IDENTIFYING AND PRIORITIZING POTENTIAL CONSERVATION SITES IN THE UPPER OCONEE SUBBASIN

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Abstract. Landscape scale conservation planning informed by stakeholders is necessary for effective conservation action. We developed a watershed level conservation planning approach by working with two local land trusts that operate in the Upper Oconee subbasin of northeast Georgia. Emphasizing the interdependency of ecological processes and human livelihood to area residents motivates stewardship; hence, we focused on conservation values that draw these linkages. In the United States, private landowner conservation is essential for successful protection of ecological processes and biodiversity. The prevalent route for involving private landowners with conservation is through partnerships with land trusts. A rapid proliferation of land trusts across the U.S. over the past decade indicates the increasing importance of private land conservation efforts. As our primary objective, we developed a GIS model for evaluating nine conservation features in the watershed using a weighted scoring system modified from the Georgia Land Conservation Program evaluation criteria. We extracted the 70 highest-ranking parcels as target recruitment parcels. The land trusts will begin targeting these 70 parcels for easement recruitment immediately. The second objective included quantifying these nine conservation features for current easements and other conservation lands to aid development of strategic conservation plans. Land trust personnel agreed with the relative scoring of their current holdings. We provided the land trusts access to the entire database of values for the features analyzed in all 34,024 parcels, empowering them to visit a potential easement site with *a priori* knowledge; thereby, enhancing the efficiency of their finite funding and personnel resources.

INTRODUCTION

Multitudes of global and continental scale conservation priority-setting schemes exist to date (Brooks et al. 2006). While attracting large sums of funding and donor support (Myers and Mittermeier 2003), the scales and subsequent coarse resolution data of these models are too general for pragmatic on-the-ground conservation planning and implementation efforts (Margules and Pressey 2000). To begin filling the research-implementation gap (Knight et al. 2008), we developed a stakeholder-informed, watershed level conservation planning approach by working with two local land trusts that operate in the Upper Oconee subbasin of northeast Georgia (Figure 1). In addition to the traditional conservation values relating to species richness, there are ecosystems and ecological processes highly valued by local watershed residents. Therefore, we selected conservation features for our model that act as proxies for conservation values that were identified as important to land trust personnel and that have value for resident well-being.

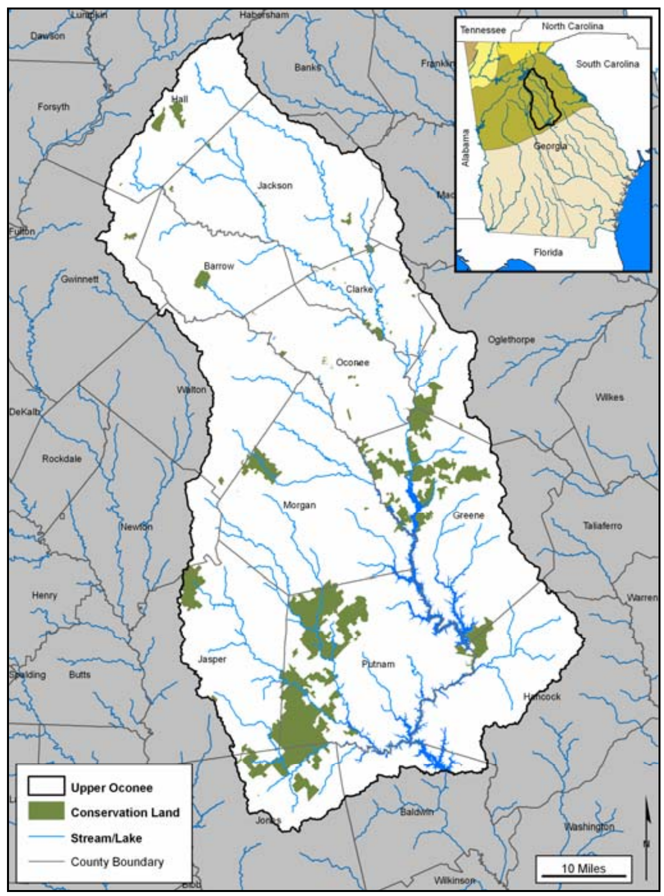

Figure 1. Map of the study site, the Upper Oconee subbasin, which is located in the Piedmont Physiographic Province in Northeast Georgia

BACKGROUND

Biodiversity has been the target of conservation efforts for at least two decades (Wilson et al. 1988). However, emphasizing the interdependency of ecological processes and human livelihood to area residents is important in addition to species richness indicators. Incorporation of an emerging concept that may afford this approach is not a new idea (Ehrlich and Mooney 1983), but a relatively recent popularization of the concept of ecosystem services (Costanza et al. 1997, Daily 1997, MEA 2005, Turner et al. 2007, Daily and Matson 2008). As defined by the United Nations' Millennium Ecosystem Assessment, ecosystems services are those environmental "goods and services provided by nature for the benefit of human welfare" (MEA 2005). The idea of ecosystem services allows for acknowledging more than the "intrinsic" value of biodiversity by expanding the breadth of the conservation argument to include the "utilitarian" values of nature (Daily 1997, Egoh et al. 2007). Hence, we chose to focus on conservation values that capture the concept of ecosystem services.

In the United States, motivating private landowners to engage in conservation is essential for successful protection of ecological processes and biodiversity (Wilcove et al. 1996, Scott et al. 2001, Merenlender et al. 2004, Rissman et al. 2007). The prevalent route for involving private landowners with conservation is through partnerships with land trusts, which are non-profit, non-governmental organizations (NGOs) that operate at scales ranging from the national level to state and local levels. Land trusts and private landowners enter into a contractual deed of conservation easement, defined as, "a voluntary legal agreement between a landowner and another party that restricts the development of a tract of land" in order to protect conservation values (Fowler 1998).[1] Essentially, a private landowner that enters into an easement agreement surrenders certain rights to the property while maintaining legal ownership of the land. The terms of the easement are unique to each property. Thus, each easement agreement includes various restrictions and permissions of land use.

The majority of land trusts are run by volunteers and have limited or no professional staff; hence, often landowners initiate easements rather than land trusts that have identified the most environmentally sensitive lands within their jurisdiction. This is motivating the scientific community to provide practitioners of private land conservation with a stakeholder-informed, scientifically driven model for recruiting easements. Another incentive is the rapid proliferation of land trusts across the U.S. over the past decade. Over the five year period 2000 – 2005, the number of land trusts registered with the Land Trust Alliance (LTA, a national-level umbrella organization for land trusts) increased by 32% to nearly 1700 organizations (LTA 2005). The acreage of land held under conservation easements by these organizations more than doubled in the same five-year period to 37 million acres (LTA 2005), which is nearly 2% of the conterminous U.S. land area using Scott et al.'s (2001) estimate of approximately 1.9 billion acres total. Considering that nature reserves constitute only about 6% of the conterminous U.S., this percentage is significant (Scott et al. 2001).

Furthermore, both the U.S. Congress and many state legislatures have recognized the public benefit of private land conservation through easements by increasing the associated income and property tax incentives. Landowners are able to apply for federal tax deductions and in some states, such as Georgia, tax credits. At least 12 states currently offer tax incentives programs (Young 2008). Local governments have joined the bandwagon also by providing property tax reductions that lower fair market value because of the encumbrance, as provided by state law. These economic incentives programs all indicate governmental recognition of the importance of private land conservation. This supports our claim of the need for scientific research to develop models for protecting private lands.

The first objective of our study was to identify and prioritize lands with high conservation value for the land trusts working in the Upper Oconee subbasin. We facilitated this objective by working with the Oconee River Land Trust (ORLT) and Athens Land Trust (ALT), and by gathering input from the land trusts on priority conservation values. Subsequently, we identified parcels of land that, if conserved, would aid maintenance and protection of critical ecological processes and important wildlife habitat. The identified conservation values included: air and water quality, flood and erosion regulation, habitat protection, and food production. Stakeholders identified water quality as one of the most important conservation values. Two-thirds of the conservation features used in the model catered to the protection of water quality, either directly or indirectly. A second goal included quantifying those conservation features that the land trusts are currently protecting to facilitate development of strategic conservation plans for easement recruitment campaigns.

METHODS

For the conservation assessment of the Upper Oconee subbasin, we focused on nine conservation features that the land trust personnel identified as important and that were easily mapped with the ArcGIS Desktop software (ESRI, Redlands, CA). The eleven datasets used for evaluating the conservation features were gathered or cre-

[1] Land trusts also purchase property, called fee simple acquisition.

ated, as necessary (Table 1). The land cover data accuracy allowed us to analyze parcels greater than or equal to five acres. We analyzed 34,024 parcels. Parcel data ranged from 2005 – 2007 for the entire region except for Hancock County, for which we had no data. Floodplain data were unavailable for Greene, Jasper, and Putnam counties, and prime farmland soils data were unavailable for Greene County. However, we evaluated parcels in these areas equally.

Table 1. GIS data layers used for prioritizing parcels; their sources, scales, and years.

(UGA NARSAL = University of Georgia Natural Resources Spatial Analysis Lab. GLUT = Georgia Land Use Trends. FEMA Q3 DFIRM = Federal Emergency Management Agency Q3 Digital Flood Insurance Maps. USGS NED = United States Geological Survey National Elevation Dataset. DNR WAP = Dept. Natural Resources Wildlife Action Plan. NRCS SSURGO = Natural Resources Conservation Science Soil Survey Geographic Database.)

GIS Data Layer	Data Source	Scale	Year
Stream Order	Created in a GIS	1:24K	1999
Natural Vegetation	UGA NARSAL GAP & GLUT	1:100K	2005
Impervious Surface Cover	UGA NARSAL GLUT	1:100K	2005
Floodplains	FEMA Q3 DFIRM	1:24K	2001
Wetlands	UGA NARSAL GLUT	1:100K	2005
Terrain Slope	USGS NED	1:100K	1999
Potential Conservation Opportunity Areas	GA DNR WAP	1:100K	2005
High Priority Waters	GA DNR WAP	1:100K	2005
Prime Farmlands	NRCS SSURGO	1:24K	2001
Connectivity	Created in a GIS	1:100K	2005
Parcels	Counties	1:24K	2005-07

Nine conservation features representing seven conservation values were evaluated for all parcels (Table 2). All features were analyzed using ArcGIS and three extensions: Spatial Analyst, Hawth's Analysis Tools (Beyer 2004) and Arc Hydro. We assessed stream order using USGS NHD 1:24K streams burned into the USGS NED 30m data and a sixteenth mile catchment minimum using Arc Hydro. This was done to extend the USGS stream lines, which have been shown to be an underestimate of actual headwater occurrences (Colson et al. 2008). The 2005 natural vegetation layer was calculated by adding 1998 Georgia GAP land cover data (Kramer et al. 2003) that were recoded for natural vegetation into a binary raster (see GA DNR 2005 for detailed method) with a binary raster of 2005 GLUT forest data (classes deciduous (41), evergreen (42), mixed (43), and forested wetland (91)). The extent of congruency between these two layers was the natural vegetation cover for our model. We used Hawth's Analysis Tools to calculate the percent of each land cover type, as well as the length of first and second order streams in each parcel.

Table 2. Seven GLCP conservation values and their respective conservation features' scoring categories for prioritizing parcels of the Upper Oconee subbasin

(PCOAs (Potential Conservation Opportunity Areas) and HPWs (High Priority Watersheds) are from the GA WAP (Georgia Wildlife Action Plan))

Conservation Value	*Conservation Feature*	*Score*			
		5	**3**	**1**	**0**
Water Quality Protection	Natural Vegetation Cover (%)	75 – 100	50 – 74	25 – 49	0 – 24
	Impervious Surface Cover of HUC 12 Sub-watershed (%)	< 5	5 – 10	-	≥ 1
Flood Protection	100-Year Flood Zone Cover (%)	≥ 50	25 – 49	1 – 24	< 1
	Headwater Streams (mi.)	≥ 1	0.5 – 0.9	0.1 – 0.4	< 0.1
Wetland Protection	Wetland Cover (%)	≥ 50	25 – 49	1 – 24	< 1
Erosion Reduction	Steep Slopes (%)	≥ 50	25 – 49	1 – 24	< 1
Habitat Protection	GA WAP Priority Area	PCOA	HPW	-	-
Agricultural Land Protection	Prime Agricultural Soils (%)	≥ 66	33 – 65	5 – 32	< 5
Landscape Connectivity	Connectivity to Conservation Lands & PCOAs	High	Moderate	Low	-

Connectivity of parcels to the protected areas in the GA DNR 2003 dataset, and to 100 ha core area PCOAs from the GA WAP, were evaluated by generating least cost distance rasters. We created these using PCOAs and protected areas as potential species source areas, and recoded 2005 GLUT land cover and impervious surface data as the cost rasters. The GLUT land cover data were reclassed as follows: rock outcrop (34), deciduous (41), mixed (43), forested wetland (91), and wetland (93) to highly passable (0); beach (7), open water (11), clear-cut and sparse (31), evergreen (42), row crops and pastures (81), to moderately passable (5); and low intensity urban (22) and high intensity urban (24) as low passability (20). We used the impervious surface raster to indicate those areas with relatively high impervious surface cover as greater costs, and to make roads and highways contiguous in the final corridor raster. We used Hawth's Analysis Tools to calculate relative cost values for each parcel. We classified parcel connectivity values into three natural categories using Jenk's Optimization (natural breaks), which seeks to minimize within class and maximize among class standard deviations.

We developed a weighted set of model parameters by assigning each parcel a score from a modified set of criteria drawn from the Georgia Land Conservation Program (GLCP, Table 2). The first model was our baseline model, totaling a possible 48 points. The second model was an area-weighted multiplicative (AWM) model, which corrected for the size differences of parcels. We multiplied baseline scores of parcels ranging 5 – 99 acres by a factor of 1, parcels ranging 100 – 499 acres by a factor of 3, and parcels over 500 acres by a factor of 5. A high score of 240 was possible.

To select target priority parcels for easement recruitment, we chose an areal target, T, of 2.75% of the subbasin. T was chosen to facilitate increasing the area protected in the Upper Oconee from its current extent of 7.25% to a total of 10%. Finally, we analyzed easements and fee simple holdings of both land trusts as well as other conservation lands to quantify the current protection status of these nine conservation features in the subbasin using the methods above. This step allows the land trusts to identify watershed level features in need of conservation and to develop planning strategies aimed at increasing their protection.

RESULTS

Of the Upper Oconee subbasin's 2,917 mi^2, natural vegetation covers 30% of the watershed. The total impervious surface cover is 2.3%, with the northwest region containing the highest coverage and the southwest region having the lowest coverage. 100-year flood zones cover 9.7% of the 1,802 mi^2 for which digitized data were available. Of the approximately 9,770 miles of GIS-calculated streams, 4,929 miles are first order streams and 2,271 miles are second order streams. This means that headwater streams, as estimated here, comprise 74% of all the streams in the subbasin. Wetlands cover 4.8%, and steep slopes extend over 0.2% of the subbasin. From the Georgia WAP, PCOAs cover 8.4%, and HPWs represent 29% of the subbasin's extent. Prime farmland soils cover 19% of the 2,400 mi^2 for which data were available.

Figure 2 shows the subbasin percentage of each feature protected in the 211.5 mi^2 of conservation lands for eight of the conservation features. Subwatershed impervious surface cover is not included because it was used as a negative indicator and is not desirable in protected areas. Landscape connectivity was categorical and was not included either. GA WAP priority areas are subdivided into their constituent parts of PCOAs and HPWs for Figure 2.

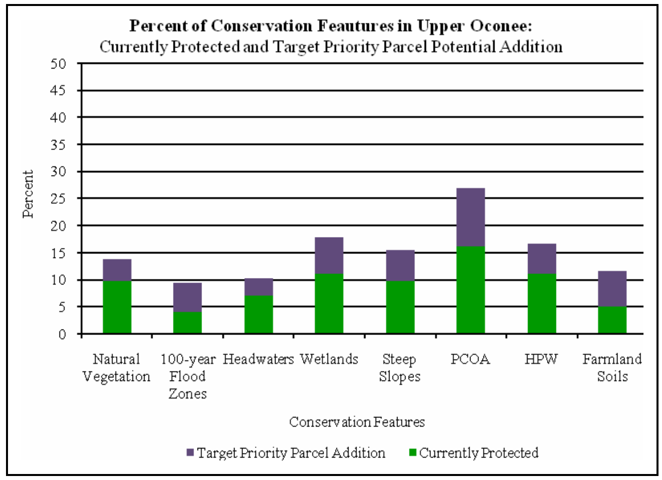

Figure 2. Percent of Upper Oconee conservation features currently protected and potential addition to that percentage from Target Priority Parcels.

Area-weighted multiplicative model scores ranged from 1 – 160, with a mean of 17.7 (Figure 3). The areal target, T, for priority area identification was defined as 2.75%; thus, the 70 highest scoring parcels were identified as the target priority parcels because they facilitated capturing T (Figure 4). These 70 parcels comprise 3.09% of the Upper Oconee subbasin. Scores ranged from 115 – 160.

Taken together, these 70 parcels encompass 35.6 mi^2 of natural vegetation; 9.4 mi^2 of 100-year flood zones; 222 miles of headwater streams; 9.4 mi^2 of wetlands; 180 acres of steep slopes; from the GA WAP, 26.7 mi^2 of PCOAs and 47.2 mi^2 of HPWs; and 30.2 mi^2 of prime farmland soils. All parcels are greater than 500 acres and located in an area identified as having a high landscape connectivity value. Figure 2 shows the potential percentage increase in these eight features' protection for the Upper Oconee Subbasin if the 70 target priority parcels were under easement.

At the time of analysis, ORLT and ALT had 20 and 14 easements and fee simple holdings in the Upper Oconee subbasin covering 1,314 and 638 GIS-calculated acres, respectively. Figure 4 shows the total acreage of eight conservation features, organized by land trust. ORLT and ALT are protecting eight and three miles, respectively, of headwater streams.

DISCUSSION

We met our objectives of 1) identifying and prioritizing parcels of land that contribute to conservation value and 2) quantifying current conservation features protected by existing land trust easements and fee simple holdings (Figures 2 and 4).

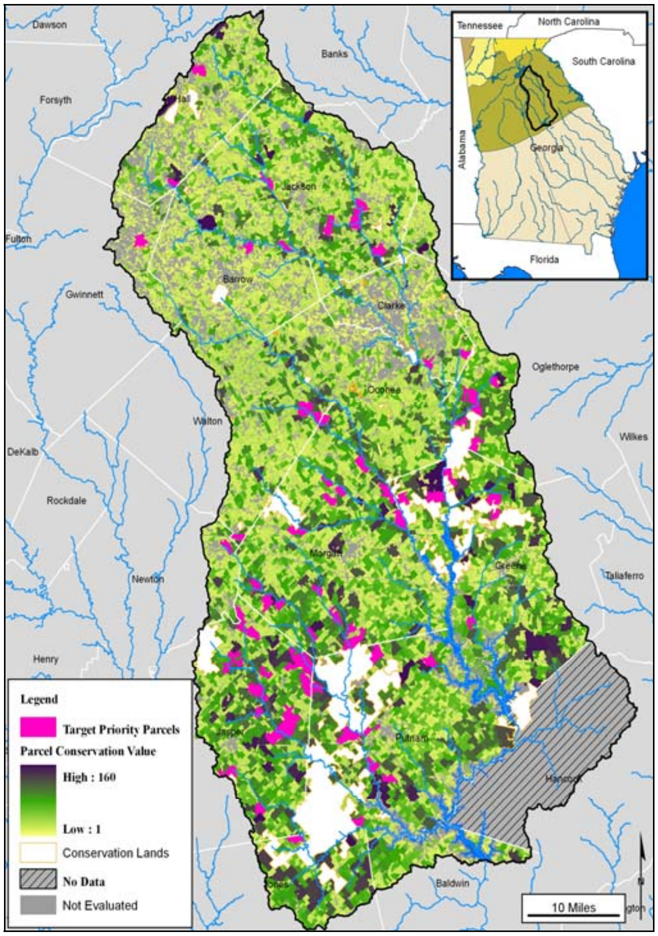

Figure 3. 70 target priority parcels with area-weighted scores for all parcels, excluding conservation lands. Higher scores equal higher conservation value.

As Figure 4 shows, the results for objective two answers the call of Rissman et al. (2007) for land trusts in the Upper Oconee subbasin. This will facilitate development of watershed level, easement recruitment strategies by the land trusts for protection of these conservation features. We chose to focus our efforts on the Upper Oconee subbasin for two reasons. First, Oconee River Land Trust and Athens Land Trust operate in the subbasin. Second, our interests were to identify specific landscape features that enhance water quality, such as wetlands and headwater streams. Watershed level planning is critical when targeting factors affecting water quality.

Upon completion of our study, UGA law students began working with the land trusts to develop a draft letter for contacting the owners of the target priority parcels. Further, the land trusts will use the database to contact landowners beyond the initial target. A significant side-benefit of this study is providing the land trusts access to the entire database of values for the features analyzed in all 34,024 parcels, which empowers them to visit potential easement sites with *a priori* knowledge.

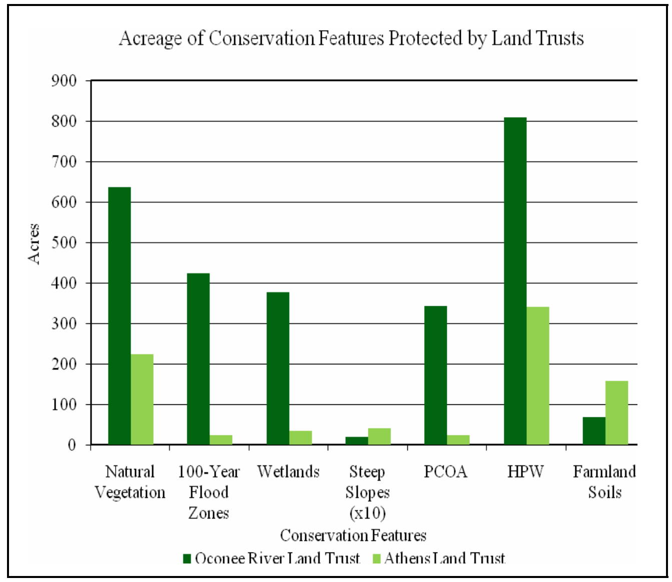

Figure 4. Acreage of eight conservation features protected by the land trusts. PCOA (Potential Conservation Opportunity Area) and HPW (High Priority Watershed) come from the GA WAP Priority Area feature in Table 2.

Our study extends the assessment made by GA DNR (2005), to identify areas with conservation values in addition to habitat and species of concern. Our model does not attempt to quantify the processes or ecosystem services provided by the conservation features, rather we view them as proxies for ecosystem services such as: air and water quality, flood and erosion regulation, and potential food production. Further, we recognize that only portions of the target parcels are of the greatest significance to stakeholder conservation goals. Further analyses using higher resolution analysis are required to identify which areas in the target parcels should be under easement.

A true accuracy assessment would benefit our results; however, due to time and financial constraints we assume the accuracy from the coarsest datasets in our model, the land cover and elevation datasets. However, we made visual assessments with 2007 National Agriculture Imagery Program (NAIP) photography to evaluate the target priority parcels. Moreover, ORLT board members agree with the relative scoring of ORLT's easements, which helps to strengthen the model's predictions, as they are experienced field staff and expert biologists with onsite knowledge of their easement holdings.

Other limitations in our analyses include the missing floodplain and prime farmland soils data, which may have skewed the results. However, many of the highest ranked parcels were in areas where the data were absent; thus, many of the highest-ranking parcels would likely be even more strongly implicated for conservation action. Additionally, although we explicitly chose to increase the number of headwater streams in our analysis beyond the USGS 1:24K streams based on the findings of Colson et al. (2008), our analysis may have spatially misidentified and/or wrongly quantified headwater streams as a result of the low accuracy of the 30m NED, leading to a misrepresentation of features contained within parcels.

CONCLUSIONS

In conclusion, conservation practitioners need services that link existing scientific data to their missions of preserving ecological processes and wildlife habitats. Developing processes and tools to facilitate the transfer of scientific knowledge into the conservation community is paramount to a successful conservation paradigm and to closing the research-implementation gap (Knight et al. 2008). Finally, It is important to recognize that any prioritization process necessarily chooses to value one set of parameters at the expense of others. There is no model that can capture the breadth of values and features we need to protect and conserve. Conservation modelers and practitioners are wise to keep these thoughts in mind throughout all phases of development and implementation of conservation strategies.

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