Prioritizing Ecosystem Service Protection and Conservation Efforts in the Forest Plantations of the Red Hills

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We use a stated choice experiment to estimate household willingness-to-pay for a program providing incentives to private forest land owners in the Red Hills region of southwest Georgia and northwest Florida. The estimated values of various program attributes inform a landscape analysis that identifies high-priority private forest land that could be targeted for conservation incentives. Households report an increase in utility from the program when it explicitly identifies a target ecosystem-service priority. Also, inclusion of stated preference values in the prioritization plan highlights a potential scarcity effect that has important implications for conservation targeting.

Key Words: conservation priority, forest ecosystem service, stated choice, valuation

Among the many ecosystem services that forests provide are timber, recreation opportunities, climate regulation, watershed services, habitat provision, and cultural services (Krieger 2001). Other than timber and some cases of recreation, these services provide mostly external benefits (they benefit someone other than the landowner). Consequently, decisions that landowners make affect the surrounding community and/or the general public. This divide between decision-maker and beneficiary leads to economic inefficiencies that can be corrected through a variety of mechanisms. The problems associated with forests are particularly well suited to approaches that offer landowners incentives to provide ecosystem services (Pagiola and Platais 2007). A number of existing and newly proposed programs have been designed to provide private landowners with incentives to maintain forest cover on their land (Mercer, Cooley, and Hamilton 2010, Elliott 2011). The programs employ tax credits, market trading systems, direct payments to landowners, and other mechanisms to reduce the divide between the decision-makers and those who benefit from the forest cover. One challenge in designing these programs is how to target payments across a landscape (Engel, Pagiola, and Wunder 2008).

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We present an approach to prioritizing rural land for ecosystem service provision in the context of privately owned forest plantations in the rural south. The Red Hills region of southwest Georgia and north Florida is known for its scenic beauty and rich biological diversity. Considered by The Nature Conservancy as one of "America's Last Great Places," the plantations of the Red Hills contain the largest contiguous area of native longleaf pine forest on private land in the United States (The Nature Conservancy 2010). Those forests once covered up to 90 million acres that stretched from Virginia to Texas; now, less than 3 percent of those longleaf pine forests remain. The extremely diverse longleaf pine forest system is home to imperiled animals such as gopher tortoises, red-cockaded woodpeckers, and Bachman's sparrows. The Red Hills population of red-cockaded woodpeckers, a federally endangered species that requires mature pine forest to survive, is the largest found on private land in the southeast (Tall Timbers 2010).

An efficient program to provide landowners with conservation incentives would allocate payments to owners of properties that offer the greatest net benefit (Engel, Pagiola, and Wunder 2008). Methods of targeting the incentives can be based on the degree of benefit provided (i.e., some quantification of the provision of ecosystem services), the amount of incentive payment required, the chance that existing ecosystem services would decline if no payment is made (additivity), or a combination of these factors (Wunscher, Engel, and Wunder 2008). Developing a system for targeting conservation incentives is similar to determining how to efficiently locate preserves and protected areas physically (e.g., Polasky, Camm, and Garber-Yonts 2001). In both cases, one would like to discern perfectly any variations in the quality and quantity of ecosystem services produced by individual locations and account for the spatial effects of fragmentation and complementarities. However, it is difficult to estimate the conservation benefit of a particular parcel or to differentiate parcels across a region. While nonmarket valuation methods can be used to value ecosystem services, those methods were designed in a context of clearly defined changes in environmental quality or quantity (Champ, Boyle, and Brown 2003).

We provide an empirical example of how stated choice data can inform conservation priorities within a landscape-level prioritization scheme. First, we conduct a preliminary assessment of the Red Hills region to identify social and ecological characteristics that are likely to affect ecosystem service values. Once the characteristics have been identified, the challenge lies in how to evaluate tradeoffs in value between parcels with different characteristics. If one parcel offers significant wildlife and cultural benefits while another offers important water-quality benefits, which one should take priority? Previous research has shown that stated preference methods can be used to evaluate tradeoffs among multiple ecosystem services (Loomis et al. 2000). We designed a stated choice experiment to estimate the relative value of various attributes in a program of payments for ecosystem service (PES) provision. When we integrate estimated willingness-to-pay for program attributes with the landscape analysis, we observe a subtle change in the relative ranking of priority properties.

Background and Motivation

The concept of ecosystem services has become an organizing principle in both ecology and economics and appeals to land managers and landowners who are trying to make efficient decisions about land uses (Brown, Bergstrom, and Loomis 2007). Numerous definitions and organizing frameworks have been developed to understand ecosystem services (Costanza et al. 1997, de Groot, Wilson, and Boumans 2002, Daily 1997, Millennium Ecosystem Assessment (MEA) 2005, Brown, Bergstrom, and Loomis et al. 2007, Boyd and Banzhaf 2007, Wallace 2007, Turner, Georgiou, and Fisher et al. 2008). These frameworks use terms such as supporting, regulating, provisioning, and cultural services (MEA 2005); ecosystem structures, processes, and services (Brown, Bergstrom, and Loomis 2007); and final and intermediate ecosystem services (Turner, Georgiou, and Fisher 2008) to describe various aspects of ecosystem services and their value.

Empirical valuation studies appear in two threads of literature. The environmental economics literature provides many empirical examples of how stated and revealed preference techniques can be used to estimate benefits lost or gained due to a specific change in environmental quality or quantity. An overview of the theory and methods used in this literature is found in Champ, Boyle, and Brown (2003) and Freeman (2003). Development and use of these methods significantly predate the relatively recent adoption of the language of ecosystem services (Gomez-Baggethun et al. 2010).

Beginning in the early 1990s, discussions of ecosystem services began to appear regularly in scientific studies of conservation and produced seminal works on natural capital, ecosystem service valuation, and sustainability (Gomez-Baggethun et al. 2010). Estimates of the value of the world's ecosystems by Costanza et al. (1997) that are often cited in studies now sparked controversy when first published (in a special issue of *Ecological Economics*). The controversy led to an educational campaign of sorts with environmental economists educating natural scientists and the conservation community on the methods, objectives, and limits of the nonmarket valuation process (e.g., Bockstael et al. 2000). As the ecosystem service concept took root in the natural sciences, interest in valuation continued to grow, in part because it was seen as a way to communicate the importance of natural resource issues to decision-makers (Gomez-Baggethun et al. 2010).

Despite the unifying language of ecosystem services, the idea of using economic valuation techniques to answer some of the questions that appear in the ecological economic, ecosystem service, and ecological literatures remains controversial. These questions relate less to how we measure value and more to how we can incorporate value into decision-making and planning. Recent examples of the approach of Costanza et al., such as Troy and Wilson (2006) and Liu et al. (2010), used ecosystem service values to characterize the spatial distribution of nature's benefits. The resulting maps are valuable tools for scientists, planners, and policymakers who want to make rapid assessments of the impacts of decisions. The popularity of InVEST, a family of tools to map and value goods and services from nature that was developed by The Natural Capital Project (www.naturalcapital.org), demonstrates how useful such tools are. Many of the prior studies relied on a relatively simple system of benefit-transfer, prompting concerns from researchers about the validity and reliability of the results. We recognize the value of producing this type of landscape-level assessment tool and demonstrate how a stated choice experiment can be designed to improve the robustness of the analysis.

Methods

We took a two-step approach to evaluating the relative ecosystem service value of private forest land in the Red Hills region: an initial landscape assessment that uses existing social and ecological data to characterize forests and a stated choice experiment to estimate household preferences for various attributes of a PES program. This section describes the study area and methods used in the landscape analysis and stated choice experiment.

Red Hill Region Boundary

The Red Hills region of southwest Georgia and northwest Florida does not have a formal political boundary. While different sources give conflicting information regarding the size of the physiographic region (Tall Timbers 2010, Cox, Baker, and Engstrom 2001), it generally has been described as the area west of the Aucilla River, east of the Ocklockonee River, and north of the Cody Escarpment (Cox, Baker, and Engstrom 2001). Using stream data (Geographic Data Technology, Inc. 1996) and a digital elevation model (DEM) of Florida (U.S. Geological Survey (USGS) 1984), we digitized this boundary. In the DEM, an elevation cutoff of 20 meters was used to represent the Cody escarpment, a value that is consistent with descriptions of this natural boundary (Puri and Vernon 1964).

Initial Landscape Assessment

For the initial landscape assessment, we reviewed the existing literature on forest ecosystem services, met with experts at Tall Timbers Research Station and Land Conservancy, and gathered information about the area from county and nongovernmental websites and printed material. Regional experts and the printed materials all highlighted wildlife habitat, aquifer recharge, and scenic roads as particularly important services for residents in the area. From those factors and others identified in the broader literature on forest ecosystem services, we selected six forest characteristics that we expected to influence the quantity and/or the value of ecosystem services: forest type, riparian status, recharge rate, habitat importance, scenic visibility, and development class. Collectively, these characteristics describe ecological and social properties of forests and the surrounding region. Some of the characteristics primarily affect the quantity or quality of ecosystem services provided; they describe the underlying ecosystem structure or function. Others primarily affect the value of the services provided; they describe the transformation from ecosystem processes to ecosystem service. For example, an acre of forest land in a riparian area has a much greater impact on water quality than an acre of nonriparian forest because of the underlying ecosystem processes at work (the water cycle). But an acre of forest land that is adjacent to a highway has a greater aesthetic value than one in the center of a large parcel because more people can view it.

We used county-level data to identify all parcels in the region owned by city, county, state, and federal entities and excluded these public lands from our analysis. We then evaluated the forest resources on the remaining parcels using our six characteristics with two or more qualitative levels for each characteristic to describe and differentiate private forest land in the region. The geospatial data layers came from Georgia's GIS clearinghouse (www.gis.state.ga.us), Florida's Geographic Data Library (www.fgdl.org), the USGS Seamless Data Warehouse (http://seamless.usgs.gov/nlcd.php), and county GIS offices and were projected into a common coordinate system (UTM NAD83 Zone 17). Vector layers were processed to select the appropriate attribute values and converted to raster layers at 30-meter cell resolution.

The first characteristic, forest type, refers to the dominant ecology of a parcel. Using data from the 2005 Georgia Land Use Trends dataset and the 2006 National Land Cover data set we established four categories of forest type: deciduous, evergreen, mixed, and forested wetland.

The riparian status characteristic refers to the location of the forest within the surrounding watershed and was based on digital line graph hydrography data. We used a binary pair of categories, riparian and nonriparian, in which riparian was any forest within 30 meters of open, moving water.

The entire Red Hills region is a significant source of groundwater recharge. Digital recharge maps for Florida were available from Southwest Florida Water Management District. Similar data were not available for Georgia. Using printed maps and published descriptions of recharge in the area (Thomas College 1994), we created a digital shape file of relative recharge rates for Thomas and Grady counties in Georgia. With these data, we opted for two categories of the relative recharge rate characteristic: a high recharge rate of more than 10 inches per year and a low rate of 1 to 10 inches per year.

The habitat importance characteristic refers to the importance of a particular parcel in providing habitat for key species. We used existing wildlife data to categorize this characteristic as low, medium, or high. We compiled data for the Georgia counties from rare species records and coded the data with low importance as an area supporting zero to five rare, threatened, or endangered species. Medium covered areas with six to eleven such species and high covered areas with more than eleven species. We gathered data for the Florida counties from the Integrated Wildlife Habitat Ranking System (Florida Fish and Wildlife Conservation Commission), which ranks Florida landscapes based on the needs of wildlife. Our low category for Florida counties encompassed areas ranked zero to four, medium indicated areas ranked five to six, and high indicated areas ranked seven to ten. While these two data sets represent different aspects of the forest biota, they both reflect a forest's overall contribution to wildlife-related ecosystem services. We specified the categories of low, medium, and high so that approximately equal proportions of forest were identified in each category in each state (about 10 percent of forests were categorized as of high importance in both Georgia and Florida).

We expected the scenic visibility of a forest to affect the quantity and quality of ecosystem services that relate to aesthetic value. For our study area, the most obvious predictor of visibility was proximity to a major road. Using data from the Georgia Department of Transportation and Jefferson and Leon County in Florida, we established two categories for scenic visibility: roadside and nonroadside. The roadside category covers land within 30 meters of an interstate highway, an on-ramp, or a state or county road.

The development status characteristic refers to how urban, suburban, or rural the area is based on housing density. Housing density can affect the per-acre value of ecosystem services in several ways. First, the benefits of many forest ecosystem services, including pollution control, aesthetics, and non-use, often are estimated as per-person values that are subsequently aggregated to determine the size of the population receiving the benefits. The more people who live nearby, the greater the aggregate benefit to society. Second, economic theory suggests that the marginal value of a resource increases as the quantity of resource that is available decreases. This implies that the limited amount of forest in urban areas provides greater value per acre than forest in rural areas where it is more common. While these factors suggest that urban forests should have a higher value per acre, it also is possible that forests in urban areas provide fewer ecosystem services per acre because they are fragmented or degraded. Finally, people living in rural areas might have very different tastes and preferences than people living in urban areas. We used housing density data from wildland-urban interface censuses to establish three categories for development status: urban (more than 120 units per square kilometer), suburban (25–120 units per square kilometer), and rural (less than 25 units per square kilometer).

Stated Choice Experiment

During the summer of 2011, we conducted a mail survey of residents in the four counties in which the Red Hills region is situated: Grady and Thomas in Georgia and Leon and Jefferson in Florida. The survey document (i) provided participants with background information on forests and ecosystem services, (ii) asked respondents about their familiarity with the region, recreation activities, and other topics, and (iii) presented questions that made up the stated choice experiment. We purchased a sample of 2,500 names and associated addresses from a commercial vendor and conducted an initial pretest of 100 surveys to test the reliability of the sample (e.g., rate of undeliverable surveys). Pretest respondents were told that they were part of a pretest and were asked additional open-ended questions designed to improve the survey instrument. Based on comments received during the pretest, we made no substantive changes to the survey instrument prior to formally mailing it to the remaining 2,400 individuals.[1] The sample was stratified by county to insure adequate coverage of counties with smaller populations (Table 1). We made three contacts: the initial mailing, which included a cover letter and the survey; a follow-up thank you / reminder postcard to everyone; and a third mailing to nonresponders that included another copy of the survey. We did not do a fourth contact (mailing a third copy of the survey) because the effect of sending a second copy was minimal.

We specifically designed the choice experiment to estimate willingness-to-pay (WTP) for a program that would target private landowners for conservation payments and to see how WTP would change with different program attributes. Respondents were invited to participate in a hypothetical referendum that would affect the future of private forests in the Red Hills region. They were told that the referendum, if passed, would create a program that would "provide financial incentives to forest land owners who manage their forest land in particular ways." The program would be voluntary—forest land owners would not be required to accept payment or change their behavior or decisions regarding their privately owned land. Respondents also were told that the program might (i) affect the acres of forested land in the region, (ii) make forests that provide particular types of ecosystem services a target priority,

[1] While this is a less rigorous pretest than is typical for stated choice experiments, the experiment used in this study was nearly identical to a previous study we conducted in Georgia, so the design benefited from focus groups and pretests from the prior study design

Table 1. Sample Stratification

County	Population		Mailings			
	County Population, 2010 U.S. Census	Percent of Four-County Population	Mailed	Percent of All Mailed	Not Deliverable	Percent of Final Sample
Grady County, Georgia	25,011	7%	400	17%	30	16%
Thomas County, Georgia	44,720	12%	800	33%	65	33%
Jefferson County, Florida	14,761	4%	240	10%	22	13%
Leon County, Florida	275,487	77%	960	40%	107	38%

(iii) allow public access to specific private forest land for light recreation, and (iv) impose a cost on every household in the region.

According to the survey information, conservation payments would be directed to properties that best protected high-priority ecosystem characteristics (services). The high-priority services were identified to respondents as wildlife habitat ("prioritize management of forests to provide the greatest impact on wildlife"), water ("prioritize management of forests near rivers, streams, and lakes in order to provide the greatest impact on water quantity and quality"), and scenic views ("prioritize management of forests along roads and highways in order to best protect scenic views"). These priority attributes represented an explicit objective under which the program would operate rather than specific outcomes that would result from the program. To say that the program would prioritize protection of forests important to wildlife is not as direct as saying the program would protect a certain number of acres of wildlife habitat or increase the red-cockaded woodpecker population by a certain percentage. At the same time, the voluntary nature of the program and the complexity of the ecosystem made it difficult to state with any certainty the actual outcomes of the program. This is a subtle difference in framing of the attribute that must be considered when interpreting WTP estimates. In our case, the choice situation had to be similar to how an actual referendum for a PES program might be written. In this respect, identifying that the priority would be wildlife habitat while not offering a prediction of what the program would achieve is realistic. Paterson (2001) used a similar approach to define farm characteristics that would cause a farm to "receive priority in the purchases of easements." Xu, Lippke, and Perez-Garcia (2002) used the concept of a dominant management strategy as an attribute in a choice experiment related to forest management to refer to the general goal of a large-scale forest management program.

Respondents were reminded that the program would only affect privately owned forest and that any public priority would not replace the owners' private management objectives. The public priorities would be used to identify targets for incentive payments. The anticipated change in forest acreage presented to

B3. Suppose you were voting on a referendum that would result in one of three alternative futures for private forests in the Red Hills region. No other alternatives are being voted on, and one of these three alternatives WILL BE adopted. Compare the three alternatives and indicate which alternative you prefer.

	Option A	**Option B**	**Option C (Status Quo)**
Change in **acreage** of private forests in your area	Increase 5 percent	Decrease 2 percent	Decrease 2 percent
Priority to protect **wildlife**	No	Yes	No
Priority to protect **water quality and quantity**	No	Yes	No
Priority to protect **scenic views**	No	Yes	No
Provide **public access** to some private forest land	$400	$25	$0
Annual **cost** to your household			
I prefer (*Check one box*)...	☐ **Option A**	☐ **Option B**	☐ **Option C**

Figure 1. Example Choice Question

Table 2. Attributes and Levels for Stated Choice Experiment

Attribute	**Levels**
Change in acreage of private forests	–2%, no change, +2%,+5%
Priority to protect wildlife	Yes, No
Priority to protect water quality and quantity	Yes, No
Priority to protect scenic views	Yes, No
Provide public access to some private forest land	Yes, No
Annual cost to your household	$0, $10, $25, $50, $75, $100, $200, $400

participants ranged from a decrease of 2 percent to an increase of 5 percent. This was not an annual rate of change; rather, it was the overall impact created by the program. How quickly that change would occur was not specified since the voluntary nature of landowner participation prohibited such a prediction. In our analysis, we focused on the values for other attributes and differences relative to the status quo, making the rate of change less of a concern. We specified the cost attribute as between $0 and $400 annually (in perpetuity) and the payment vehicle was a combination of higher prices for wood products, water, energy, and other products.[2] Table 2 lists the attributes and attribute levels.

[2] We used this flexible payment vehicle to accommodate differences in property and income taxes and in utility rates between Florida and Georgia. It was difficult to identify a single, specific payment vehicle that would make sense to residents in both states. As our focus was on relative values of program attributes, this was not a significant concern in our application, and we opted for the more generic language.

Each choice occasion in the survey presented three alternative futures for private forests in the region. One alternative was constant across all of the questions and illustrated the status quo (what would happen if the referendum did not pass): a 2 percent decrease in forested area, no public priority, no public access, and zero cost). We created an orthogonal main-effects experimental design with 25 choice questions (50 distinct profiles plus the status quo). The 25 questions were blocked into five groups so that each survey respondent was asked five choice questions and there were five versions of the survey. An example choice question is shown in Figure 1.

Household Willingness-to-Pay Model

We estimated individual WTP with a standard random utility model (RUM) in which utility was assumed to consist of two components. The utility individual *i* receives by choosing (or consuming) alternative *j* is given by

$$U_{ij} = V_{ij}(x_j;\ \beta) + \varepsilon_{ij}$$

where V_{ij} is the deterministic portion of utility based on a vector of alternative specific attributes, X_j, and preference parameters, β, and ε_{ij} is the random component of utility, which is known to the respondent but cannot be observed by the analyst. Faced with a choice between two (or more) alternatives, the respondent chooses alternative *j* if and only if the utility of doing so is greater than the respondent's utility from any other option in the choice set. Assuming ε_i is randomly distributed across alternatives with a Gumbel distribution with a scale parameter equal to 1, the estimator is a standard multinomial logit model in which the probability of choosing alternative *j* given a particular set of alternatives, *C*, is a function of the deterministic component of utility. We estimated several specifications for V_j, all of which built on a simple model that included the attribute levels and a status quo constant, so that

$$V_j = \beta_1 Area_j + \beta_2 Wild_j + \beta_3 Water_j + \beta_4 Road_j + \beta_5 Access_j + \beta_6 SQ_j + \beta_y Cost_j$$

where *Area* is the percent increase in forested land area; *Wild*, *Water*, *Road*, and *Access* are binary variables that indicate whether these forest services would be a priority objective of the program; and *Cost* is the cost of the alternative. One alternative-specific constant was included to address a potential status quo effect. *SQ* equals 1 if the choice alternative is the status quo and zero otherwise. We refer to this specification as the base model.

To incorporate individual characteristics available from the survey data, we estimated two extensions to the base model. In Extended Model 1, the individual characteristics interact with the status quo constant. In Extended Model 2, some individual characteristics interact with the status quo constant while others interact with the choice attributes. In addition to these multinomial logit (MNL) models, we estimated several mixed multinomial logit (MMNL) models to allow for unobserved preference heterogeneity. While these more sophisticated models often lead to a better model fit, this was not the case with our data. All of the MMNL models we estimated were inferior with respect to several model selection criteria (Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and ρ^2), and few of the individual parameters were statistically different from zero. No variance parameter was significant. One reason to use the MMNL or other models like it is to relax the assumption of independence of irrelevant alternatives (IIA) required in the MNL model. We used the Hausman and McFadden (1984) approach to test the assumption of IIA in all of our MNL models. None of the tests rejected the IIA restriction, suggesting that the IIA property is not violated and further supporting our use of the simpler MNL model (Louviere et al. 2000).

With the base model, an individual's marginal WTP for a 1-percent increase in forest area is estimated by $\beta_1 / (-\beta_y)$ and an individual's WTP for inclusion of a particular public priority is the ratio of the estimated coefficients on that variable to the coefficients on the cost variable. For example, the utility gained by individual *i* due to an explicit priority of protecting wildlife habitat (relative to no such priority) is $\beta_2 / (-\beta_y)$. Because we expect individual tastes and preferences related to forest benefits to vary by region, we estimated separate MNL models for individuals by county.

Results and Discussion

As we have defined it, the Red Hills region covers 653,721 acres (Figure 2). This is slightly larger than the area defined in Cox, Baker, and Engstrom (2001) of 2,400 square kilometers (593,053 acres). About two-thirds of the area in our definition is in Florida—32 percent in Jefferson County and 35 percent in Leon County. Twenty-six percent of the area is in Thomas County, Georgia, and 7 percent is in Grady County, Georgia. Almost all (99 percent) of the region is privately owned, and 68 percent is privately owned forest land. It is that 68 percent of private forest that is the focus of our analysis.

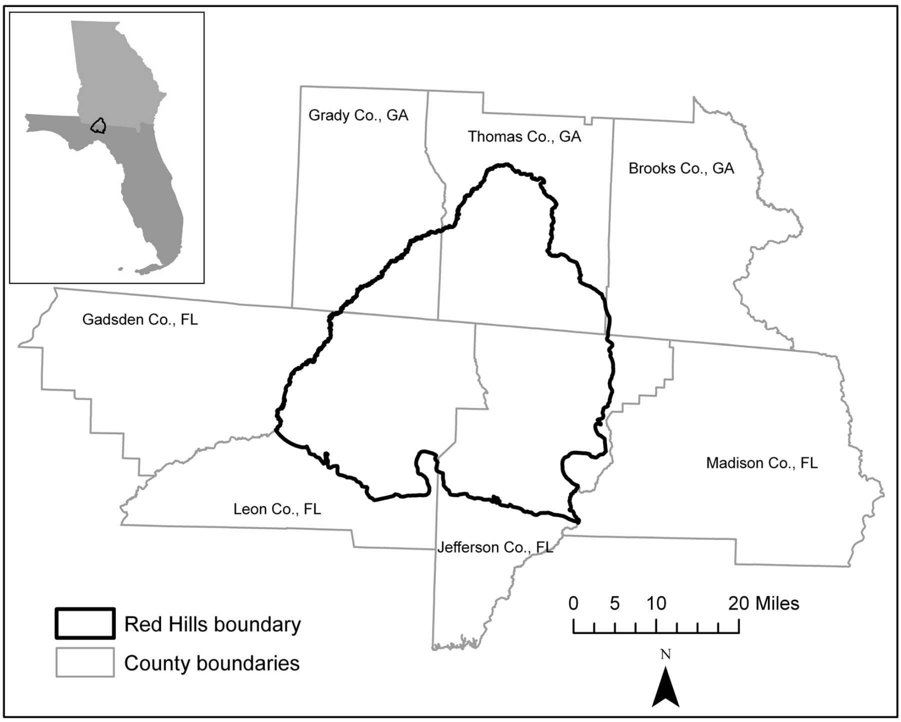

Figure 2. Map of the Red Hills Region

Landscape Analysis

Table 3 reports the relative abundance of each characteristic in the region. Almost 50 percent of the forests are evergreen. While there is a dense network of streams and many miles of roads in the area, our use of a 30-meter buffer on either side of streams and roads to define riparian status and scenic views meant that relatively little of the area's forest land was considered riparian (7.9 percent) or roadside (1.7 percent). The entire region provides a relatively high recharge rate, but 75 percent of the region was classified as high recharge in our analysis (indicating more than 10 inches per year). Similarly, in a statewide analysis, the Red Hills region would likely be classified as having high habitat importance, but our goal was to differentiate characteristics within the region. In reclassifying species abundance and habitat importance data into three levels, we wanted to be conservative in our designation of high or medium habitat importance. The resulting percentages were close to our *a priori* targets of 10 percent high, 40 percent medium, and 50 percent low. Finally, 90 percent of the region is considered rural with some urban and suburban influences mostly from Tallahassee, Florida, which is situated just south of the region in Leon County.

Based on the six forest characteristics selected, there were 288 (= $2^3 \cdot 3^2 \cdot 4$) possible combinations of characteristics that could describe private forests in the region, though not all of those combinations were present on the ground. For example, there were no forests characterized as deciduous, suburban, and as having high habitat importance. Conversely, there were many forests that

Table 3. Relative Abundance of Forest Characteristics in the Red Hills Region

Forest Characteristics		Percent of Private Forests in the Red Hill Region
Forest type:	Deciduous	9.1
	Evergreen	47.8
	Mixed	16.4
	Forested wetlands	26.7
Riparian status:	Riparian	7.9
	Not riparian	92.1
Recharge rate:	High recharge	76.1
	Low recharge	23.9
Habitat importance:	High	10.4
	Middle	36.5
	Low	53.1
Scenic visibility:	Roadside	1.7
	Not roadside	98.3
Development status:	Urban	2.8
	Suburban	7.1
	Rural	90.1

were characterized as rural, nonriparian, nonroadside, and having low habitat importance.

When conservation priorities are predetermined and the relationship between forest characteristics and those priorities is clear, the simple characterization of forest land properties and level of contribution would be sufficient for prioritizing properties for conservation. For example, if the conservation goal is solely to maintain habitat for endangered species, other characteristics become irrelevant. The limitation lies in how to rank the relative importance of multiple conservation objectives. One approach is to grant highest priority to the forests that contribute to the greatest number of services. In that case, a forest with high habitat importance and a high recharge rate would be considered as of higher priority than a riparian forest because the former contributes to two ecosystem services (groundwater recharge and wildlife) and the latter to only one (water quality). Many conservation organizations use this scoring system-style approach (sometimes with a good deal of sophistication) (Ferraro 2004). We used this approach to develop one of the priority maps depicted in Figure 3. While simple and easy to implement, this method implicitly weighs each ecosystem service as being equally valuable or important, which is not necessarily the case. An alternative approach is to incorporate stated preference data to inform the relative importance of each acre to aggregate welfare.

Survey Data

Table 1 shows the population of each county, the number of surveys mailed to each county, the number of undeliverable surveys, and the breakdown of returned surveys by county. Overall, the response rate was 22.7 percent. While this was lower than desired, for this application we were primarily concerned with the relative ranking of different program priorities. Nonrespondents could be expected to have a smaller WTP for forest conservation in general, but it is not obvious that they would have significantly different preference rankings for the attributes of the conservation program we described. In this case, nonresponse bias is less of a concern.

We report a summary of responses to the survey questions about knowledge of the region, preferences for forest management, and demographics in Tables 4, 5, and 6. We list average responses by county; in many respects, the responses were similar across counties. Overall, residents were aware of the ecological significance of the Red Hills region and generally recognized the need to manage forests for multiple purposes, including timber, recreation, wildlife habitat, and water protection. Most respondents believed that a forest land owner should be compensated for any economic loss incurred as a result of government regulation, but the strength of support varied (87 percent agreed in Jefferson County, 71 percent in Thomas County). Opinions were mixed regarding the type of regulation that should be used to protect environmental quality with relatively little support for mandatory regulations and more support for incentive programs.

Multinomial Logit Estimation

Tables 7 and 8 report the regression results for each county for the base model and two extended models (Ext1 and Ext2). In the base model, most coefficients are statistically significant and have the expected signs (negative for cost and positive for other attributes). Surprisingly the coefficient on public access is negative for all counties, though never significantly different from zero. In fact, the public access coefficient is not significantly different from zero in any model, which implies that respondents had a non-positive WTP for public access to private land. This region generally has a strong private-property-right mentality, and respondents may have rejected the general idea of public access to private land. Also, hunting leases provide individuals who do not own forest land with access to private property for hunting and other recreation activities. That mechanism may satisfy many respondents' demand for access. Finally, this result is likely to have been affected by the payment mechanism used—a general increase in prices, taxes, and utility costs. Had the question allowed for a "user fee" to pay for access, the results almost certainly would have been different. Because of these problems, we do not consider the public access attribute in the remainder of the analysis.

In the base model, the coefficient on *SQ* is significantly positive for three of the four counties, suggesting a status quo effect. Previous research has shown that people often prefer to maintain the status quo, *ceteris paribus*, and that changing to any other alternative would result in loss of utility (Samuelson

Table 4. Respondents' Self-reported Knowledge and Awareness of the Region by County

	Jefferson County Florida	Leon County Florida	Grady County Georgia	Thomas County Georgia
Before this survey, had you heard the term Red Hills region used to describe this area? (percent Yes) (*Heard)*	67%	67%	74%	75%
Before this survey, how would you rate your knowledge of the unique ecological or cultural characteristics of the Red Hills region used to describe this area?				
Percent reporting "Significant understanding" or "Expert understanding"	28%	28%	23%	32%
Percent reporting "Some knowledge"	43%	50%	65%	50%
Percent reporting "little or no knowledge"	29%	25%	12%	18%
Before this survey, were you aware that groups are working to protect and maintain the current landscape in the Red Hills region? (percent Yes)	47%	45%	55%	54%
Do you own at least one acre of land with some tree cover located anywhere in Georgia or Florida? (percent Yes)* (*Own*)	65%	32.4%	70%	49%
Average landholding for those who own forest land in Georgia*	31 acres	17 acres	35 acres	77 acres
Average landholding for those who own forest land in Florida*	50 acres	25 acres	0.5 acres	1 acre

* Responses statistically different across counties at the 0.05 level.

Table 5. Respondent Preferences Related to Forest Management by County

	Jefferson County Florida	Leon County Florida	Grady County Georgia	Thomas County Georgia
	Percent Yes			
If you were able to provide input regarding how forested land in the region should be managed, which of the following would you identify as an important management priority?				
Producing timber and other wood products*	67	40	49	60
Providing recreational opportunities	85	82	76	74
Protecting threatened or endangered species*	75	84	66	84
Protecting streams, wetlands, and water quality*	94	91	81	94
Protecting scenic views along roads and highways	71	73	59	65
Protecting property values of surrounding lands*	77	38	50	53
	Percent Who “Strongly Agree” or “Somewhat Agree” with Statement			
If a forest land owner is prevented from cutting trees on his land because of government regulations, the landowner should be paid for the economic loss.* (*Compensate*)	87	73	85	71
I would support a program that required forest land owners to comply with regulations designed to provide benefits for the public. (*Regulation*)	36	41	38	34
I would support a program that provided tax-funded incentives for forest land owners to voluntarily comply with regulations designed to provide benefits for the public. (*Tax incentive*)	56	56	56	48
I would support a program that provided non-tax-funded incentives for forest land owners to voluntarily comply with regulations designed to provide benefits for the public.* (*Non-tax*)	74	64	56	61

* Responses statistically different across counties at the 0.05 level.

Table 6. Demographic Characteristics of Respondents by County

	Jefferson County Florida	Leon County Florida	Grady County Georgia	Thomas County Georgia
Average age	57 years	53 years	56 years	58 years
Percent male	74%	63%	63%	64%
Median education level*	Associate degree completed	Bachelor’s degree completed	Some college	Associate degree completed
Median income range*	$60,000–70,000	$70,000–80,000	$60,000–70,000	$50,000–60,000

* Responses statistically different across counties at the 90 percent level.

Table 7. Coefficient Estimates and Standard Errors from Multinomial Logit Regression Results of the Base Model and Extended Model 1

	Jefferson County Florida		Leon County Florida		Grady County Georgia		Thomas County Georgia	
	Base	*Ext1*	*Base*	*Ext1*	*Base*	*Ext1*	*Base*	*Ext1*
Area	0.146* (0.048)	0.158* (0.058)	0.074* (0.028)	0.073* (0.030)	0.048 (0.042)	0.012 (0.053)	0.085* (0.031)	0.104* (0.036)
Wild	0.684* (0.222)	0.757* (0.265)	1.097* (0.137)	1.098* (0.148)	0.745* (0.208)	0.892* (0.261)	1.029* (0.149)	1.095* (0.173)
Water	1.281* (0.226)	1.466* (0.277)	1.794* (0.150)	1.708* (0.162)	1.040* (0.202)	1.103* (0.261)	0.986* (0.145)	0.975* (0.163)
Road	0.637* (0.220)	0.802* (0.262)	0.621* (0.138)	0.701* (0.147)	0.487* (0.202)	0.530* (0.248)	0.489* (0.142)	0.629* (0.160)
Public Access	0.218 (0.195)	0.197 (0.228)	0.069 (0.126)	0.098 (0.132)	0.008 (0.181)	−0.073 (0.222)	−0.067 (0.129)	−0.091 (0.147)
Cost	−0.002* (0.001)	−0.001 (0.001)	−0.004* (0.001)	−0.004* (0.001)	−0.004* (0.001)	−0.005* (0.001)	−0.003* (0.001)	−0.003* (0.001)
SQ	1.473* (0.479)	−5.944* (2.020)	0.827* (0.296)	−1.710* (0.711)	0.820* (0.421)	−4.512* (1.617)	0.447 (0.325)	−4.437* (0.945)
*SQ*Concern*	—	−1.865* (0.589)	—	−0.937* (0.326)	—	−0.301 (0.505)	—	−0.781* (0.315)
*SQ*Compensate*	—	−1.224* (0.350)	—	0.290* (0.169)	—	0.116 (0.275)	—	−0.187 (0.124)
*SQ*Regulation*	—	−1.699* (0.363)	—	−0.309* (0.125)	—	−1.964* (0.349)	—	−0.837* (0.146)
*SQ*TaxIncentive*	—	−0.457 (0.273)	—	−0.406* (0.110)	—	0.019 (0.305)	—	−0.454* (0.121)
*SQ*Non-tax*	—	−0.153 (0.240)	—	−0.163 (0.118)	—	−0.088 (0.259)	—	−0.182 (0.117)
*SQ*Heard*	—	−0.471 (0.715)	—	−0.902* (0.321)	—	1.458* (0.555)	—	−1.179* (0.428)
*SQ*Own*	—	−0.750 (0.713)	—	0.501 (0.391)	—	−1.128 (0.579)	—	0.746* (0.336)
*SQ*LargeLot*	—	0.735 (0.747)	—	1.414* (0.464)	—	−0.524 (0.604)	—	−1.733* (0.540)
*SQ*Rural*	—	−2.413* (0.876)	—	−1.341* (0.367)	—	−0.876 (0.599)	—	1.137* (0.420)
*SQ*Bird*	—	−0.650* (0.342)	—	0.185 (0.133)	—	−0.041 (0.190)	—	−0.261* (0.134)
*SQ*Hunt*	—	0.939* (0.287)	—	0.167 (0.127)	—	−0.010 (0.229)	—	−0.158 (0.142)
LL value	−207.49	−123.84	−478.75	−378.1.3	−242.87	−140.67	−431.06	−315.48
ρ^2	0.133	0.370	0.263	0.334	0.124	0.386	0.180	0.283
AIC	1.95	1.60	1.51	1.40	1.97	1.53	1.72	1.57

* Significantly different from zero at the 0.1 level.

Note: Standard errors are in parentheses.

Table 8. Coefficient Estimates and Standard Errors from Extended Model 2

	Jefferson County Florida		Leon County Florida		Grady County Georgia		Thomas County Georgia	
	β	*Std. Error*	β	*Std. Error*	β	*Std. Error*	β	*Std. Error*
Area	0.022	0.130	0.017	0.061	–0.048	0.146	0.024	0.067
*Area*Own*	0.163	0.106	–0.062	0.058	–0.140	0.094	–0.104*	0.054
*Area*Rural*	0.275*	0.105	0.128	0.052	–0.026	0.103	–0.021	0.056
*Area*LargeLot*	–0.024	0.107	–0.237	0.120	0.140	0.099	0.114	0.080
*Area*Bird*	–0.027	0.044	0.026	0.019	0.025	0.031	0.041*	0.021
*Area*Hunt*	–0.028	0.033	–0.009	0.020	0.025	0.033	0.011	0.020
Wild	–0.657	0.746	1.429	0.301	0.941	0.715	0.836*	0.335
*Wild*Own*	–0.482	0.604	–0.877	0.303	0.702	0.501	0.020	0.279
*Wild*Rural*	1.043*	0.571	–0.026	0.285	–0.386	0.512	–0.760*	0.288
*Wild*LargeLot*	–0.632	0.635	0.283	0.523	–0.340	0.496	1.047*	0.442
*Wild*Bird*	0.920*	0.246	–0.004	0.097	0.046	0.163	0.071	0.112
*Wild*Hunt*	–0.628*	0.196	–0.006	0.106	–0.069	0.185	0.176	0.108
Water	1.432*	0.736	1.947	0.315	0.319	0.686	0.642*	0.332
*Water*Own*	–0.035	0.580	0.387	0.305	0.414	0.493	–0.456	0.282
*Water*Rural*	–0.226	0.563	0.866	0.281	–0.103	0.529	0.090	0.281
*Water*LargeLot*	–0.349	0.591	–0.866*	0.559	–0.871*	0.518	0.184	0.440
*Water*Bird*	0.226	0.231	–0.013	0.099	0.150	0.168	0.246*	0.113
*Water*Hunt*	0.011	0.186	–0.298	0.108	0.240	0.187	–0.069	0.108
Road	0.339	0.743	1.311	0.304	0.355	0.700	0.752*	0.327
*Road*Own*	0.467	0.584	–0.315	0.300	0.313	0.493	–0.151	0.279
*Road*Rural*	1.260*	0.572	0.203	0.286	0.190	0.511	–0.517*	0.281
*Road*LargeLot*	–0.130	0.620	–0.113	0.550	0.407	0.529	0.857*	0.421
*Road*Bird*	0.177	0.235	–0.194*	0.097	–0.286*	0.173	–0.007	0.111
*Road*Hunt*	–0.595*	0.187	–0.012	0.106	0.241	0.179	0.072	0.105
Access	0.304	0.273	0.133	0.141	–0.004	0.243	–0.060	0.149
Cost	–0.002	0.002	–0.004*	0.001	–0.006*	0.002	–0.003*	0.001
SQ	–6.283*	1.815	–1.218*	0.680	–6.002*	1.596	–4.491*	0.870
*SQ*Concern*	1.752*	0.555	–0.734	0.311	0.123	0.530	–0.708*	0.308
*SQ*Compensate*	–1.077*	0.311	0.219	0.161	0.225	0.279	–0.159	0.124
*SQ*Non-tax*	–0.134	0.242	–0.144	0.113	0.080	0.269	–0.158	0.116
*SQ*Regulation*	–1.607*	0.337	–0.323*	0.122	–1.858*	0.338	–0.850*	0.144
*SQ*TaxIncentive*	–0.341	0.249	–0.396	0.109	–0.245	0.317	–0.450*	0.119
*SQ*Heard*	–0.344	0.642	–0.937*	0.312	0.612	0.564	–0.952*	0.397
LL value	–111.40		–364.79		–133.69		–307.79	
ρ2	0.433		0.357		0.416		0.300	
AIC	1.69		1.42		1.66		1.62	

* Significantly different from zero at the 0.1 level.

and Zeckhauser 1988). Possible factors influencing the presence or size of a status quo effect include a desire to protest the valuation exercise or the good, attitudes toward the environment, and task complexity (Meyerhoff and Liebe 2009). In our survey, the status quo alternative was described as no adoption of a new forest conservation program. Only 12.5 percent of all respondents chose the status quo option on all five choice occasions, 24.0 percent never chose the status quo, and 63.5 percent chose the status quo for some choice occasions but not for others. The relatively low percentage of respondents who consistently chose the status quo suggests that most participants were willing, in principle, to pay for a conservation program in the area (Meyerhoff and Liebe 2009). The proportion of respondents who never opted for the status quo is higher and suggests some level of yea-saying or hypothetical bias, which would result in upwardly biased estimates of WTP. However, as we were focused on relative values, we left that question to future research. We included individual attributes as interactions with *SQ* in the extended models to better understand heterogeneity in preference for the status quo.

Individual-specific variables, such as demographics and responses to other survey questions, are choice invariant and so fall out of the MNL estimation model (Greene 2007). One solution is to interact the individual characteristics with the choice-specific constants (e.g., *SQ*) or choice attributes. Extended Model 1 (Table 7) included eleven individual characteristics as interactions with the status quo constant (*SQ*). This allowed for heterogeneity in the preference to maintain the status quo over choosing one of the alternatives. Extended Model 2 (Table 8) included some individual characteristics as interactions with the status quo constant but included other individual characteristics as interactions with the choice attributes (*Area, Water, Wild, Road*). This allowed for heterogeneity in the status quo effect and in a preference for individual program attributes.

Both extended models included variables related to respondents' demographic, recreation, and attitudinal characteristics, which we obtained through other survey questions. *Concern* was a dummy variable indicating that the respondent had concerns about how forests in the region were being managed. *Compensate, Regulation, TaxIncentive,* and *Non-tax* indicated how strongly the respondent agreed (rated on a scale of 1 to 5) with statements that landowners should be compensated for losses caused by government regulations, that they would support a program that required forest land owners to comply with regulations, or that they would support a tax-funded or non-tax-funded incentive program for landowners. *Heard* was a dummy variable indicating that the respondent had heard the term "Red Hills region." *Own* indicated that the respondent owned at least 1 acre of forest land somewhere in Georgia or Florida, while *LargeLot* indicated that the respondent's current primary residence was on property consisting of at least 5 acres. *Rural* indicated that the respondent "grew up" in a rural area, and *Bird* and *Hunt* referred to how frequently (on a scale of 1 to 5) the respondent went birdwatching and hunting respectively.

The inclusion of interaction terms significantly improved the overall fit of the model. Both of our extended models had higher ρ^2 values and lower AIC values than the base model and were well within the range of 0.2 to 0.4, which is considered extremely good for MNL models (Louviere, Hensher, and Swait 2000). However, there was little evidence supporting one extended model over the other. The results of both suggest that there are several factors that influence the magnitude of the status quo effect. Respondents who reported concern about how forests in the region were being managed were less likely to opt for the status quo. These respondents might not believe there is significant risk of diminished ecosystem service value given the relative abundance of forest cover currently available. Respondents who support mandatory forest regulations or voluntary incentive programs also are less likely to opt for the status quo. This suggests that at least some of the status quo effect represents respondents protesting the underlying mechanism of the incentive program itself. After we accounted for differences in individual characteristics, the sign on the *SQ* constant was significantly negative, indicating a preference for implementation of one of the conservation programs depicted.

The coefficient estimates on interactions between the choice attributes suggest there is some variation in program preference, though relatively few of the individual parameter estimates were statistically significant. Thomas County respondents who owned at least one acre of forest land reported a lower WTP for increased forest area compared to other respondents, while those who liked to go birdwatching reported a higher WTP than other respondents. Those who grew up in a rural area had a lower WTP than other respondents for a program that prioritizes wildlife and scenic road services. Respondents residing on large lots had a higher WTP for those program priorities than did other respondents. Owners of large parcels may believe that they would benefit from a PES program directly because they would likely be targeted to receive payments.

Household Willingness-to-Pay for a PES Program

Estimates of expected household WTP for all counties are reported in Table 9. Extended Model 2 allows for heterogeneity in preferences for program attributes. For this model, we report estimates of average WTP evaluated at the sample mean for each characteristic plus the range of WTP estimates expected due to variation in individual characteristics. For example, in Thomas County, household WTP for a program that would prioritize wildlife habitat ranged from $24 to $669 depending on individual characteristics. WTP was relatively greater for respondents who (i) owned forest land, (ii) lived on a large lot, and (iii) liked to go birdwatching or hunting and lower for those who grew up in a rural area. Based on the sample mean of these characteristics, the expected WTP is $367. We note that the sample mean does not necessarily reflect the true population mean for these characteristics; rather, it provides a point of comparison with the other models.

The WTP estimates are generally consistent across models, but there is significant variation across counties. Based on results from the first extended model, residents of Jefferson County were willing to pay $114 per year per household for a program that would provide a 1 percent increase in forested land in the Red Hills while residents of Grady County were willing to pay only $2 for the same program. Similarly, residents of Thomas County were willing to pay $340 per year per household to prioritize protection of wildlife habitat in the region while residents of Jefferson County were willing to pay $545 for such protection. All three models demonstrate a similar pattern in terms of WTP for various conservation priorities. Of the public priorities offered in the survey, residents of all of the counties expressed a clear preference for a program that would prioritize protection of water resources and an equal or smaller preference for a program that would prioritize protection of wildlife habitat. Their WTP for a program that would prioritize conservation of scenic roads was significantly smaller but respondents from all counties did report positive WTP for this priority as well.

Identifying Conservation Priorities

Stated choice experiments usually are designed to generate marginal values and household WTP estimates like the results presented in Tables 7, 8, and 9. One can use such results to compare household WTP for various attributes, estimate the aggregate benefit of different PES programs, or model how a change in population might lead to a change in aggregate WTP for such a program. However, our goal was to use the information to prioritize different parcels of forest across the region in terms of their role in providing ecosystem services valued by the public. Based on the results of Extended Model 1, we estimated the aggregate benefit of PES programs with different priorities

Table 9. Willingness to Pay per Household by County

	One Percent Increase in Forested Land	Program That Prioritizes Wildlife Habitat	Program That Prioritizes Forests Important for Water	Program That Prioritizes Scenic Views along Roads
Jefferson County, Florida				
Base	$72	$340	$636	$316
Extended Model 1	$114	$545	$1,055	$577
Extended Model 2	$85	$296	$894	$324
Ext2 Expected Range 2[a]	$0–236	$0–670	$422–857	$0–1150
Number of households – Census 2010: 17,573				
Leon County, Florida				
Base	$20	$291	$475	$165
Extended Model 1	$20	$302	$471	$193
Extended Model 2	$20	$307	$480	$206
Ext2 Expected Range 2[a]	$0–47	$140–466	$210–871	$187–412
Number of households – Census 2010: 9,418				
Grady County, Georgia				
Base	$14	$211	$295	$138
Extended Model 1	$2	$164	$203	$97
Extended Model 2	$3	$154	$193	$79
Ext2 Expected Range 2[a]	$0–22	$22–260	$0–173	$11–232
Number of households – Census 2010: 110,945				
Thomas County, Georgia				
Base	$25	$297	$285	$141
Extended Model 1	$32	$340	$303	$195
Extended Model 2	$35	$363	$306	$210
Ext2 Expected Range 2[a]	$0–59	$24–669	$36–361	$24–522
Number of households – Census 2010: 5,646				

[a] Range of WTP estimates expected due to variation in observable characteristics.

Note: This model allows for heterogeneity in WTP for program attributes. We report the estimated WTP evaluated at the sample mean of the individual characteristics as a point of comparison to the other models.

relative to a program without a specified priority (Table 10). If a PES program were to be developed, our analysis suggests that the aggregate WTP for a program that would prioritize protection of water resources would be $65.4 million greater than a program that would not have a specified priority (i.e., would not discriminate payments based on the relative production of water-related ecosystem services). Similarly, aggregate WTP for programs that prioritize wildlife habitat and scenic views would be $44.1 million and $29.0 million, respectively. If the program would target existing forests (of any type) to avoid loss of forest in the region, the estimated aggregate WTP to avoid a 1 percent (or 4,762 acre) loss of forest land would be $3.4 million (relative to a program that would not result in any change in forest land cover).

From Table 10, we know that the region's residents prefer prioritization of water over wildlife or scenic views. To use these estimates of the aggregate benefits of conservation priorities to inform a parcel-level conservation-payment targeting scheme, however, we also need to consider the potential of individual parcels to contribute to these priorities. In a sense, we are left searching for the elusive ecological production functions that describe how an individual parcel can contribute to the overall level of ecosystem service production in the region. Such production functions ideally would account for variations in the quality and/or quantity of ecosystem services produced, benefits or losses of services related to spatial arrangements of land cover (e.g., fragmentation), and ecological thresholds. Of course, these complex interaction functions are often unknown and sometimes unknowable. We use a simple model of production functions to achieve our larger goal of using preference data from choice experiments to inform conservation priorities, but we see more complex models as a fruitful area for further research.

Table 10. Relative Welfare Effects of Various Program Attributes for the Preferred Model

	Increase in Aggregate Welfare due to Inclusion of Specific Program Goals	**Number of Acres Potentially Contributing to This Goal**	**Average Benefit per Contributing Acre**
To avoid 1 percent loss of forest land	$3.4 million	4,762 (representing 1 percent of current forest land)	$714
To prioritize protection of water resources	$65.4 million	125,577	$520
To prioritize protection of wildlife habitat	$44.1 million	48,437	$910
To prioritize protection of scenic views	$29.0 million	7,636	$3,798

We use the underlying forest characteristics as a proxy for ecosystem-service-production functions. It is reasonable, though admittedly simplistic, to assume that riparian forests, wetland forests, and forests in regions with a relatively high rate of water recharge are particularly important for water-related ecosystem services and would be targeted by a program focused on protecting water resources. Our choice experiment estimates indicate that $65.4 million of aggregate consumer surplus is available for a program that would prioritize conservation of forests to protect water resources. Our GIS analysis indicates that there are 125,577 acres of riparian, wetland, and high-recharge forests in the Red Hills region. If each acre was equally capable of providing water-related services and the spatial distribution of forest land (e.g., fragmentation) did not affect the overall production of the services, owners of targeted properties could receive up to an average of $520 per contributing acre. Similarly, we can assume that roadside forests are particularly important for protecting scenic views and would be the focus of a program prioritizing scenic views (as conveyed in the stated choice experiment). The $29.0 million aggregate WTP to prioritize scenic views, when applied equally to the 7,636 acres of roadside forests in the region, suggests an average benefit of $3,798 per contributing acre. The $44.1 million aggregate WTP to prioritize protection of wildlife, when applied to the 48,437 acres of land classified as highly important, suggests an average benefit of $910 per contributing acre.

Our assumptions imply a binary ecosystem-service production function with no spatial externalities. The ecosystem service is either provided or not provided on a given acre; there is no variation in the quantity or quality of the service produced. Clearly, some riparian acres are more significant than others, and there are likely to be gains from protecting contiguous parcels of forest that are important for wildlife habitat. More complex models of the ecological production function could use a factor-analysis distance-function approach (e.g., Ferraro 2004) to define the number of "standard units" of ecosystem services provided by a given acre, and that model would generate unique maps of conservation targets.

We provide two maps depicting potential conservation priorities in Figure 3. In both maps, darker shades reflect higher-priority parcels. The map on the top is based only on information from the landscape analysis so parcels with a greater number of characteristics that relate to ecosystem service production are identified as high priority. For example, a riparian forest that provides important wildlife support is assigned two points while a forest with just one of those characteristics is assigned one point. As previously discussed, the underlying and often unstated assumption with this approach is that each characteristic is equally valuable in producing ecosystem services. In reality, some ecosystem services can be produced by a relatively small number of acres and some ecosystem services provide greater benefit than others. The map on the bottom is based on the preference data from our stated choice experiment and our assessment of acre-level contributions to ecosystem service production. We use similar ranges of shades and number of categories in both maps to facilitate comparison. There are subtle but distinct differences apparent in the maps. Most notably, the inclusion of preference data suggests a greater concentration of priority parcels in the southwest portion of the region, which is closer to Tallahassee, and along roads throughout the center of the region. This reflects the tradeoff between the relative value of scenic views and the scarcity of resources that can provide that service.

Figure 3. Map of Potential Conservation Priorities without (top) and with (bottom) Incorporation of Stated Preferences

Note: Darker shades reflect higher-priority parcels.

Conclusion

We used a combination of existing ecological and social data and the results of an original stated choice experiment to identify forest lands that could be priority targets for conservation efforts. Our initial landscape assessment used existing data to identify forest characteristics expected to affect ecosystem service values. This approach can be used to target specific ecosystem services if the desirable services are defined *a priori* by the decision-maker. For example, a conservation organization interested in protecting water quality or quantity would likely want to target riparian forests or forested wetlands. While intuitive and commonly used, this type of analysis is limited in its ability to assess the relative importance of different types of ecosystem services. Hence the value of stated choice or other nonmarket valuation techniques.

Based on our stated choice experiment, we found that respondents reported increased utility for a program that would target land based on specific ecosystem service priorities, such as water resources, wildlife habitat, and scenic beauty relative to a PES program with no specified ecosystem service priority. Of the three services, the scenic view priority generated the smallest aggregate benefit. However, when we consider the relative scarcity of roadside forests that provide scenic views, the average benefit provided by a contributing acre is higher for this service. This apparent switch in relative ranking was uncovered by our integration of the estimated preferences with the landscape analysis.

The WTP estimates from our stated choice experiment are sensitive to the valuation technique chosen and to the model's specifications. Our framing of the choice attributes reflected our goal of estimating preferences for different attributes of a potential incentive program. We used the data to understand how respondents' support for such a program would vary based on program characteristics. Our attributes are less direct than ones used in other stated choice settings and are a potential source of error. Among the program characteristics that we did not include but that would be useful in future research are attributes related to the entity that manages the program. Our payment vehicle also was more broadly defined than is typical to allow us to accommodate differences in tax and utility rates across state lines. As our focus was on the relative value of different attributes, this is of limited concern for this application but should be considered in future work.

Our aggregate benefit measures also are affected by the scale of our analysis. We surveyed only residents of the four counties in the region, and the aggregate benefit estimates are limited to that population. Ecosystem services could be valued differently by residents outside the region. The red-cockaded woodpecker, for example, is a familiar species that is important to people throughout the southeast and potentially throughout the country. In connection with this species, the distance decay function of WTP for scenic roads could have a significantly thinner tail. It is possible that these benefits, generated outside the region, could alter the qualitative implications of our analysis.

A useful focus for future research would be development of more sophisticated models that could describe the potential contribution of an individual parcel to larger societal objectives. In other words, how do we go from aggregate values of WTP to actual parcel-level prioritization? In this study, we relied on assumptions about the ecosystem production function, and it would be useful to consider how we could more accurately incorporate issues related to fragmentation, degradation, and variation in quality into our approach. While the theoretical literature on these topics is sizable, there is not much guidance available for practical decisions. Future work could use a more sophisticated approach to the landscape analysis, perhaps with a factor analysis or a distance function approach, to model the complex relationship between ecosystem attributes (i.e., measures of ecosystem structure) and ecosystem services. These relationships could then be used in the choice experiment directly as attributes or background information or to improve the characterization of "contributing acres," which is needed to translate aggregate welfare estimates into maps of the relative importance of individual parcels.

A second question that emerged from this study relates to the need for monetary estimates at all. If the primary goal is to assess relative preferences for forest attributes (which is, in fact, the original intent of a conjoint-analysis), it is not clear that monetization of value is necessary. Some researchers have considered the potential of assessing relative preferences without a cost attribute (Carlsson, Frykblom, and Hagerkvist et al. 2007). While not appropriate in every case, such an approach might provide enough information for problems such as ours to establish conservation priorities while avoiding some problems common to stated preference studies (low response rates, payment vehicle bias, protest zeros, scenario rejection, etc.).

On a more practical level, our results underscore the potential for social welfare gains from conservation efforts. Mercer, Cooley, and Hamilton (2010) found that the average payment for ecosystem services from federal, state, and nongovernmental agencies and individuals to private forest land owners between 2005 and 2007 averaged \$7 to \$8 per acre per year in Georgia and \$11 to \$12 per acre per year in Florida. The results of our stated choice experiment suggest that the public benefit of conserving forests in the region would support significantly greater payments than the current opportunities, and our survey focused on those forest ecosystem services that provide significant externalities *and* are likely to vary across forests within the region. We did not include some services that previous studies have shown to be quite valuable, most notably climate regulation through carbon storage. Including these factors would have increased the difference between potential benefits and current opportunities.

We have attempted to connect traditional nonmarket valuation studies that focus on accurately quantifying the benefits of a specific change in ecosystem services with other, often interdisciplinary studies that use estimated nonmarket values to characterize the overall value of ecosystem services from a landscape. The motivating question was how to prioritize private parcels of forest land in the Red Hills region for targeted conservation efforts. Such efforts could involve incentive payments to landowners, regulations, or simple landowner education. Given a limited budget, how do agencies charged with protecting natural resources prioritize their efforts? Incorporating economic preference data with a landscape-type approach is a useful starting point.

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