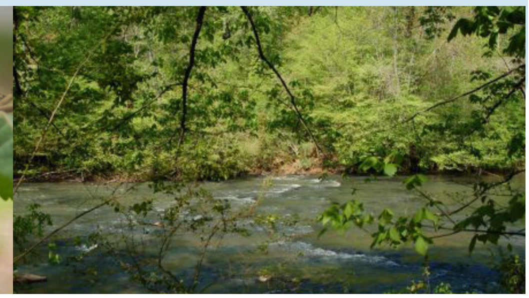
Motivating Private Landowner Conservation to Maximize Ecosystem Services





Dean Hardy
August 2008

river basin CENTER

ODUM SCHOOL OF ECOLOGY | THE UNIVERSITY OF GEORGIA

Funds for this project were provided by the Georgia Forestry Commission's Urban and Community Forestry Grant Program, 2007–2008.

river basin CENTER

Odum School of Ecology
The University of Georgia

Georgia Forestry Commission

MOTIVATING PRIVATE LANDOWNER CONSERVATION TO MAXIMIZE ECOSYSTEM SERVICES

Dean Hardy
River Basin Center, Odum School of Ecology, University of Georgia

Abstract

Motivating private landowners to engage in conservation is imperative for successful biodiversity preservation and protection of ecosystem processes in the United States. The existing public lands system was not designed to protect biodiversity or critical ecosystems. The prevalent route for involving private landowners with conservation is through partnerships with land trusts, whereby land trusts and private landowners enter into a contractual deed of conservation easement. A rapid proliferation of land trusts across the U.S. over the past decade has signified the increased awareness of the importance of private land conservation efforts. In addition to the contemporary conservation easements process conducted by the majority of land trusts, which is opportunistic in nature and allows continued uses that might jeopardize ecological resources, a more proactive approach is needed to secure the critical habitats and ecosystems for the survival of species, including humans. The purpose of this project is to assist two local land trusts operating in the Upper Oconee Subbasin of northeast Georgia, Oconee River Land Trust (ORLT) and Athens Land Trust (ALT), with development of easement recruitment campaigns that will become part of their strategic conservation plans. Private parcels were ranked in a GIS following a scoring system modified from the Georgia Land Conservation Program's criteria. The 16 highest ranking parcels were extracted as *Parcels of Potential Conservation Importance* and visually assessed with 2007 aerial imagery. Further analysis included evaluating current easements. Land trust staff agreed with the relative scoring of easements. Beginning immediately, priority parcels will be targeted by the land trusts for easement recruitment. Further, by providing the land trusts access to the entire database of values for features analyzed for all 34,468 parcels, they are empowered to visit a potential easement site with *a priori* knowledge; thus enhancing finite funding and personnel resources.

Keywords: conservation easements, land trusts, priority areas, ecosystem services, Upper Oconee

Introduction

Motivation

Motivating private landowners to engage in conservation is imperative for successful biodiversity preservation and protection of ecosystem processes in the United States (Wilcove et al. 1996, Scott et al. 2001, Merenlender et al. 2004, Rissman et al. 2007). Estimates of the distributions of threatened and endangered plant and animal species suggest that greater than 90% occur on private lands, while two-thirds of these species are estimated to have more than 60% of their habitat on such lands (GAO 1994, Groves et al. 2000). The United States public lands system was originally established in the early 20th century in areas having high recreational and/or aesthetic value and without commercial interest and human presence, (Pressey 1994)[1]. These areas were not designated using biodiversity or other biological parameters; thus, much of the currently held public lands do not protect regions of high biodiversity or valuable ecosystem processes. Using two criteria as proxies for biodiversity, elevation and soil productivity, Scott et al. (2001), found that the majority of U.S. nature reserves (national parks, national forests, designated wilderness areas, national wildlife refuges, Indian reservations, and county parks) are at high elevations in regions of low soil productivity. This is in contrast to the biogeographical distribution estimates of most species, which are found at low elevations on higher productivity soils (Scott et al. 2001). Additionally, Noss et al. (1995) observed that 126 ecosystems in the U.S. are in at least a threatened state, indicating loss of valuable ecosystem processes. This leads me to surmise that with less than 6% of the conterminous U.S. in nature reserves (Scott et al. 2001) that the majority of these ecosystems and their processes most likely occur on private lands. Thus, engaging private landowners with a voluntary, incentive-based conservation plan is critical for protection of biodiversity and ecosystems processes.

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 (e.g. The Nature Conservancy (TNC)) to state (e.g. Georgia Land Trust) and local levels.[2] 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). 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. Examples of rights that are often restricted include: subdivision of the property, construction in sensitive areas, clearcutting of timber, and alteration of the topography. Examples of rights that are often reserved include: hunting, farming, selective timber harvesting, and development in specific areas of the property. However, there is *no* standard and each easement agreement can include any variation of the above-mentioned restrictions and permitted uses, plus an entire array of other property rights and restrictions.

The biological importance of private lands (Groves et al. 2000) and the opportunistic nature of conservation easement agreements[3] is motivating the scientific community to provide practitioners of private land conservation with a scientifically-informed model for procuring easements. Of further encouragement is the rapid proliferation of land trusts across the U.S. over the past decade, signifying an increased awareness of the importance of private land conservation efforts in the broader community. Over a 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 registered organizations (LTA 2005). The acreage of land held under conservation easements by these organizations more than doubled in the same

---

[1] It is important to recognize that there was not always a lack of human presence in these areas. They were often inhabited by Native Americans (Spence 1999).

[2] Land trusts also provide protection in some cases by purchasing land in fee simple and dedicating it to one or more conservation uses.

[3] Given the fact that the majority of land trusts are run by volunteers and have no professional staff, most easements are currently initiated by landowners rather than by land trusts which have identified the most environmentally sensitive lands within their jurisdiction.

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. This percentage is significant considering that only about 6% of the conterminous U.S. is held in nature reserves (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. Congress increased the tax deduction for the years 2006–2009 from 30% of adjusted gross income (AGI) over six years to 50% of AGI over 16 years (100% for ranchers and farmers) in August 2006, retroactive to January 1st of that year. At least 12 states currently offer tax incentives programs (Young 2008). The Georgia Conservation Tax Credit Act (H.B. 1107) which established Georgia's first state-level tax incentive for landowners entering into conservation easements, was passed in April of 2006. The resulting incentive allows for a state tax credit of 25% of the fair market value of the easement up to $250K applied over six years. A tax credit is different from a deduction in that the credit is a direct subtraction from taxes owed, rather than a deduction on taxable income, as with the federal incentives program. Local governments have joined the bandwagon by providing property tax reductions where the fair market value has been reduced as a result of the encumbrance. These economic incentives programs all indicate governmental recognition of the importance of private land conservation, and the need for scientific research to develop models for protecting private lands.

In order to determine the effectiveness of conservation easements in protecting biodiversity, we need a comprehensive quantification of the species and ecosystems being protected. This set of data do not currently exist because published data are too aggregated (Merenlender et al. 2004). However, Rissman et al. (2007) undertook an analysis of 119 easements held by TNC (the largest land trust) and found that nearly 50% were working landscapes, meaning agriculture and ranching were still permitted, and that 85% still allowed some form of residential or commercial use. Rissman et al. (2007) indicate that these findings suggest the likelihood of habitat disturbance and fragmentation in these areas.

In addition to the contemporary conservation easement recruitment process conducted by the majority of land trusts, which is opportunistic in nature and allows continued uses that might jeopardize ecological resources, a more proactive approach is needed to secure the critical habitats and ecosystems for the survival of species, including humans. This need is in accord with the results of the Rissman et al. (2007) study mentioned above and the acknowledgement by Merenlender et al. (2004) that current easement holdings are not quantifiable biologically due to disparate data held by land trusts. Thus, scientific research that enhances the biological sustainability components of private land conservation through quantification of these properties is needed by the land trust community.

Moreover, if land trusts go beyond the existing, tax-based, incentives package by utilizing a more methodical and targeted approach that incorporates ecosystems and their processes, the ecological relevance of easements could be strengthened, thereby enriching the validity of private lands conservation. Incorporation of an emerging concept that may afford this approach, which is not a new idea (Ehrlich and Mooney 1983), but a relatively recent recognition of the utility of the concept of *ecosystem services*, which has re-entered conservation literature and efforts (Costanza et al. 1997, Daily 1997, MEA 2005, Turner et al. 2007). 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 just the "intrinsic" value of biodiversity and expands the breadth of the conservation argument to include the "utilitarian" values of nature (Daily 1997, Egoh et al. 2007). Although conservation practitioners should be conscious of the implications of incorporating nature into the market place (Heal 2000, Ghazoul 2007, 2008), and careful in their assumptions about how to value ecosystem services (Bockstael et al. 2000), the support that conservation may garner from the public by implicating a broader audience in the benefits of conservation through the concept of ecosystem services may outweigh the cost of susceptibility to market fluctuations. However, in implementing such a shift, conservation practitioners should understand how to best maximize the efficiency of conservation efforts by comprehending the benefits and costs associated with the trade-offs between conservation for biodiversity and for ecosystem services, which are not always equal in spatial or temporal domains (Chan et al. 2006, Naidoo and Ricketts 2006, Chan et al. 2007). Thus, an intention of this project is to merge, in part, protection of wildlife habitat, while concomitantly protecting those ecosystems and their processes that provide valuable ecosystem services.

Purpose

The purpose of this project is to assist two local land trusts operating in the Upper Oconee subbasin of northeast Georgia, Oconee River Land Trust (ORLT) and Athens Land Trust (ALT), with development of easement recruitment campaigns that will become part of their strategic conservation plans. This goal was facilitated through gathering input from land trust staffs on priority landscape values, and subsequently identifying parcels of land that are priorities for maintaining and protecting important wildlife habitat and critical ecosystem services, such as: large intact forests, flood mitigation, water quality and quantity, erosion control, air quality, and food production. Additionally, the parcel prioritization scheme benefits the land trusts' limited funding and personnel resources by providing target areas, maximizing resource use. Promoting increased forest cover through limiting development in the landscape benefits wildlife, air and water quality, and, ultimately, downstream users of the ecosystem services provided. This research enables increased protection of these resources by helping local conservation organizations develop proactive management plans, in turn leading to more effective recruitment of conservation easements.

Objectives

The **primary objective** of this project is to identify those top-ranking parcels of land in the Upper Oconee subbasin that maximize the protection of wildlife habitat and ecosystem services. The parameters are taken directly from or derived from existing land cover data, as well as other GIS data sources. These data are used to evaluate relative conservation importance of parcels in the subbasin, emphasizing ecosystem services, specifically those that are associated with the Georgia Land Conservation Program (GLCP). Habitat connectivity and area are also included. The seven primary categories of this study are taken directly from GLCP, and the subcategories are modified to fit the existing data in the GIS. The **second objective** is to document these features under currently held ORLT and ALT easements.

Methods

Study Site

The study site is the Upper Oconee subbasin (Hydrologic Unit Code 8, or HUC 8) in northeast Georgia located in the piedmont ecoregion (Omernik 1987), and covers 2915 mi^2 (Figure 1).

GIS Data Layers

Table 1 shows a list of the data used for evaluating parcels and each dataset's attributed information. Appendix I – GIS Data Layers, shows the spatial representations of the individual datasets (Figures 1 - 10). All datasets were obtained from their respective sources (Table 1) and reprojected (if necessary) into North American Datum (NAD) 83 Universal Transverse Mercator (UTM) Zone 17N before analyses began. Dates for parcel data range from 2005 – 2007, and were obtained from Northeast Georgia and Middle Georgia Regional Development Centers, as well as Gwinnett County's GIS Deptartment. All of the data layers were then clipped to the extent of the Upper Oconee for evaluation of parcels.

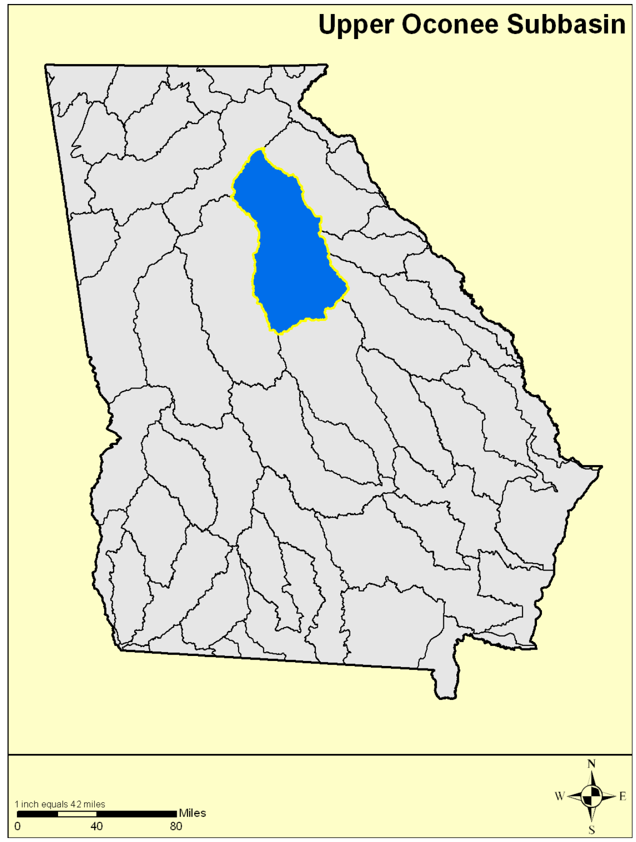


Figure 1 USGS HUC 8 boundaries of Georgia clipped to its borders. The Upper Oconee subbasin is highlighted blue.

Parcel data for Hancock County in the southeast corner of the study region have not been digitized, thus this area was not evaluated. Floodplain data from FEMA's Q3 floodmaps were not available for Greene, Jasper, and Putnam counties. Prime farmland soils from the SSURGO dataset were not available for Greene County. However, parcels in these counties were evaluated equally (see Appendix I Figures 4 and 9 for spatial extents). Only parcels that had their centroid in the Upper Oconee and that were greater than or equal to five acres were evaluated. The resolution and resulting accuracy of the land cover data that were used limits the minimum mapping unit to five acres. Parcels less than five acres were denoted as not evaluated in the results. 34,468 parcels were evaluated.

Scoring

An additive model was developed by assigning each parcel of land in the Upper Oconee a score based on a subset of partially modified criteria drawn from the Georgia Land Conservation Program (GLCP) Evaluation Criteria. The GLCP criteria were chosen as a guideline based on recommendations from land trust and GA DNR staff. The text box insert displays a list of these criteria's 10 categories with the ratio of points available in this project's model to those available on the GLCP evaluation form in parantheses. The seven categories boxed in red were used in the current model. For a detailed description of the current model's scoring method, see Table 2., and for spatial representations of each of the 11 parameters used, see Appendix II, Figures 1-12.

Table 1 GIS data layers used for prioritizing parcels, their sources, scales, and years. EPD = Environmental Protection Division. 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
303D Listed Streams	GA EPD	1:24,000	2002
Natural Vegetation	UGA NARSAL GAP & GLUT	1:100,000	2005
Impervious Surface Cover	UGA NARSAL GLUT	1:100,000	2005
Floodplains	FEMA Q3 DFIRM	1:24,000	2001
Wetlands	UGA NARSAL GLUT	1:100,000	2005
Terrain Slope	USGS NED	1:24,000	1999
Potential Conservation Opportunity Areas	GA DNR WAP	1:100,000	2005
High Priority Waters	GA DNR WAP	1:100,000	2005
Prime Farmlands	NRCS SSURGO	1:24,000	2001
Connectivity	Created in a GIS	1:100,000	2005

Text Box Insert

Georgia Land Conservation Program Categories

1. Water quality protection for rivers, streams, and lakes (23/50);
2. Flood protection (5/10);
3. Wetlands protection (5/15);
4. Reduction of erosion through protection of steep slopes, areas with erodible soils and stream banks (5/20);
5. Protection of riparian buffers and other areas that serve as natural habitat and corridors for native plant and animal species (8/33);
6. Protection of prime agricultural and forestry lands (10/20);
7. Protection of cultural sites, heritage corridors, and archaeological and historic resources (0/20);
8. Scenic protection (0/10);
9. Provision of recreation in the form of boating, hiking, camping, fishing, hunting, running, jogging, biking, walking, and similar outdoor activities (0/42); and
10. Connection of existing or planned areas contributing to the goals set out in this paragraph (5/20) (O.C.G.A. Sec. 36-22-1 (5)).

Factor 1: Water Quality Protection

Parcels were evaluated for intersection with 303d stream features that were located within a 100 foot buffer of the stream's linear representation. The buffer helps correct for spatial inconsistencies in the two datasets (parcels and streams), and the inherent misrepresentation of rivers as linear lines with no breadth. 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 of recoding) with a binary raster of 2005 GLUT forest data (classes deciduous (41), evergreen (42), mixed (43), and forested wetland (91)). The locations where these two rasters overlayed were considered to be an updated (2005) extent of natural vegetation cover for this research. Impervious surface cover percentage was evaluated for each parcel and for each HUC 10 watershed in the Upper Oconee using Hawth's Tools' Zonal Stats ++ tool.

Factor 2: Floodplain Protection

Hawth's Tools' *Polygon in Polygon Analysis* tool was used to evaluate the percent of FEMA Q3 DFIRMs in each parcel.

Factor 3: Wetland Protection

2005 GLUT data were reclassified into a binary raster composed of wetlands and no wetlands for the Upper Oconee. Hawth's Tools' *Zonal Stats ++* tool was used to calculate the percent of wetland data in each parcel.

Factor 4: Erosion Reduction

USGS NED 10m DEM data were used to calculate slopes for the study region. The resulting slope raster was recoded into a binary raster of slopes greater than or equal

Table 2 Seven criteria and their subcategories with the scoring system used for evaluating parcels of the Upper Oconee Subbasin. Subcategories marked with an asterisk denote modification of GLCP criteria.

CRITERIA	Subcategory	5	3	1	0
FACTOR 1: *WATER QUALITY PROTECTION*	≥ 100m from 303d Evaluated Stream Segment*	Supporting	Partially Supporting	-	-
	Natural Vegetation Cover	75 – 100 %	50 – 74 %	25 – 49 %	0 – 24 %
	Impervious Surface Cover	0 – 0.4 %	0.5 – 0.9 %	1 – 2.9 %	≥ 3%
	Impervious Surface Cover of HUC 10 Watershed	0 – 0.4 %	0.5 – 1.9 %	2 – 4.9 %	≥ 5%
FACTOR 2: *FLOOD PROTECTION*	100 Year Flood Zone Cover	≥ 50 %	25 – 49 %	1 – 24 %	< 1 %
FACTOR 3: *WETLANDS PROTECTION*	Wetland Cover*	≥ 50 %	25 – 49 %	1 – 24 %	< 1 %
FACTOR 4: *EROSION REDUCTION*	Percent of Slopes ≥ 20%	≥ 50 %	25 – 49 %	1 – 24 %	< 1 %
FACTOR 5: *GEORGIA WAP*	Located in PCOA or HPW	PCOA	HPW	-	-
FACTOR 6: *PRIME AGRICULTURAL LANDS & AREA PROTECTED*	Prime Agricultural Land*	≥ 66 %	33 – 65 %	5 – 32 %	< 5 %
	Size of Parcel*	≥ 500 acres	100 – 499 acres	5 – 99 acres	-
FACTOR 7: *LANDSCAPE CONNECTIVITY*	Connectivity to Conservation Lands	High	Moderate	Low	-

to 20% and slopes less than 20%. Hawth's Tools' *Zonal Stats ++* tool was used to evaluate the percentage of each parcel with slopes ≥ 20%.

Factor 5: Georgia WAP

All parcels having their centroid in the High Priority Watersheds or Potential Conservation Opportunity Areas from the Georgia WAP (GA DNR 2005) were marked.

Factor 6: Prime Agricultural Lands & Area Protected

2001 NRCS SSURGO data were used to create a GIS layer of those lands with prime farmland soils. Hawth's Tools' *Polygon in Polygon Analysis* tool was used to evaluate the percent of prime farmland soils in each parcel.

Factor 7: Landscape Connectivity

Connectivity of parcels to existing conservation lands in the DNR database were evaluated by generating least cost distance rasters. These were created using existing conservation lands as 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: open water (11), rock outcrop (34), deciduous (41), mixed (43), forested wetland (91), and wetland (93) to highly passable (0); beach (7), clearcut and sparse (31), evergreen (42), row crops and pastures (81), to moderately passable (50); and low intensity urban (22) and high intensity urban (24) as low passability (100). The impervious surface raster was used to indicate those areas with high impervious surface cover as higher costs, and to make roads and highways more contiguous in the final corridor raster. Hawth's Tools *Zonal Stats* ++ tool was used to calculate relative cost values for each parcel. Parcels were classified into three natural categories using Jenk's Optimization (i.e. natural breaks) that seeks to minimize within class standard deviation and maximize between class standard deviation.

Models

Three models were developed that emphasize different aspects of the criteria evaluated. The first model is a purely additive model resulting in a raw score of the criteria used, totalling a possible 61 points (see Table 2 for details).

The second model is an area-weighted multiplicative model, which underscores the size of available habitat. This scoring method utilizes the results of the additive model, but emphasizes the importance of area by multiplying the raw score from the additive model by an area-weighted factor. Raw scores of parcels ranging 5–99 acres were multiplied by a factor of 1, parcels ranging 100–499 acres were multiplied by a factor of 3, and parcels ranging over 500 acres were multiplied by a factor of 5. A high score of 305 is possible.

The third model is a connectivity-weighted multiplicative model, which emphasizes biological connectivity in the landscape. Parcels were ranked according to Jenk's Optimization as described above for factor 7 into three natural categories, low, moderate, and high. Raw scores from the additive model were then multiplied by 1, 3, and 5, respectively, for each of these connectivity rankings. A high score of 305 is possible.

The final result is a combination of the two multiplicative models. The 98th percentiles of each of the two models were determined, and parcels that achieved this percentile from both models were denoted as *Parcels of Potential Conservation Importance*.

Results

Objective 1: Upper Oconee Priority Parcels

Figure 2 shows the additive model's raw scores for the evaluated parcels using the scoring system in Table 2. The highest ranking parcels scored 42 out of 61 possible points. Figure 3 displays the spatial distribution of the area-weighted multiplicative (AWM) model and the top 60 parcels in the 98th percentile. AWM model high scores were 210 out of 305 possible

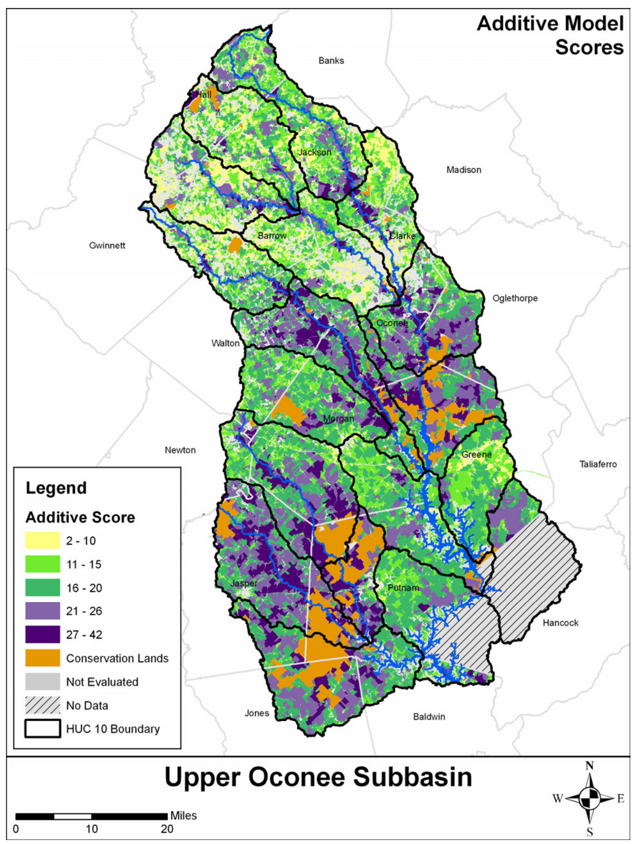


Figure 2 Relative ranking of parcels in the Upper Oconee Subbasin evaluated by an additive model score derived from 10 biological parameters similar to the Georgia Land Conservation Program criteria. Categories were determined using Jenk's Optimization.

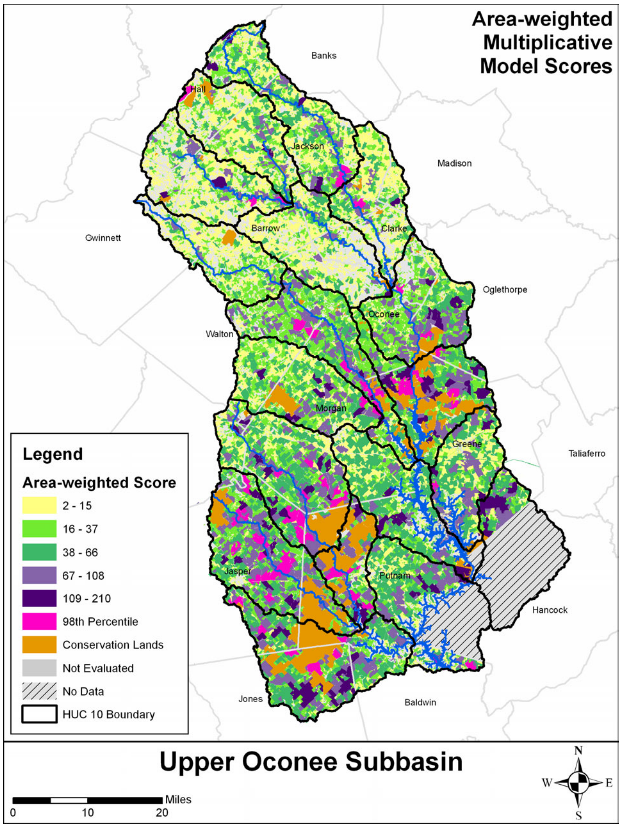


Figure 3 Relative ranking of parcels in the Upper Oconee Subbasin determined by an area-weighted multiplicative model score derived from 10 biological parameters similar to the Georgia Land Conservation Program criteria. Categories were determined using Jenk's Optimization.

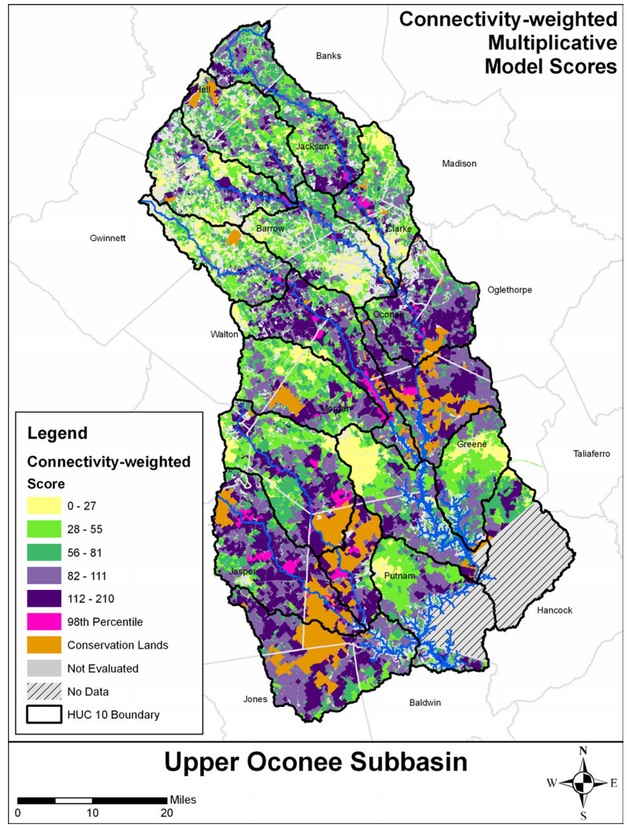


Figure 4 Relative ranking of parcels in the Upper Oconee Subbasin determined by a connectivity-weighted multiplicative model score derived from 10 biological parameters similar to the Georgia Land Conservation Program criteria. Categories were determined using Jenk's Optimization.

points. Figure 4 represents the spatial distribution of the connectivity-weighted multiplicative (CWM) model and the 132 parcels in the 98th percentile. The highest scores for the CWM model were 210 out of 305 possible points.

Figure 5 is the overlay of the AWM and CWM models, and the *Parcels of Potential Conservation Importance* are those that met the 98th percentile for both models. 16 parcels were congruent from these two layers, sharing a high score for area and landscape connectivity. Table 3 shows the parcel information associated with each of the 16 highest ranking parcels shown in Figure 5.

Objective 2: Existing Conservation Easements

Tables 4 and 5 show scores and relative ranks of existing conservation easements for each of the three models (Additive, AWM, CWM models) in decreasing order of conservation value for ORLT and ALT, respectively. Easement parcel values for features analyzed are available in an Excel spreadsheet as an associated file with this report (ParcelAnalysis.xls).

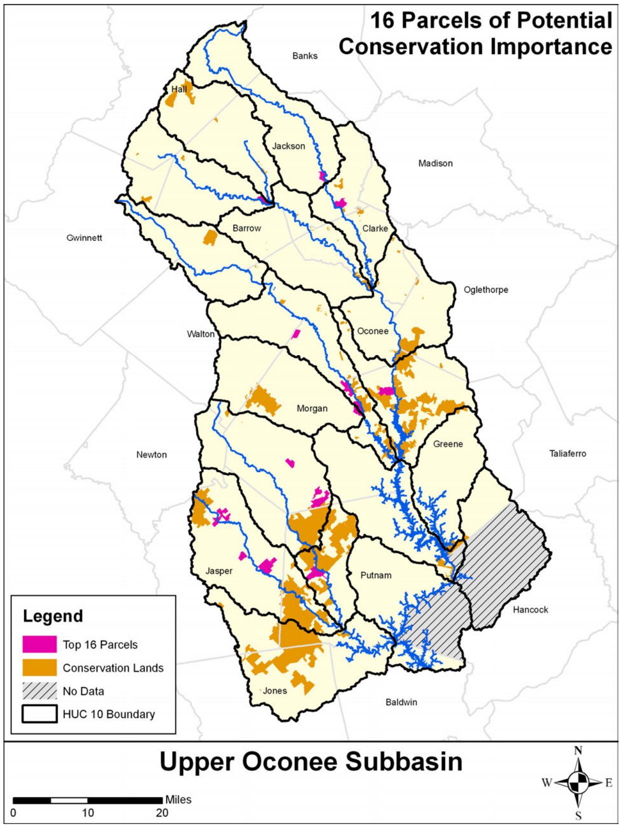


Figure 5 16 Parcels of Potential Conservation Importance derived from the addition of two multiplicative models 98th percentiles, which emphasize parcel area and landscape connectivity with existing conservation lands. These parcels are of potential conservation importance for the preservation of ecosystem services and wildlife habitat.

Further, large tracts of forest are implicated by high percentages of canopy cover. Although not used as a parameter in the model, all but two of the 16 parcels have canopy cover of >65%.

The model appears to have worked well; however, without ground-truthing, it is difficult to evaluate the accuracy of the model's ranking system. Aerial-truthing with (NAIP) 2007 National Agriculture Imagery Program photography was conducted and 14 of the 16 proposed high priority parcels were determined to be correctly classed and scored. Jasper county parcels 030 001 and 030 003 were aerially identified as row crop agriculture, conctrary to the 2005 GLUT classification of mostly evergreen and deciduous forests. In the

Discussion

The project objectives of 1) identifying the highest priority parcels of privately owned land for conservation in the Upper Oconee, and 2) documenting current ecosystem services of easements were met.

The primary objective was met through identification of the 16 highest ranking parcels in the subbasin. These parcels all rank high in size, landscape connectivity, and especially in naturally vegetated forest. 12 of the 16 parcels have over 300 acres of natural vegetation and all 16 coincide with PCOAs, and 11 are in HPWs of the Georgia WAP. Thus, in turn, this project can be viewed as an extension to the assessment made by Georgia DNR staff persons, Matt Elliot and Chris Canalos (GA DNR 2005), that evaluated large tracts of critical wildlife habitat. The extension explicitly targets ecosystems (e.g. wetlands, floodplains) that harness critical ecosystem processes (e.g. flood mitigation, water filtration), which are highly valued ecosystem services for the end users, citizens of Georgia.

Table 3 Parcel information for the highest ranking 16 Parcels of Potential Conservation Importance resulting from the addition of the 98th percentiles from the AWM and CWM models. These parcels are of potential conservation importance for the preservation of ecosystem services and wildlife habitat.

PARCEL NO.	COUNTY	GIS ACRES	ADDITIVE	Area-WMM	Connectivity-WMM
033 016	Morgan	1326.3	42	210	210
056 052	Morgan	502.7	39	195	195
029 058	Jasper	532.5	38	190	190
016 000 0010	Greene	1337.4	37	185	185
024 043	Morgan	1109.4	37	185	185
035 004	Putnam	1532.1	36	180	180
027 001	Jackson	641.3	35	175	175
085 001	Jackson	643.2	35	175	175
017 067	Jackson	962.2	34	170	170
010 044	Jasper	1519.3	34	170	170
030 003	Jasper	781.1	34	170	170
030 001	Jasper	1123.2	34	170	170
055 048	Morgan	1028.4	34	170	170
038 026	Morgan	582.8	34	170	170
055 013	Morgan	540.5	34	170	170
002 001	Morgan	613.9	34	170	170

Conservation Value

coming year, site visits with land trust staff will take place at these 14 parcels, and potentially other higher scoring parcels. Additionally, 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 biologists.

The two land trusts that were the target audiences of this project, were actively engaged in the preliminary phases. They assisted with determining which data to include in the modeling process, answering questions concerning how to best meet their organizations' conservation goals and objectives. Beginning immediately, these 14 priority parcels will be targeted by the land trusts' staff persons for easement recruitment. Further, by providing the land trusts access to the entire database of values for features analyzed for all 34,468 parcels, they are empowered to visit a potential easement site with *a priori* knowledge. This will also assist with making the decision of whether or not to visit a potential easement site.

In addition to the Excel database of the parcels, the land trusts will also have access to GeoPDFs®[4] of the highest ranking parcels, as well as the GIS spatial database. This will provide them opportunities of examining potential easement sites from within the office, and viewing landscape features in and around the parcel of interest; thus, conserving finite funding and resources by limiting potentially unnecessary site visits.

Table 4 Oconee River Land Trust's easement analysis showing scores from three models. Easements are ranked in decreasing order of conservation importance.

NAME	COUNTY	GIS ACRES	ADDITIVE	Area-WMM	Connectivity-WMM
FENNELL	JACKSON	132.7	41	123	205
JEFFCO	JACKSON	177.2	33	99	165
MULBERRY	BARROW	33.9	28	28	140
BEAR CREEK	JACKSON	10.5	27	27	135
GUMLOG-RIVERMIST	JACKSON	103.8	27	81	135
MULBERRY #2	BARROW	32.4	26	26	130
BATH	OCONEE	261.4	26	78	130
COOK	JACKSON	41.6	23	23	115
KESLER	JACKSON	7.7	22	22	110
BOULDER SPRINGS	OCONEE	137.9	22	66	110
ODUM	CLARKE	16.1	19	19	95
NATURE WALK	CLARKE	45.4	18	18	90
GOLDTHWAITE	WALTON	78.1	18	18	90
WRIGHT WIDENER	OGLETHORPE	11.4	17	17	85
THOMAS FARMS	CLARKE	47.5	17	17	85
DOVE CREEK	OCONEE	44.7	16	16	80
HELFMAN MEYERS	OGLETHORPE	8.6	15	15	75
MARTIN MEADOWS	CLARKE	79.1	15	15	75
ROLLING GLEN	OCONEE	33.3	14	14	70
NATURE WALK	CLARKE	7.0	12	12	60

Conservation Value

Table 5 Athens Land Trust's easement analysis showing scores from three models. Easements are ranked in decreasing order of conservation value.

NAME	COUNTY	GIS ACRES	ADDITIVE	Area-WMM	Connectivity-WMM
HATMAKER	CLARKE	27.5	26	26	130
JORDAN	CLARKE	14.3	25	25	125
MITCHELL FARM	OCONEE	193.0	23	69	115
BRYANT	OCONEE	58.9	22	22	110
HOUSE FARM	OCONEE	143.1	21	63	105
LANGDALE FARM	CLARKE	69.4	20	20	100
MILFORD HILLS	CLARKE	24.3	18	18	90
KENNEY RIDGE #2	CLARKE	17.2	17	17	85
BRYANT	OCONEE	10.2	16	16	80
BOWDEN PARK	CLARKE	17.7	16	16	80
HOUSE FARM	OCONEE	19.3	16	16	80
FIVE ACRES WOODS	CLARKE	5.0	15	15	75
PINECREST	CLARKE	10.2	15	15	75
KENNEY RIDGE #3	CLARKE	17.3	14	14	70
KENNEY RIDGE #1	CLARKE	4.5	13	0	65

Conservation Value

A weakness in the model includes a lack of headwater stream proximities to parcels as a parameter in the analyses. This undermines the significance of headwater streams' contributions to water quality, a valuable resource for downstream users. The missing floodplain and prime farmland soils data may have skewed the results, although many of the highest ranked parcels are in areas where the absent data (e.g. floodplains in Jasper County) would be located; thus, many of the highest ranking parcels would be more strongly implicated for conservation action.

[4] A product of TerraGo Technologies®. An interactive geospatially referenced PDF.

Conclusion

Future variations of the model will include a sensitivity analysis, truthing against empirical data (e.g. Christmas bird counts & species of concern occurrence data), a headwater streams factor, and a dichotomous prioritizing process that ranks urban parcels separately from non-urban parcels utilizing census population data. This last component acknowledges the importance of greenspace in urban settings that may not be recognized by the current model's scoring system due to the emphasis on parcel size and natural vegetation cover. Urban forest patches and greenspaces are important for recreation, and may function as vital wildlife corridors, especially for migrating birds. Another variation will likely include using units of analysis of equal size, for example, 50 acres. This will allow us to target ecosystems of interest that result as low percentages due to large parcel tracts or division by parcel lines in this model.

In conclusion, it is important to recognize that any prioritization process necessarily chooses to value one set of parameters at the expense of others. For example, in this model, cultural heritage sites, viewsheds, and agricultural lands (although partially encapsulated through the prime agricultural soils parameter) were not evaluated, thereby denying representation to these valuable historical, scenic, and vital landscape features. This is not to discredit the prioritized parcels or modeling process of this project. The intention here is to make aware end users of this and other priority models, that all features are not considered in prioritization schemes. The chosen parameters are intended to answer one set of questions, as accurately as possible. There is no model that can capture the breadth of interested values and features we wish 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.

References

Bockstael, N. E., A. M. Freeman, R. J. Kopp, P. R. Portney, and V. K. Smith. 2000. On measuring economic values for nature. Environmental Science & Technology **34**:1384-1389.

Chan, K. M. A., R. M. Pringle, J. Ranganathan, C. L. Boggs, Y. L. Chan, P. R. Ehrlich, P. K. Haff, N. E. Heller, K. Al-Krafaji, and D. P. Macmynowski. 2007. When agendas collide: Human welfare and biological conservation. Conservation Biology **21**:59-68.

Chan, K. M. A., M. R. Shaw, D. R. Cameron, E. C. Underwood, and G. C. Daily. 2006. Conservation planning for ecosystem services. Plos Biology **4**:2138-2152.

Costanza, R., R. dArge, R. deGroot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. Oneill, J. Paruelo, R. G. Raskin, P. Sutton, and M. vandenBelt. 1997. The value of the world's ecosystem services and natural capital. Nature **387**:253-260.

Daily, G. C. 1997. Nature's services : societal dependence on natural ecosystems. Island Press, Washington, DC.

Egoh, B., M. Rouget, B. Reyers, A. T. Knight, R. M. Cowling, A. S. van Jaarsveld, and A. Welz. 2007. Integrating ecosystem services into conservation assessments: A review. Ecological Economics **63**:714-721.

Ehrlich, P. R. and H. A. Mooney. 1983. Extinction, Substitution, and Ecosystem Services. BioScience **33**:248-254.

Fowler, L. 1998. A Landowner's Guide: Conservation easements for natural resource protection. Georgia Land Trust Service Center.

GA DNR. 2005. Wildlife Action Plan for Georgia. Wildlife Resources Division.

GAO. 1994. Endangered Species Act: Information on Species Protection on Nonfederal lands. U. S. General Accounting Office, Washington, D.C.

Ghazoul, J. 2007. Challenges to the uptake of the ecosystem service rationale for conservation. Conservation Biology **21**:1651-1652.

Ghazoul, J. 2008. The ecosystem service controversy: There is sufficient evidence for controversy. Gaia-Ecological Perspectives for Science and Society **17**:17-18.

Groves, C. R., R. L. S. Kutner, D. M. Storms, M. P. Murray, J. M. Scott, M. Schafale, A. S. Weakley, and R. L. Pressey. 2000. Owning up to our responsibilities: who owns lands important for biodiversity. Pages xxv, 399 p. *in* B. A. Stein, L. S. Kutner, J. S. Adams, Nature Conservancy (U.S.), and Association for Biodiversity Information., editors. Precious heritage : the status of biodiversity in the United States. Oxford University Press, Oxford ; New York.

Heal, G. 2000. Valuing ecosystem services. Ecosystems **3**:24-30.

Kramer, E., M. J. Conroy, M. J. Elliot, E. A. Anderson, W. R. Burnback, and J. Epstein. 2003. The Georgia Gap Analysis Project. University of Georgia and USGS, Athens, GA.

LTA. 2005. National Land Trust Census Report. Land Trust Alliance, Washington D.C.

MEA. 2005. Ecosystems and human well-being : synthesis. Island Press, Washington, DC.

Merenlender, A. M., L. Huntsinger, G. Guthey, and S. K. Fairfax. 2004. Land trusts and conservation easements: Who is conserving what for whom? Conservation Biology **18**:65-75.

Naidoo, R. and T. H. Ricketts. 2006. Mapping the economic costs and benefits of conservation. Plos Biology **4**:2153-2164.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of the loss and degradation. Biological Report 28, U.S. Department of the Interior, National Biological Service, Washington, D.C.

Pressey, R. L. 1994. Ad Hoc Reservations - Forward or Backward Steps in Developing Representative Reserve Systems. Conservation Biology **8**:662-668.

Rissman, A. R., L. Lozier, T. Comendant, P. Kareiva, J. M. Kiesecker, M. R. Shaw, and A. M. Merenlender. 2007. Conservation easements: Biodiversity protection and private use. Conservation Biology **21**:709-718.

Scott, J. M., F. W. Davis, R. G. McGhie, R. G. Wright, C. Groves, and J. Estes. 2001. Nature reserves: Do they capture the full range of America's biological diversity? Ecological Applications **11**:999-1007.

Spence, M. D. 1999. Dispossessing the wilderness : Indian removal and the making of the national parks. Oxford University Press, New York.

Turner, W. R., K. Brandon, T. M. Brooks, R. Costanza, G. A. B. da Fonseca, and R. Portela. 2007. Global conservation of biodiversity and ecosystem services. Bioscience **57**:868-873.

Wilcove, D. S., M. J. Bean, R. Bonnie, and M. McMillan. 1996. Rebuilding the Ark: Toward a More Effective Endangered Species Act for Private Land. Environmental Defense Fund, Washington, D.C.

Young, C. L. 2008. Conservation Easement Tax Credits in Environmental Federalism.117 Yale L.J. Pocket Part 218, http://thepocketpart.org/2008/04/01/young.html.

Appendix I – GIS Data Layers

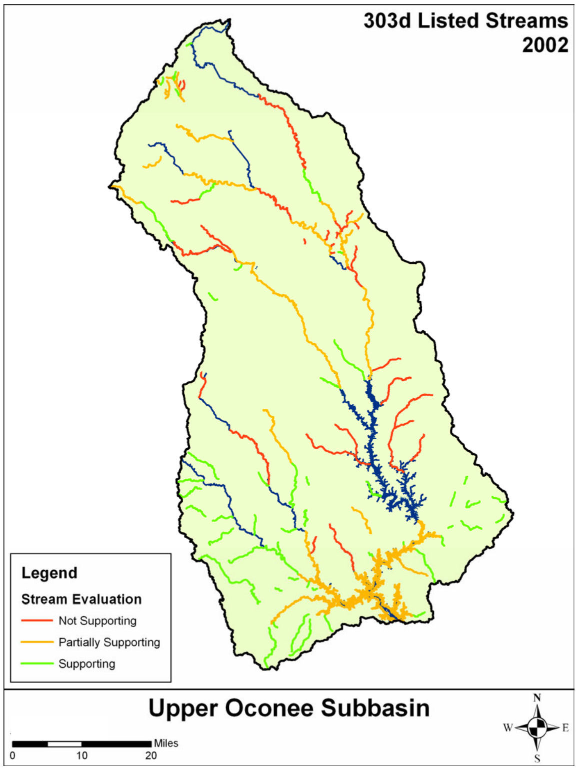


Figure 1 303d listed streams evaluations from GA EPD 2002 dataset for the Upper Oconee Subbasin.

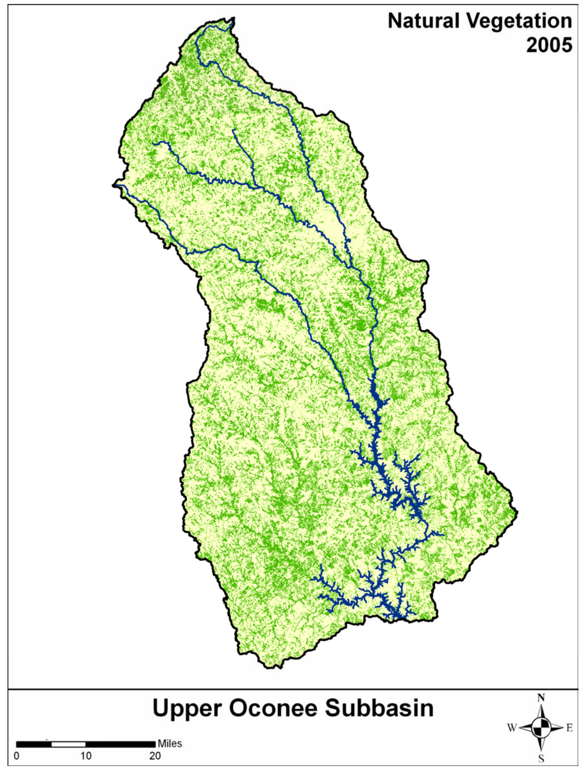


Figure 2 Natural vegetation derived from 1998 GA GAP and 2005 GLUT data for the Upper Oconee Subbasin.

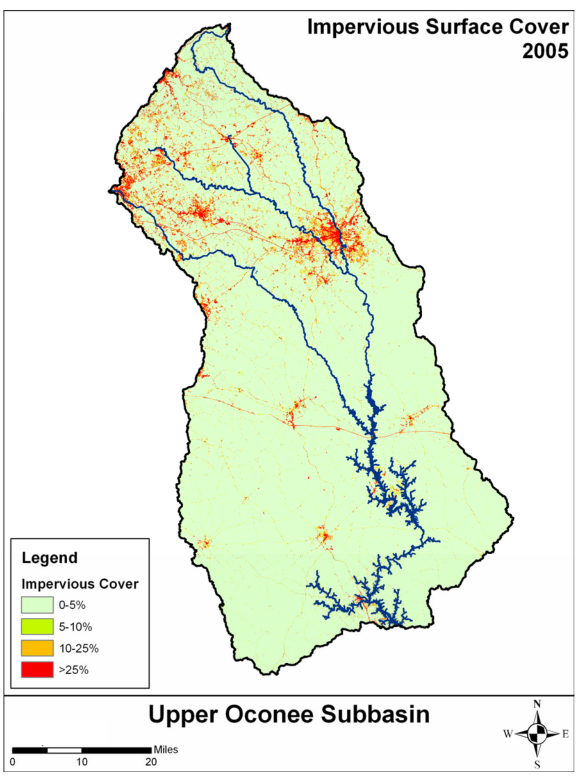


Figure 3 Impervious surface cover from 2005 GLUT dataset for the Upper Oconee Subbasin.

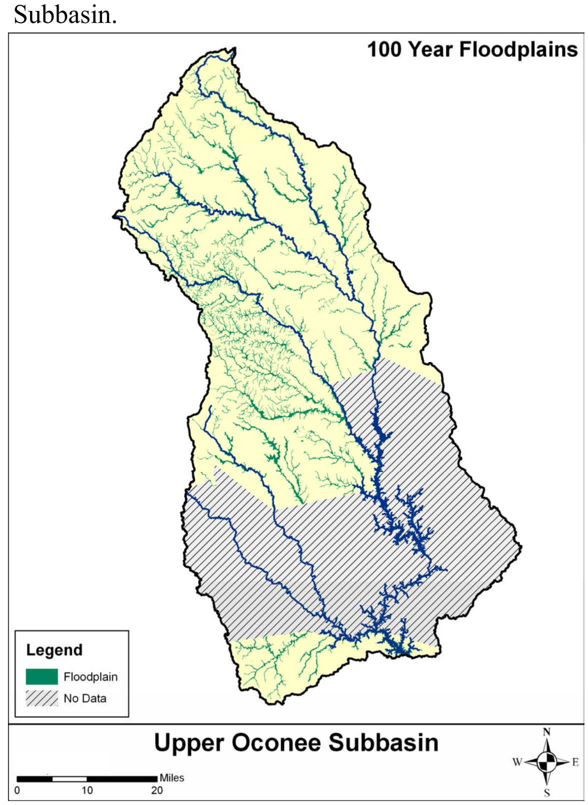


Figure 4 100 year floodzones from the 2001 FEMA Q3 DFIRM dataset for the Upper Oconee Subbasin.

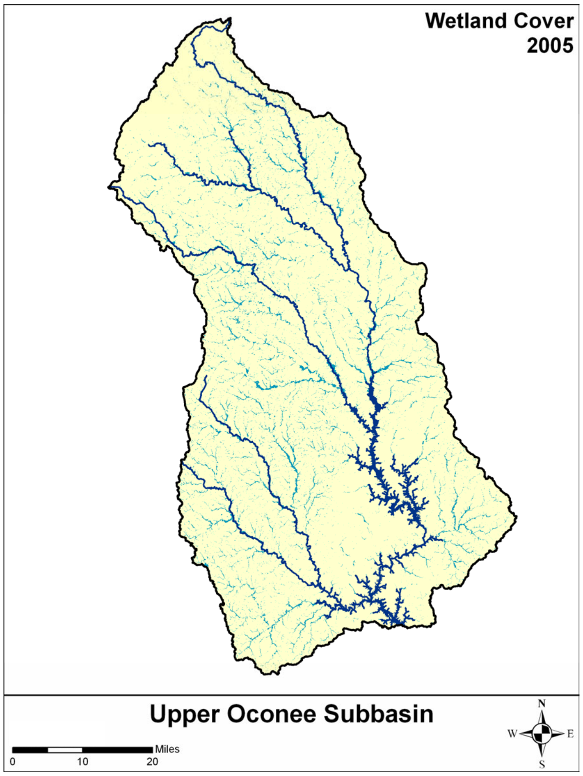


Figure 5 Wetland cover from the 2005 GLUT dataset for the Upper Oconee Subbasin.

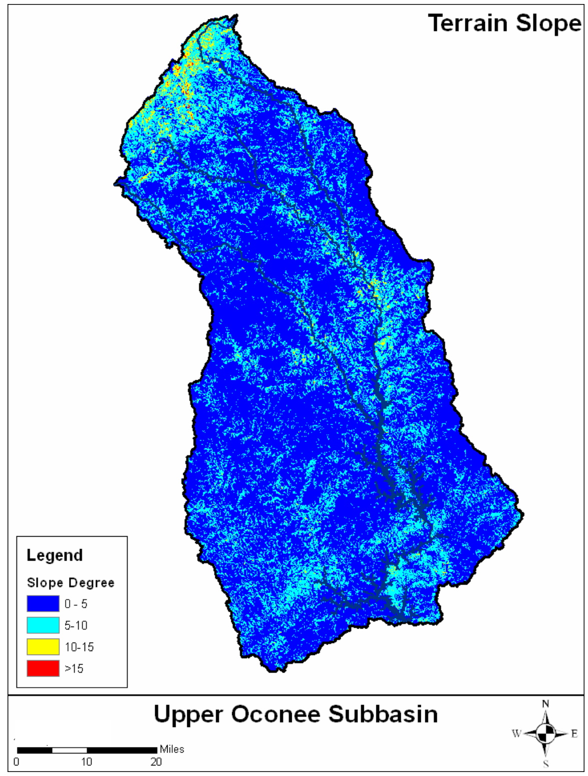


Figure 6 Terrain slope from the 1999 USGS NED dataset for the Upper Oconee Subbasin.

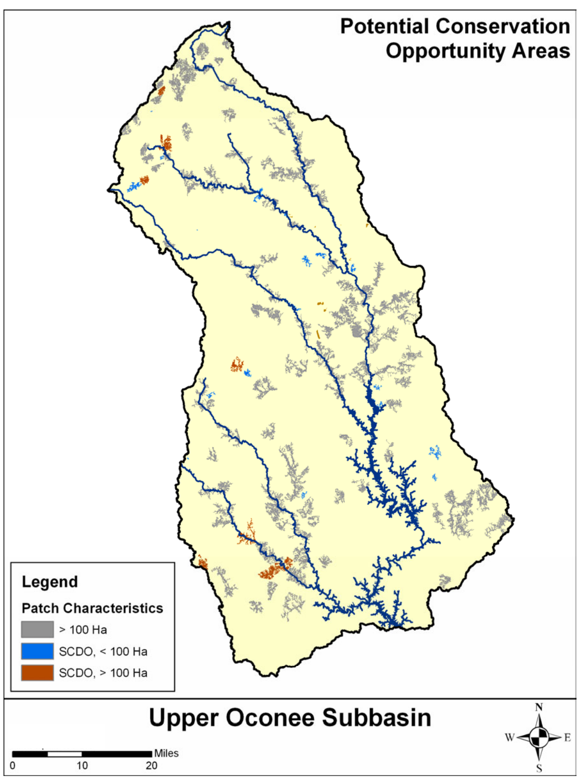


Figure 7 Potential conservation opportunity areas from the 2005 GA WAP for the Upper Oconee Subbasin.

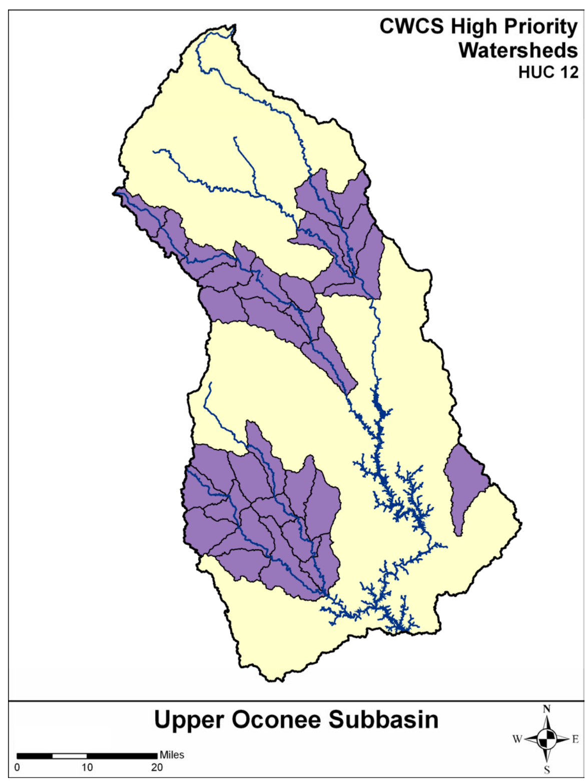


Figure 8 High priority waters from the 2005 GA WAP for the Upper Oconee Subbasin.

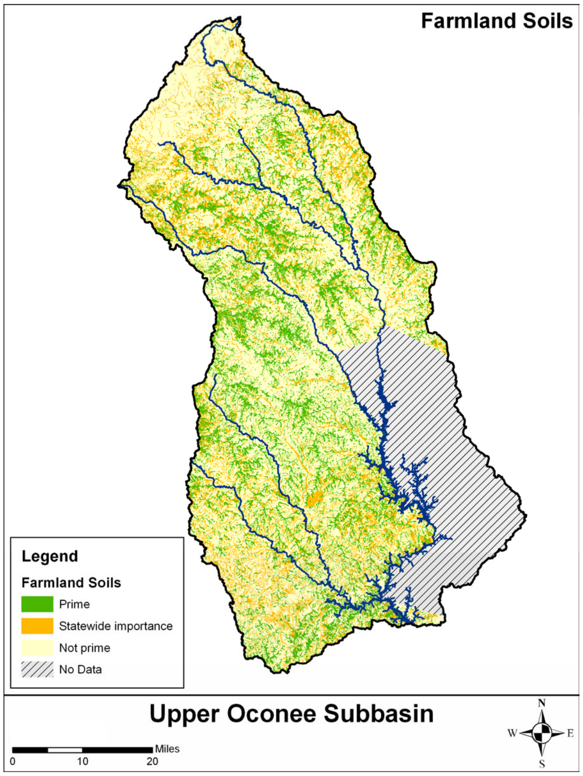


Figure 9 Prime farmland soils from the 2001 NRCS SSURGO dataset for the Upper Oconee Subbasin.

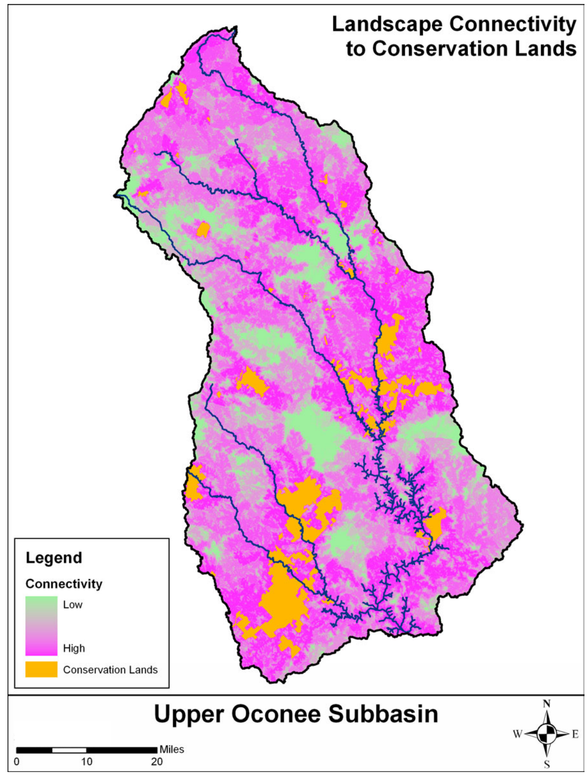


Figure 10 Landscape connectivity to existing conservation lands derived from the 2005 GLUT dataset for the Upper Oconee Subbasin.

Appendix II – Parcel Evaluations

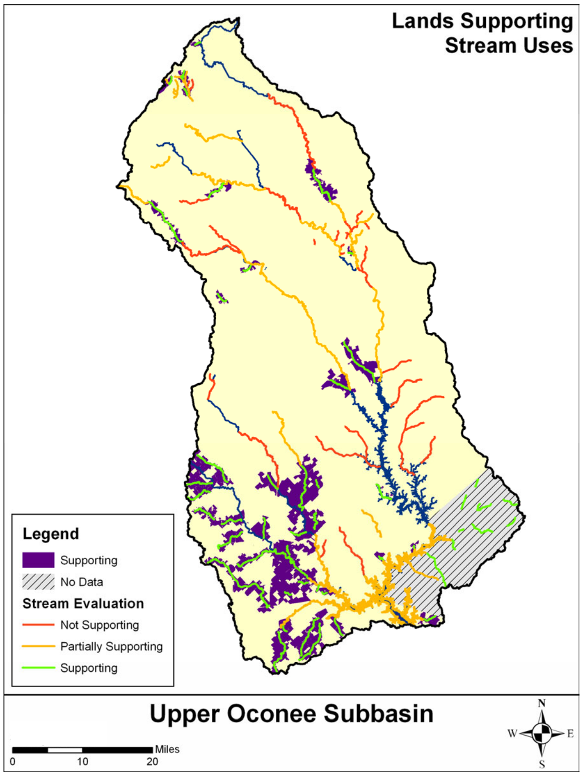


Figure 1 Upper Oconee parcels adjacent to streams supporting uses per the 2002 GA EPD 303d list.

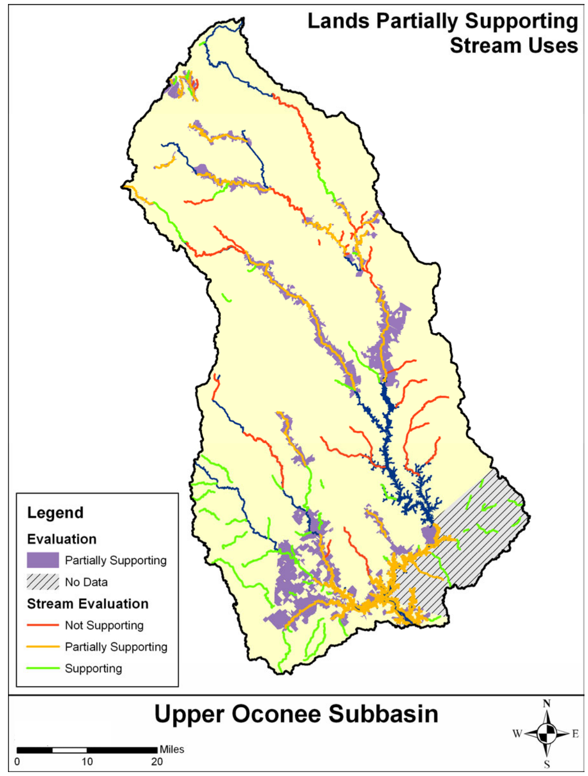


Figure 2 Upper Oconee parcels adjacent to streams partially supporting uses from 2002 GA EPD 303d list.

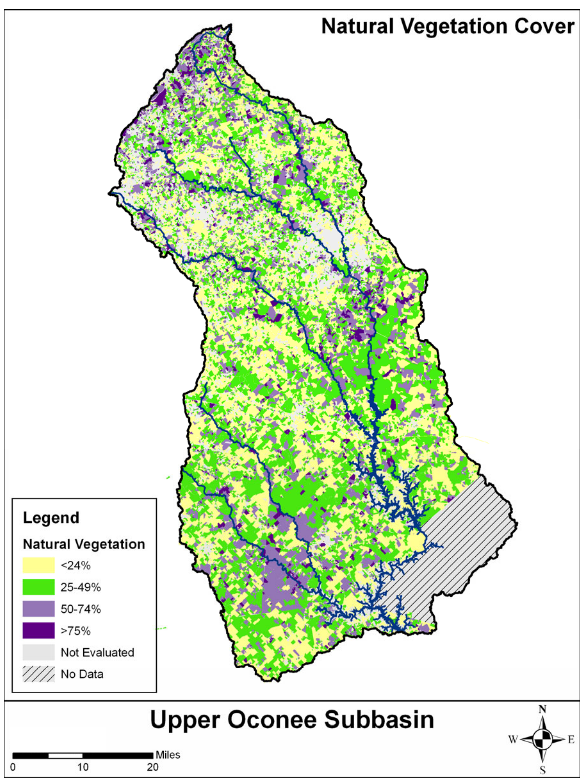


Figure 3 Upper Oconee parcels ranked into four scoring categories for natural vegetation cover from the 1998 GA GAP and 2005 GLUT datasets

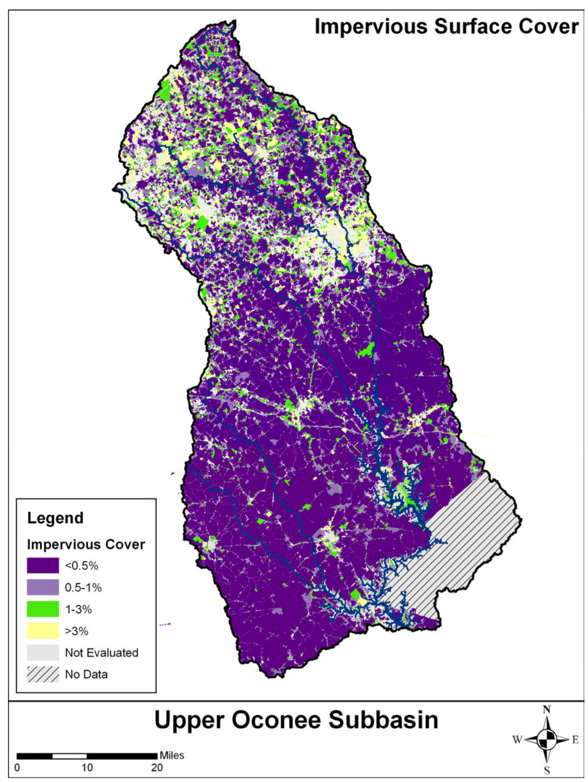


Figure 4 Upper Oconee parcels ranked into four scoring categories for impervious surface cover from the 2005 GLUT dataset.

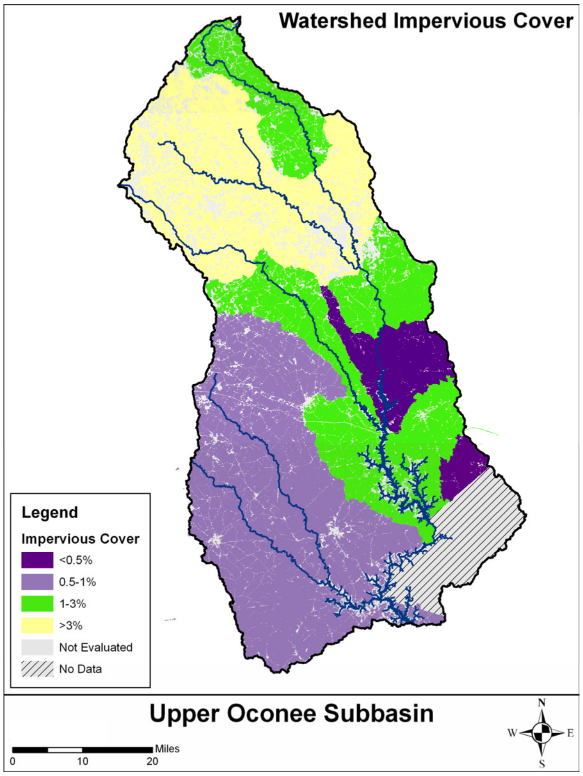


Figure 5 Upper Oconee parcels ranked into four categories based on HUC 10 watershed impervious surface cover from the 2005 GLUT dataset.

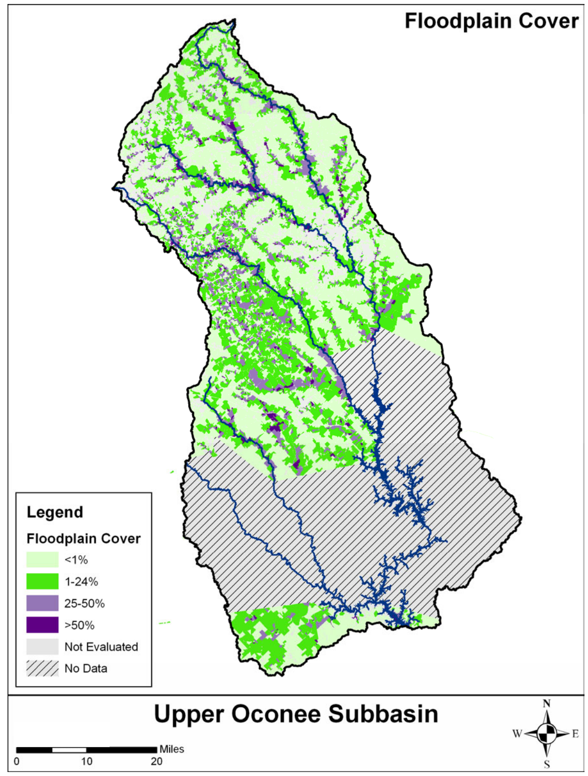


Figure 6 Upper Oconee parcels ranked into four categories for 100 year floodplain cover from the 2001 FEMA Q3 DFIRM dataset.

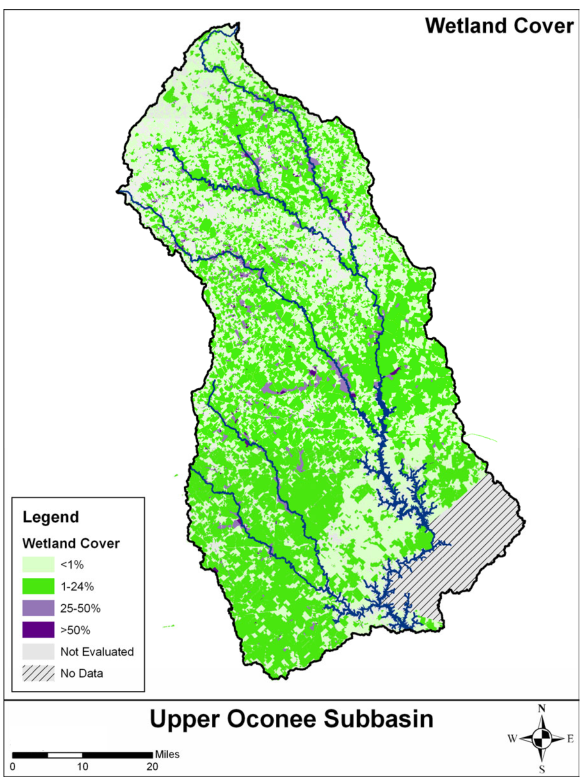


Figure 7 Upper Oconee parcels ranked into four categories of wetland cover from the 2005 GLUT dataset.

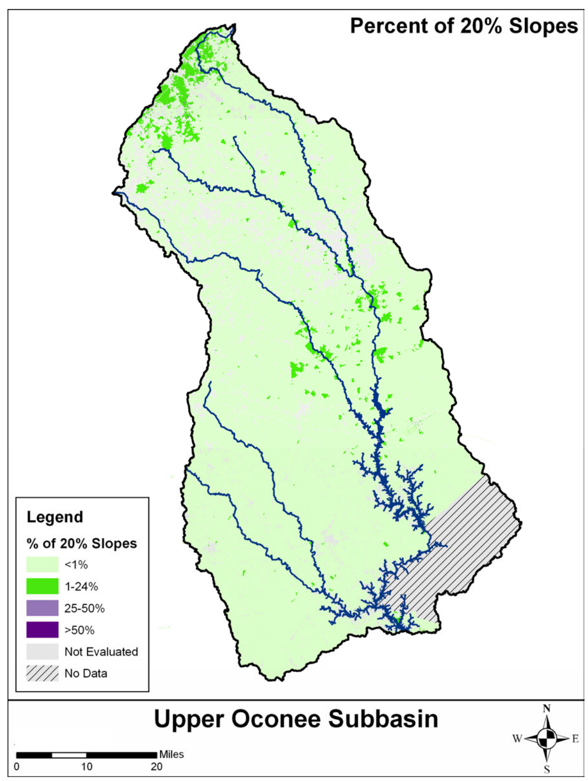


Figure 8 Upper Oconee parcels ranked into four categories of percent cover of slopes $\geq$ 20% from the 1999 USGS NED dataset.

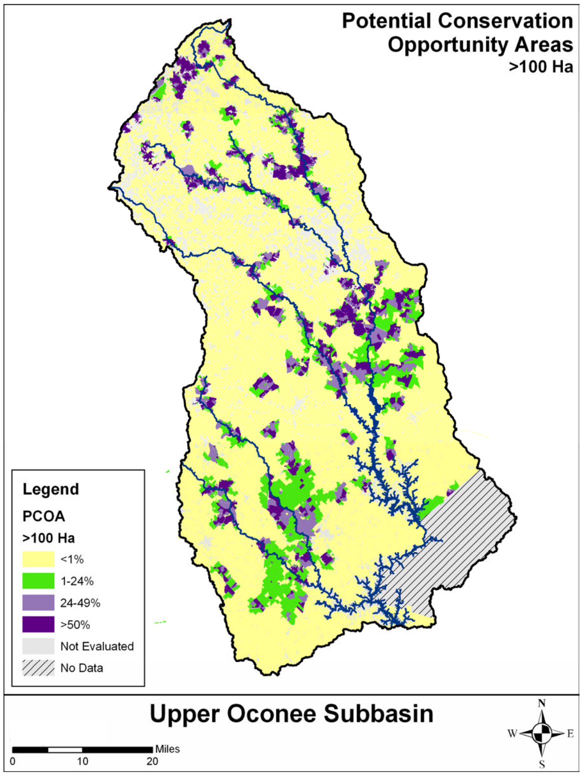


Figure 9 Upper Oconee parcels ranked into four categories of percent cover of potential conservation opportunity areas from the 2005 GA WAP.

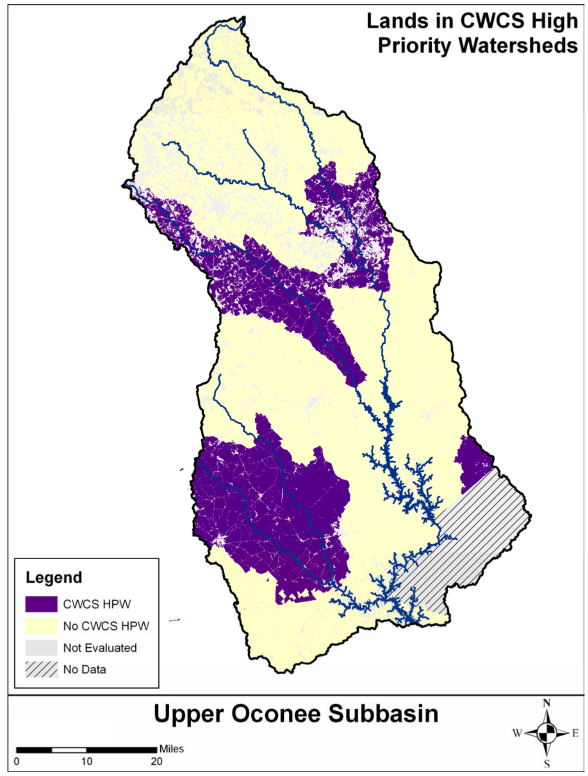


Figure 10 Upper Oconee parcels in a high priority watershed from the 2005 GA WAP.

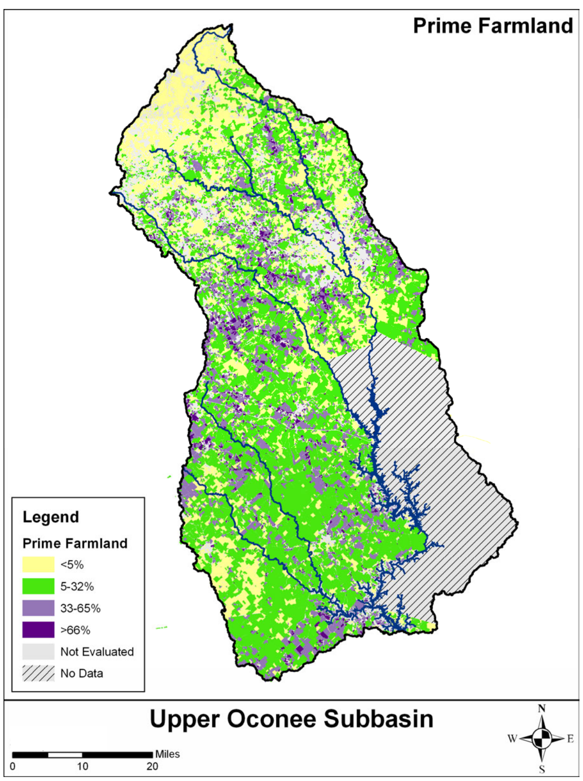


Figure 11 Upper Oconee parcels ranked into four categories of prime farmland soils from the 2001 NRCS SSURGO dataset.

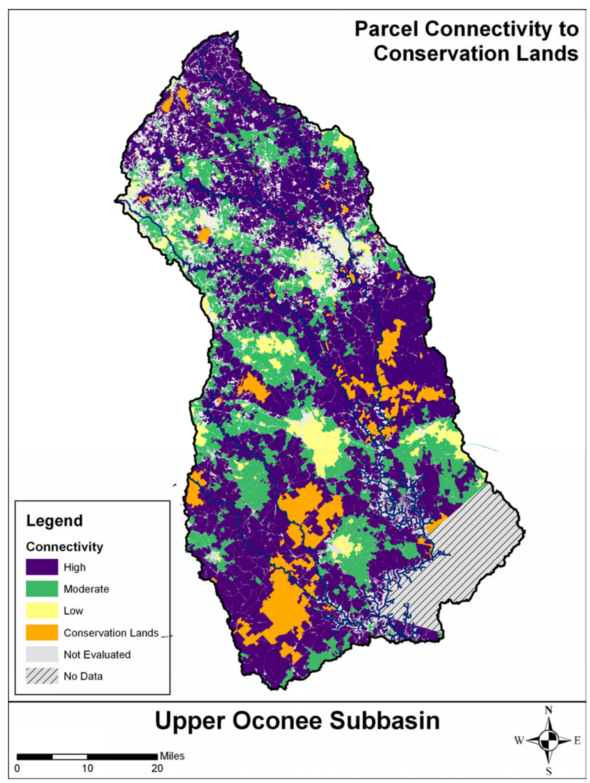


Figure 12 Upper Oconee parcels ranked into three categories of relative connectivity to existing conservation lands using 2005 GLUT urbanization and impervious surface data as higher cost areas.