand the context under which the program will be implemented. A summary of the interviews can be found here: Interview Summaries

A.4 Stakeholder Contact List

Based on the interviews conducted, information provided by GFF and independent research, a contact list of key stakeholders was developed. This also includes a log of communication or outreach done. The contact list can be found here: Master Contact List

A.5 Sample Surveys

Utility survey
Hydro survey
Corporation survey
Landowner A

A.6 Sample LMSA

See the Dovetail Report Chapter 6 for LMSA elements here:
(Katheryn, Fernholz, Ashley McFarland, James Klang. (2021) Understanding Payments for Ecosystem Services: Opportunities for Forests, Water and Private Landowners in Georgia and the Southeastern United States. Research Report. Dovetail Partners and TBL Consultants, LLC.)

A.7 Land Cover Analysis

HUC10_LandCoverAnalysis.xlsx
index.xlsx

A.8 Funding

Funding opportunities for source water protection and watershed planning efforts are being consolidated by:

- EPA Water Finance Clearinghouse
- U.S. Conference of Mayors – Local Infrastructure Hub
- Environmental Policy Innovation Center
- Naturally Resilient Communities partnership
- Georgetown's Climate Center

Additional funding opportunities include: 1) NFWS Resilient Communities Program, 2) FEMA's PDM program, 3) FEMA's BRIC program, 4) HUD's CDBG's, 5) USDA's EQIP, 6) EPA's technical assistance grant for rural…, 7) EPA's Environmental Justice Grants, 8) EPA's WIFIA program, and 9) NFWS America the Beautiful Challenge 10) USDA's EWP, 11) EPA's WIFIA, 12) USDA's RCPP

A.9 Utilities Summary

A list of the utilities in the Upper Oconee was developed to include name and basic information that could result in both their mapping and engagement. It can be accessed here: Utilities Summary.

A.10 Presentation Slidedeck

MP Presentation 4.10.22

A.11 Key References Bookmarks List

Literature Review and Case Study Resources

Bookmark Research List:
Ecosystem Services Market Development - Georgia Forestry Foundation
Forests & Water Connection Initiative
Duke-Forest-Strategic-Plan-Public-11Dec17.pdf
Management – Duke Forest

TNC Water Funds Toolbox
Home - U.S. Endowment for Forestry & Communities, Inc.
EnviroAtlas Interactive Map | US EPA
Appalachian Carbon Exchange
Criteria and Documents
Forest Inventory Analysis | Georgia Forestry Commission
Keeping Forests 2021 Year In Review - Emerging Markets Section - YouTube
download
Natural & Working Lands | NC DEQ
Upper_Oconee_Watershed_GIS_Mapping_Analysis_Report_UGA_Dwivedi_March192020.pdf
Southeastern Partnership for Forests & Water - Resources
Research Library - SE Partnership for Forestry and Water Quality
Upper Oconee Watershed Network – Protecting the Upper Oconee Watershed through monitoring, education, advocacy, and recreation
How's My Waterway - Community
Stormwater Management Program | Athens-Clarke County, GA - Official Website
Oconee Rivers Greenway Commission | Athens-Clarke County, GA - Official Website
Athens Land Trust
SPARROW Southeast
SPARROW Mappers | U.S. Geological Survey
Forest Vegetation Simulator (FVS)
onX: GPS Map Apps for Hunting, Hiking & Off-Roading
North Carolina Forest Service
Water Quality & BMPs | Georgia Forestry Commission
Keeping Forests
Savannah River Basin Watershed Assessment
Programs - Savannah Riverkeeper
Forests to Faucets 2.0
Final Registration List - GA
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Georgia Forestry Commission: Industry Directory
Georgia Forestry Commission: Industry Overview

Forest Inventory and Analysis National Program - Timber Products Output
Microsoft Word - Logging Haul Distances
Watershed Protection Branch - Lists | Environmental Protection Division
Student Resources | Georgia Forestry Commission
USDA - National Agricultural Statistics Service - Georgia
How's My Waterway - Community
Georgia Forestry Commission (/resources/directories/forestry-services-contractors/index.cfm)
Drinking Water | Environmental Protection Division
Forest Inventory and Analysis National Program - National Woodland Owner Survey
Drinking Water Mapping Application to Protect Source Waters (DWMAPS) | US EPA
Water Supply Watersheds | Environmental Protection Division
Georgia | US EPA
FRS Facility Query Results | Envirofacts | US EPA
Facility Registry Service (FRS) | US EPA
SDWIS Search | US EPA
FRS Query | US EPA
Data Downloads | US EPA
SDWIS Model | US EPA
Web Soil Survey - Home
Oconee River - Georgia Water Planning And Policy Center
Waters of the Oconee River Basin
We shouldn't have to wonder "Who is responsible for my water?" We should know
U.S. Community Water Systems Service Boundaries, v3.0.0 | CUAHSI HydroShare
A_Buyers_Guide_MontanaWaterRights
Watershed Protection Program | Raleigh
2015-2045 Conservation Strategy.pdf
Conserving Forests to Protect Water
Effect of Forest Cover on Water Treatment Costs | Water Economics and Policy
Watershed Protection & Management | Denver Water