

**ACS Student Development and Engagement Grants
Model Internships**

Title: Assessing costs of exurbanization of forest and farmland on south-central Tennessee's Cumberland Plateau and Sequatchie Valley: student-faculty research in environmental studies

Investigators:

Deborah McGrath, Assistant Professor of Biology

C. Ken Smith, Associate Professor of Forestry and Geology, and Chair of Environmental Studies

University of the South, 735 University Avenue, Sewanee, TN 37383-1000

E-mail: dmcgrath@sewanee.edu, ksmith@sewanee.edu

Phone: 931-598-1991 (McGrath), 931-598-3219 (Smith)

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Project Summary

Research at the wildland-urban interface (WUI) has gained importance because of the impact of human habitations on water quality, biodiversity, and the integrity of forest and farmland in undeveloped natural areas. The southern Cumberland Plateau supports some of the most biologically diverse ecosystems in North America, but much of this land is privately owned and not under any zoning or growth restrictions. Thus the potential for unrestricted exurban growth is high, as are the potential negative impacts on ecosystems services provided by these natural areas. In addition to the ecological costs of converting forest and farmland to housing, studies show that the cost of new developments often exceeds the revenue generated by property taxes.

In a pilot study conducted with the help of five undergraduate Environmental Studies majors, we compared the economic and ecological costs of two models of development occurring in this region; upland forest conversion to low-density homes and subdivision of valley farmlands. This study was initiated in response to needs of a local land trust and city planners who expressed concern about increasing exurban growth into Tennessee's Sequatchie Valley farmland and Cumberland Plateau forest. To develop our methodology for quantifying costs region-wide, we first examined two adjacent 1,500-acre tracts of land running from the top of the Plateau down into the Sequatchie Valley near the town of Dunlap, Tennessee. Using tax parcel maps and GIS, three students compared the history of land use, sales transactions and development trajectories on the two properties. To begin examining the ecological impacts of development, two students monitored stream water draining the properties, working closely with the Tennessee Department of Environment and Conservation (TDEC) to learn different methods for assessing water quality.

To date, our research has demonstrated that the price of upland forested property increased over 100-fold during the last five years, with nearly half the land purchased by non-residents (Floridians). The cost of extending roads, water and electricity to the upland properties was much higher, while tax revenue from developed farmland was greater. Preliminary results indicate higher stream water turbidity and nutrient concentrations downstream from upland properties, suggesting watershed impairment in the low-density development. Student presentations of this preliminary information to members of the Land Trust for Tennessee, as well as to planners and developers, have been very well received. With the case study nearing completion, we see that our students have a broader perspective on environmental problem-solving and a greater ability to work effectively as research collaborators with professionals in the field. Research on the changing landscape of Tennessee's wildland urban interface is scarce, of great interest to many stakeholders and essential to development planning so as to minimize its costs to communities and ecosystem services. The objectives of our collaborative research are to:

1. Strengthen interdisciplinary research collaborations in environmental studies that bring together students and faculty from the natural and social sciences in an effort to address pressing public issues at the wildland-urban interface.
2. Expand our research to a county-wide scale to examine the costs and benefits that exurban growth brings to a region.
3. Use the results of this research to inform stakeholders in rural communities about what is happening in their region and identify key undeveloped areas to target for conservation.

Specifically, we request funds to provide research internships for two environmental studies students this summer (\$4,000.00) that would allow them the opportunity for more in depth research and greater one-on-one contact with faculty and members of the Land Trust of Tennessee. The students will continue this research for one calendar year to complete a senior thesis project and share the results with stakeholders in our region. We also seek funds for travel (\$1000.00) so that the students can present the research at the Ecological Society of America meeting (Aug 2006) and

the 2nd biannual Wildland Urban Interface conference (March 2007). Total request is \$5,000.00. (For more information on the project, please see Appendix.)

Institutional Support

To date, we have received institutional support for this research from the Departments of Forestry and Geology, Biology, the Environmental Studies program and the Landscape Analysis Lab (LAL). Such support includes purchase of GIS software and access to scanned tax maps for the state of Tennessee, assistance by GIS personnel, instrumentation and reagents for water quality monitoring, transport to field sites, and travel to presentations. TDEC has also loaned us equipment, such as a flow meter, and our students have accompanied their scientists on numerous field trips to learn different methodologies for assessing water quality, such as benthic macroinvertebrate studies and counts for E-coli bacteria.

Currently, there are only a dozen summer internships shared among the sciences. As part of the current capital campaign, the University is seeking funds to endow ten more competitive student internships for the natural, physical and social sciences. We are also using the results of the pilot study and past land use studies conducted on top of the Plateau by the LAL to support a request for funding from the EPA Network for Sustainability Program. This will enable us to connect our knowledge of current events to networks of concerned stakeholders who can help direct planning at different scales.

Evaluation and Dissemination of Results

As previously stated, a primary objective of our research is to share our results with stakeholders, including county executives, developers, state land managers and business owners, in attempt to better inform decisions about land use change and growth. In the next month, we will address these stakeholders in Sequatchie County to deliver our preliminary results from the pilot study. In addition to continued communication with these stakeholders, the results of our expanded study will be presented to a larger academic and professional audience at the Ecological Society of American meeting held in Memphis, TN in August 2006, and at the second biannual Wildland-Urban Interface conference hosted by Auburn University in March 2007.

We will measure the success of this project in various ways.

1. A primary goal is to involve students as collaborators in interdisciplinary applied environmental research. Possible measures of success include the quality of student presentations at stakeholder and professional meetings, honors seminars and theses and continued student recruitment (indicating student interest) into this project. We will also coauthor papers to be submitted to the Journal of Environmental Quality and Society and Natural Resources.
2. Our goal is to better inform Sequatchie County land managers and decision makers and our measure of success would be if they used our information. Deliverables will include digital tax and land use maps and data on the cost of community services and water quality. Another means of evaluating the project would be continued regional interest in this issue and progress addressing some of the challenges it presents.

In conclusion, an interdisciplinary approach is needed to quantify and understand the rapid change that this region is about to experience. One of the primary objectives of this project is to form an interdisciplinary team capable of tracking, projecting, and interpreting the consequences of development in the study area. Through participation in this study, our environmental studies

students will improve their skills as scientists, collaborators and problem solvers. They will gain experience both presenting their research to academic and professional audiences and interacting with nonacademic stakeholders in situations aimed at addressing pressing issues at the wildland urban interface. Our pilot study has demonstrated that our own scholarship progresses more rapidly with the added help of student collaborators, especially if they can work with us during the summer months. Finally, we hope that the results of our research will be used by decision makers in our region to mitigate the impacts of exurban growth.

Collaborators

University of the South- Deborah McGrath (Biology) and Ken Smith (Forestry and Geology)

Megan Hinkle, Mary Bruce Gray and Haley Merrill – Environmental Policy majors (C'06)

Jim Shaffer and Holly Zafian – Ecology and Biodiversity majors (C06)

Sarah Simmons – Environmental Policy majors (C'07)

Jordan Casey –Ecology and Biodiversity major (C'09)

Land Trust for Tennessee -Eileen Hennessy and May Bartlett– South Cumberlands, Sequatchie Valley project

City of Chattanooga - Jeff Pfitzer – Director of city budget and planning

Proposed budget for ACS funding

Expenditure	Quantity	Unit Cost	Total Cost
Student summer internships for two students	2 ten-week internships@\$200.00/week for Sarah Simmons and Jordan Casey	\$2000.00	\$4000.00
Student travel money to present research at the ESA (Aug 2006) and WUI conference (Mar 2007) includes registration, travel, accommodations	Funds for two students to travel to two conferences	\$250.00/student/trip	\$1000.00
Total Requested			\$5,000.00

Timetable of research activities

Timeframe	Economic Costs	Ecological Costs	Deliverables
March – May 2006	Finish cost calculations for 2-property case study; add in multipliers for construction employment; research regional conservation development examples	Continue monthly monitoring of chemistry and flow at case study sites; conduct benthic invert diversity studies and E-coli counts	Case study presentation to Dunlap stakeholders (farmers, developers, executives & land trust) Poster at Scientific Sewanee
June – August 2006	Rectify, digitize and join tax parcel map data to aerial photos of Sequatchie, Marion and Hamilton counties	Identify sites and expand water monitoring – chemistry, diversity, counts	Presentation with students at Ecological Society of America meeting in Memphis
Sept – Dec 2006	Cost of community services study in expanded study region	Water quality monitoring	Digital land use maps; 12 months of water data
Jan – April 2007	Finish cost of community service study for expanded region. Prepare presentations and theses.	Finish calendar year of water monitoring. Prepare presentations and theses.	Senior theses WUI conference Scientific Sewanee Journal of Environmental Quality

APPENDIX

Project Description

The Problem

The wildland-urban interface (WUI) is generally defined as areas where human habitation is intermixed with undeveloped natural vegetation. With increases in population and demand for secondary homes, the WUI is gaining attention due to wildfire destruction of homes, the introduction of exotic species, the reduction of forested areas, impacts on biodiversity, and changes in water quality (Radeloff et al. 2005). According to a recent analysis, the eastern US has the greatest extent of WUI areas, and the southern Appalachians is one of the largest (Nowak et al. 2005, Stein et al. 2005).

The southern Appalachians and the Cumberland Plateau region along with their associated valleys are some of the most biologically diverse areas in North America, (Ricketts et al. 1999) making the dramatic increase in WUI areas in this region of particular concern. The upland forests serve as important neotropical migratory bird habitat and the region's watersheds protect some of the most biologically diverse freshwater ecosystems in the world (McGrath et al. 2004). The majority of these lands are privately owned and not under any zoning or growth restrictions, thus the potential for unrestricted growth outside urban areas is high, as are the potential negative impacts on natural areas.

Another concern in the rural south is the loss of traditional agricultural lands to urban development. In the valleys of the Appalachians, the soils are some of the most productive in the world. These farms also provide valuable open space as low density urban developments expand along paved corridors. The loss of these productive soils to housing development is a key component of land use change in the region that is directly tied to the expansion of the WUI. According to the American Farmland Trust, Tennessee has the 8th highest rate of farmland conversion to urban uses in the United States (www.farmland.org/farmingontheedge/index.htm), and the Sequatchie Valley is currently undergoing rapid change.

The maintenance of water quality and quantity is an ecosystem service that is recognized as vital to human society (Wear et al. 1998) and protecting terrestrial habitat surrounding sensitive wetlands from agriculture, silviculture and urban development is critical for maintaining aquatic biodiversity (Semlitsch and Bodie, 2003, Jones et al. 1999). Rapid sprawling growth throughout the southeastern United States has been implicated in the degradation of surface and subsurface waters, flooding, storm water runoff, decreased dry weather flows and reductions in water quality (Tennessee Growth Readiness Program 2006). There is growing awareness throughout the state of Tennessee about how unregulated growth threatens water resources. Tennessee is a primacy state, meaning that Water Pollution Control in the Tennessee Department of Environment and Conservation (TDEC) oversees the enforcement of the 1977 Clean Water Act, which mandates that waters of the state must be fishable and swimmable. A study of Sequatchie River drainage basin comparing fish and invertebrate populations in 1970 and 1999 demonstrated serious declines in the diversity and abundance of aquatic biota in all nine tributaries sampled (NRCS 1999). TDEC is now in the process of sampling reference streams throughout EPA region 68, which covers the Cumberland Plateau and the Sequatchie Valley, in order to establish total maximum daily loads (TMDLs) that will be used to issue permits and monitor water quality in this ecoregion. Even so, TDEC's human resources are stretched thin across the state, making it difficult to monitor changes in water accompanying development, especially in remote rural regions.

In addition to the ecological and social costs of converting forest and farm to housing, there are concerns that the economic costs of extending services to suburban and exurban developments may in essence be a public subsidy to private development (Burchell et al. 2000). As timber companies and small farmers divest of their lands in the region, land speculation and proposed low-density housing developments have the southern Cumberland Plateau and valleys ripe for changes already seen in western North Carolina and in north Georgia. In many of these rural areas, county governments do not have suitable information to help guide them through these rapidly changing times. In addition, no attempts are made to estimate the costs of extending community services to new developments, and these costs have been shown to exceed new revenue in some regions of the country (Freedgood et al. 2002).

In September and October 2005, the Landscape Analysis Lab at the University of the South, in collaboration with the University of Tennessee, hosted two meetings with county executives and state officials from the 16 counties of Tennessee's portion of the Cumberland Plateau and Sequatchie Valley. County officials attending these meetings expressed a variety of concerns during these sessions, and some of the summary statements included the following:

- Planning and development assistance is not uniform across the plateau. Counties are in different development and planning districts and compete for funding. A regional vision is thus difficult to achieve.
- Opposition to zoning, increased property taxes, and restrictions to private property rights is widespread.
- An increase in housing developments is frequently seen as a positive development, while costs of extending services such as sewer, water, roads, police, garbage, or increased school enrollment not always considered.

Pilot Study

As an initial step, last fall a team of two professors, a staff member, and three Environmental Policy students have contacted agencies and personnel that have collected data in the study area in recent years, collected maps, images, and data pertinent to the study area. The students examined other areas in the US that have experienced urban sprawl into natural and farmed areas, researched existing growth restrictions and the impacts of these restrictions, and uncovered methods used to examine the public costs of private development. We also closely examined the work of the American Farmland Trust (www.farmland.org/farmingontheedge/index.htm) and the US Forest Service study group entitled Forests on the Edge (www.fs.fed.us/projects/fote/about.shtml). As previously mentioned, studies led by these two groups have demonstrated that our region is one of the most critical areas in the United States.

Over the past academic year, our student team has concentrated their efforts on understanding how two tracts of land near Dunlap, Tennessee have been subdivided and developed. These two tracts were chosen because they were of a manageable size (approx. 1500 acres each), they were located in the geographical region of interest, and they represented typical plateau forest and valley farm tracts under development in the area. Using tax parcel maps and GIS, the students compared the history of land use, sales transactions and development trajectories on the two properties. During the spring semester, two environmental studies students joined the team to collect water samples

and track water quality above and below these developed tracts employing techniques used by TDEC Water Pollution Control.

To date, the pilot study has demonstrated that the price of upland forested property increased over 100-fold during the last five years, with nearly half the land purchased by non-residents. The cost of extending roads, water and electricity to the upland properties was much higher, while tax revenue from developed farmland was greater. Preliminary results show elevated stream water turbidity and nutrient concentrations downstream from upland properties, suggesting watershed impairment in the low-density development. Student presentations of this preliminary information to members of the Land Trust for Tennessee, as well as to planners and developers, have been very well received.

Following completion of the pilot study, we will focus this summer on a transect that crosses several development classifications (T-zones) ranging from downtown Chattanooga (urban core) through older grid-network neighborhoods and suburban development in north Chattanooga to working landscapes and rural preserves on Walden's Ridge (plateau) and in the Sequatchie Valley. Tentatively, this transect will exit downtown Chattanooga and roughly follow Highway 127 to Dunlap.

We are very excited about the progress made by our Environmental Policy and Ecology and Biodiversity majors in beginning this interdisciplinary investigation of the costs of exurbanization in our region. Working in teams of two or three has produced great efficiency and synergy as these undergraduate students bring complementary skills, disciplinary training, as well as fresh ideas and perspectives, to the research. While the five students working on the pilot study will graduate in May, we have already identified two Environmental Policy majors and one Ecology and Biodiversity major who are engaged and excited about continuing the research this summer and throughout the next calendar year. Our biggest challenge is to find funding to support undergraduate summer internships and travel in this type of applied research aimed at environmental problem solving.

Specifically, we are requesting funds to provide research internships for two new environmental studies students (Sarah Simmons, Environmental Policy C'07 and Jordan Casey Ecology and Biodiversity C'09) this summer that would allow them the opportunity for more in depth research and greater one-on-one contact with faculty and the Land Trust of Tennessee. Sarah and Jordan will continue this research for one calendar year to complete a senior thesis project and share the results with stakeholders in our region. In addition, we seek funding to cover travel costs so that students can present the research at two upcoming professional conferences (ESA Aug 2006 and WUI 2007).

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