The economic value of open space in the Cumberland Region

Report Prepared for

Cumberland Region Tomorrow

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May 7, 2018

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EXECUTIVE SUMMARY

Green open space – public parks, farmland, forests, wetlands - provide substantial economic, environmental and health benefits. These benefits are lost when open space is converted to other purposes. Unfortunately, these benefits are poorly understood leading to policy debates and land development decisions that ignore or undervalue these benefits. In contrast, the benefits of converting open space to other uses such as residential housing, commercial properties, or industrial facilities are well known. This combination of well understood benefits of open space conversion and poorly understood open space benefits leads to excessive open space conversion. In short, residents are in danger of giving up their natural assets for far less than they are worth. To address this issue, this study estimates the economic value generated by open space in a 10-county region in Middle Tennessee (Cheatham, Davidson, Dickson, Maury, Montgomery, Robertson, Rutherford, Sumner, Williamson, and Wilson).

Approximately 91 percent of the study area is open space. This area includes large residential lots, parks, greenways and trails, working farms, wildlife management areas, and large forested areas. Using previous valuation studies, existing surveys of Tennessee residents, extensive GIS data, and standard statistical analysis, this study estimates the value of open space in ten-county study area by measuring impacts across four areas:

1) the value of recreational activity on open space and associated avoided health-care costs

2) the value of ecosystem services provided by open space

3) jobs and revenue created as a result of activity on and associated with open space

4) the economic impact of open space on residential property values

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This analysis reveals that open space contributes to the regional economy in a variety of ways, with benefits accruing to businesses, governments, and households. The economic benefits created by open space accrue to residents in different ways. Open space generates direct revenue streams to individuals and governments. Open space also appreciates the value of most residents' most valuable asset – their home. Open space also mitigates or eliminates costs that would otherwise be paid by individuals, governments, and businesses. Because these values differ, the estimates in this study should not be added together to produce a single aggregate value of open space in the ten-county study area.

Instead, the estimates in this study should be used to provide guidance to elected leaders, policy makers, and the public as they make decisions that impact the provision of open space in the region. These estimates also dispel the notion that undeveloped open space represents a hindrance on the local economy. However, it is important to note that this study does not analyze the costs associated with acquiring, preserving, or maintaining land as protected open space, and does not represent a benefit-cost analysis.

Recreation and Health

Open spaces generate benefits through the value residents gain from engaging in recreation and exercise for free or at below-market rates instead of turning to private markets for the same recreation and exercise opportunities. Residents also enjoy the health costs that are avoided through recreation and exercise on open space. Business benefit from the increased productivity that comes from a healthy workforce.

Key Findings

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- *Over $1.3 billion in benefits accrue annually to residents who participate in recreational activities on public open space in the Cumberland Region.* This estimate is equivalent to $1,913 in recreational-use benefits per household per year. This value represents the additional amount of money that residents would be willing to spend in the private market to participate in recreational activities they currently enjoy on public open space.

- *The direct and indirect medical cost savings due to physical activity on open space is estimated to be $213.7 million per year for the study area.* Direct medical costs refer to the costs of actually treating the illnesses or medical conditions caused or exacerbated by physical inactivity, which include cardiovascular diseases, diabetes, depression, and certain cancers as well as obesity. These costs include preventive, diagnostic, and treatment services incurred at hospitals and other medical facilities.

- *The total reduction in workers' compensation costs, including both direct and indirect costs, is estimated at $4.5 million per year for the study area.* Individuals can be eligible to collect workers' compensation payments when injuries occur in the workplace. Research has shown that physical *in*activity can increase the risk of suffering strains and sprains and the duration of the recovery period (Chenoworth and Bortz 2005).

- *It is estimated that businesses in the study area avoid $247.7 million per year lost productivity costs because of the exercise their employees in engage in on open space in the region.* There are two ways an employee's physical inactivity can lead to lost productivity. The first is not being present or attending to duty or work (i.e., absenteeism). The second is being at work when they should be at home, either because they are ill or because they are too tired to be effective (i.e., presenteeism).

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Who Benefits?

- Households: Open space provides residents a free or low-cost opportunity to engage in physical activity. This physical activity lowers medical costs of residents

- Businesses: The physical activity available on open space contribute to the health of the region's workforce. A healthier workforce leads to avoided medical costs, workers' compensation, and lost productivity costs.

Ecosystem Service Values

Open space provides value by supporting and enhancing naturally occurring environmental processes that are beneficial to governments, businesses, and households. Examples include water supply, flood mitigation, provision of wildlife habitat, pollination, air pollution removal, and carbon sequestration and storage. If these open spaces were developed, governments in the study area would be forced to replicate necessary public services such as flood control and air pollution mitigation though alternative and more costly means. By relying on the natural landscapes on open space, significant expenses can be avoided.

Key Findings

- *The 3 million acres (4,838 square miles) of open space in ten-county study area contribute an estimated $3.2 billion in annual cost savings and economic benefits through the provision of seven ecosystem services: water supply, water quality, flood mitigation, wildlife habitat, pollination, air pollution removal, and carbon sequestration.* The allocation of ecosystem service benefits across the study area depends on the amount and type of open space in each county.

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- *Trees on open space in the ten county study area annually provide $325 million in air pollution removal benefits.* If all the forested open space in the ten-county region were developed, residents would experience an additional $325 million in pollution-related impacts annually. The economic benefit of the pollution removal depends on how harmful each of these pollutants is to human health and ecosystem function and the amount of forested open space in each county.

Who Benefits?

- Governments: local governments avoid having to spend money to replicate vital environmental functions provided by open space using costly artificial methods.

- Businesses: Businesses avoid having to pay additional to replicate the environmental functions provided by open space

- Households: Residents avoid having to pay additional taxes to replicate the environmental function provided by open space and to repair damage caused by flooding and air pollution.

Economic Activity

Open space generates a variety of economic activities ranging from agricultural production on working farms to timber produced from timberlands to tourism. This study estimates the spending, employment, earnings, and tax revenues associated with these activities.

Key Findings

- *It is estimated that over $16 billion in annual spending occurs on and because of agriculture and forestry in the ten county study region.* Examples of these

expenditures include spending for the purchase of agricultural commodities produced on farmland and spending to purchase timber products produced on forests.

- *Agriculture and forestry in the ten-county study region contributes up to 178,000 jobs to the regional economy.* Examples of these jobs include farmers, distributers, and suppliers working on farmland; loggers and mill operators that handle timber produced from forests.

- *Salaries paid to individuals working jobs in agriculture and forestry in the ten-county study region total over $5.2 billion per year.*

- *The economic activity that takes place on and because of open space in the ten-county study region generates up to $272 million in sales tax revenues.*

- *Open space is the catalyst for a wide range of tourist activities. However, these benefits are difficult to measure precisely.* Open space in the ten-county study region generates at minimum $219 million and up to $7.2 billion in direct tourist spending.

Who Benefits?

- <u>Businesses</u>: farmland, forestland, and parks are a source of commerce

- <u>Governments</u>: The economic activity associated with open space generates tax revenue for governments in the form of sales and property taxes.

- <u>Households</u>: Open space provides economic opportunity for residents in the form of employment and wages.

Property Values

The open space in the ten-county study region adds to the overall value of its housing stock because homeowners are willing to pay a premium to live in close proximity to open space. This

increased wealth is captured by residents through higher sales values of homes near open space and generates increased government revenues via larger property tax collections. This study utilizes nearly half a million home appraisals in the ten-county study region to estimate the effect of open space on residential property values and resulting fiscal impacts.

Key Findings

- *All forests, wetlands, agricultural lands, shrub-scrub, and developed open space in the ten-county region increases the total value of the housing stock in the ten counties in Middle Tennessee by $15 billion.* This represents an average property value increase of $30,535 due to the presence of the current stock of open space. The current open space in the ten-county region adds sixteen percent to the average home value. How much open space adds to home values depends on the type of open space (for example forest, agricultural land) in the vicinity of the house.

- *$118 million in property tax revenues in the ten county study area is due to the current stock of open space in the region.* Increased home values attributable to open space would directly increase the property tax that residents pay to county and municipal governments and school districts in the study area.

Who Benefits

- <u>Households and Businesses</u>: Nearby open space contributes to home values which increases home equity and wealth when the home is sold.

- <u>Governments</u>: Property value increases attributable to open space result in property tax revenues for local governments.

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1. INTRODUCTION

1.1 PURPOSE OF THE REPORT

One of Middle Tennessee's most valuable assets is its natural landscapes. Unfortunately, policy debates and land development decisions often ignore or at best undervalue the substantial economic, environmental, and health benefits generated by open space such as public parks, farmland, and forestland. Many of these benefits are quantified by markets. For example, farmland can be valued using market prices for the agricultural commodities it yields. The property value "premium" associated with real estate near open space can be quantified using housing markets. The value residents and visitors to the area place on recreation opportunities provided by open space can even be proxied by open space access fees. However, market values capture only a portion of the total benefits generated by open space. Forestlands support wildlife, reduce regional air pollution, enhance water quality, sequester carbon and even help promote mental health. Access fees will not reflect the true value of recreational opportunities since they are not always required and are often set sufficient only to offset the cost of maintaining recreational facilities. Non-market values of open space are difficult to quantify but often constitute a large portion of the total value attached to open space. For example, cropland and pasture fuel local agricultural economies, parks and greenways provide recreational opportunities, forests provide wildlife habitat, and wetlands work to naturally mitigate floods. A better understanding of the benefits provided by open space can improve land-management decisions and address the common misperception that undeveloped or protected open space is a wasteful use of land that contributes nothing to local economies.

To inform Middle Tennessee residents of the value of these open space benefits, this study estimates the economic value of the 4,838 square miles of open space in a ten-county

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region of Middle Tennessee (see Figure 1). The study area includes Cheatham, Davidson, Dickson, Maury, Montgomery, Robertson, Rutherford, Sumner, Williamson, and Wilson Counties as well as the rapidly growing city of Nashville. The analysis focuses on green open space (land that is primarily covered with grass, trees, shrubs, or other vegetation), which includes large residential lots, parks and playgrounds, agricultural land, riparian areas, wetlands, and forestlands.
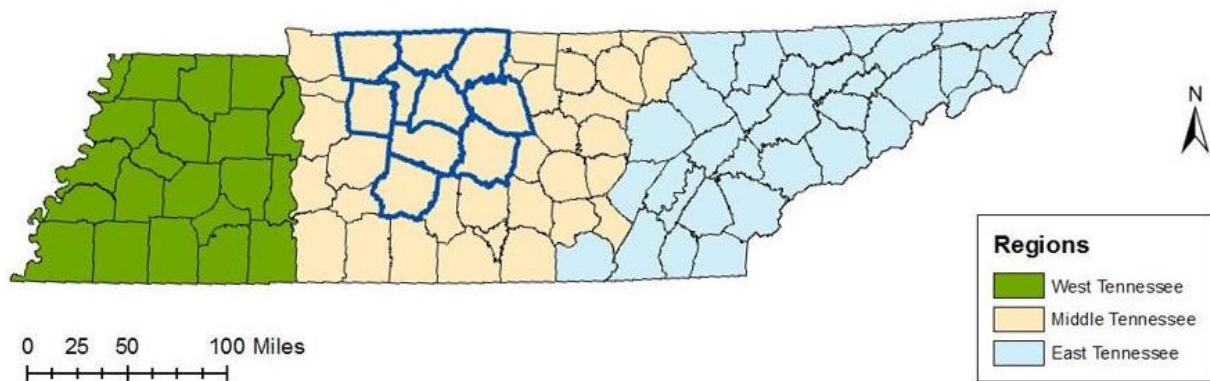
Figure 1. Ten-county study area in Middle Tennessee

The economic value of these 4,838 square miles of open space is estimated by measuring open space benefits in five areas:

1. Jobs and revenues created as a result of economic activity tied to open space

2. The effect of open space on residential property values and property tax revenues

3. The values residents and non-residents place on recreation on open space including health-related cost savings provided by open space

4. Environmental values of ecosystem services provided by open space

The first three categories capture open-space values generated by increased economic activity, appreciation of goods produced in the economy, or cost savings that raise personal

incomes of residents if these ten counties. Of course, many values related to open space cannot be captured by the additional dollars in economic activity generated. In fact, many alternative uses for open space such as residential and commercial development will be viewed as a higher-valued use when comparisons are based solely on these market-based measures of value. For example, while proximity to open space may enhance nearby property values, it may not increase existing housing values more than the value of a new home built on the park site. The last two categories capture oft-cited non-market values of open space. These non-market values are measured much less frequently but can constitute a significant portion of the total value attributable to open space.

This study makes no policy recommendations. Instead, the estimates of the economic value of particular open space benefits are intended to inform land-use and development decisions in this ten-county region of Middle Tennessee. Specifically, these estimates will provide a more complete depiction of the full range of economic, health, and environmental benefits provided by open space and counter the common and incorrect assumption that the economic value of open space is zero.

1.2   STUDY APPROACH

Benefits versus values

The primary objective of this study is to estimate the economic value of the benefits provided by open space in the north-central portion of Middle Tennessee. Here we distinguish between a benefit or service provided by open space and the value of that benefit. Table 1 illustrates the different benefits provided by open space and the way these benefits generate economic value. Open space benefits fall into one of five categories: 1) economic activity, 2)

property values, 3) health, 4) recreation, and 5) ecosystem services. Each of these open-space benefits can create economic value in four ways:

1. **Wealth generation** such as higher property values and earnings generated by industries dependent on open space (i.e., agriculture, forestry, and tourism)

2. **Tax revenues** such as increased property-tax revenues due to higher property values or sales-tax revenues from the sale of agricultural and forestry commodities.

3. **Avoided costs** such as the dollars that would be spent to improve water quality or mitigate floods in the absence of open space.

4. **Willingness to pay**, which captures what individuals would be willing to pay for recreational activities or wildlife habitat if these services were not provided by open space.

The first two categories are value generated by the presence of open space, while the last two are economic costs avoided by the presence of open space. For example, a city or town may be forced to expand or improve stormwater infrastructure if large areas of forest are developed into a parking lot. Residents are generally willing to pay to run and bike in city parks and greenways even though they often do not have to pay any access fee to enjoy these recreational pursuits. While all four categories are viewed as the economic value created by open space, the last two—avoided costs and willingness to pay—are not based on actual monetary transactions. Unlike wealth generation and tax revenues, avoided costs and willingness to pay should be viewed not as actual income generated but as the value that residents, non-residents, businesses and local governments gain from open space benefits above what they must already pay for these benefits (which is often zero).

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Table 1. Open space benefits and the subsequent values generated

		Ways open space creates economic value			
		Wealth generation	Tax revenue	Avoided costs	Willingness to pay
Open space benefits	Economic activity	✓	✓		
	Property values	✓	✓		
	Health			✓	
	Recreation	✓			✓
	Ecosystem services			✓	✓

Open space is required for a number of important industries in Tennessee. For example, agricultural production relies on cropland and pastures, the forest products industry relies on forestlands, and the tourism industry relies on the scenic beauty that open space provides. This study estimates the spending, employment, earnings, and tax revenues associated with these economic activities. These estimates represent the economic impact generated from open space. This economic impact typically exceeds the direct economic cost of open-space land parcels because open space generally requires fewer services such as sewer and electrical lines and roads. By contrast, services to residential parcels cost far more than the tax revenue they generate, even when sales taxes are considered, primarily because of the cost of public schools required for the children who live there.[1]

Homeowners are willing to pay a premium to live in close proximity to open space. This preference among homeowners suggests that the existing open space in the study area adds to the overall value of the housing stock. Residents capture this increase in wealth through higher sales values for homes near open space. State and local governments capture this increase in wealth

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[1] http://www.farmlandinfo.org/cost-community-services-study-robertson-county-tennessee

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via larger property tax collections. For the property-value benefits of open space, this study estimates the change in residential property value associated with different types of open space and the resulting impact on property tax collections.

Residents use open space for recreation and exercise. Without open space, residents would be forced to seek out these activities in the private market such as through the purchase of a gym membership or membership in a private hunting club. Rigorous exercise on open space also helps residents avoid many costly health ailments and benefits the region's businesses through increases in worker productivity and decreases in absenteeism. For the recreation benefits provided by open space, this study estimates the willingness to pay for recreational access provided by open space and the economic impact for hunting access. For the health benefits of open space, this study estimates the medical cost savings, workers compensation cost savings, and lost productivity cost savings.

Finally, open space also provides value in the form of ecosystem services such as clean-water provision, flood control, and air-pollution mitigation. If open space were developed, the region would be forced to spend money to replicate these ecosystem services. Middle Tennessee enjoys significant cost savings from the natural landscapes found on the region's open spaces. This study estimates the cost savings associated with several ecosystem services provided by the region's open spaces including water supply, water quality, flood mitigation, wildlife habitat, pollination, air pollution removal, and carbon sequestration and storage.

The study does not attempt to quantify the value of several other benefits associated with open space such as cultural, spiritual, aesthetic, stress-reduction, mental health, community cohesion, energy savings, and crime reduction. Though several independent studies have documented a relationship between forested landscapes and mental health (Berman, et al.

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2008;Kühn, et al. 2017;Ward Thompson, et al. 2012). This study does not include these benefits because of data limitations and because these benefits are more difficult to measure. Even so, their absence from this study should not be interpreted as an indication that these open space benefits are not present in the study area.

Methodology

This study utilizes several analytic techniques and data sources. The economic impact analysis utilized a combination of standard input-output modeling and RIMS II multipliers for the ten-county study area to estimate spending, jobs, and earnings associated with agriculture, forestry and tourism. The study employed the hedonic[2] price method to estimate the impact of open space on residential property values. As part of the study, researchers created a comprehensive database of appraised property values in the study region. Researchers used this property-value database as a key input in a two-stage least-squares regression that estimated the hedonic price function. The study also employed benefit-transfer methods to estimate the health, recreation and ecosystem service benefits where primary data collection was not feasible due to budget constraints. Benefit transfer methods use value estimates from studies in similar locations to infer value in the study area of interest (for example the north-central portion of Middle Tennessee). A complete account of study methodology is included in the technical appendices.

The economic benefits presented in this study represent a vast improvement over the common and incorrect assumption that the economic value of open space is zero. However, it is important to note that the economic benefits presented in this study are meant to serve as

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[2] The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides.

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estimates and not exact values. The analysis is subject to caveats common to any valuation study: substitution effects, double counting, and value estimation. Our analysis implicitly assumes that residents would stop participating in recreation and exercising if all open space were developed though they may substitute other forms of recreation and exercise. Depending on the magnitude of this substitution effect, residents would replace some of the value currently derived from recreational activity on open space rather than do nothing. Consequently, estimates of recreational value in our study should not be interpreted as money that would be lost if all open space in the study area were developed. Instead these estimates should be viewed as an upper bound on the recreational value of the existing stock of open space.

Double counting occurs when a value is overstated when accounted for in two separate analyses. Some double counting is expected to exist in the evaluation of recreational and health cost savings. For example, people will likely include the value of health benefits when they state a willingness to pay for recreation. Some double counting is also expected between property value impacts and recreational benefits. For example, people will include recreational use values in their assessment of a home's value. A smaller amount of double counting may also be present between property value impacts and ecosystem services. For example, home prices may reflect the flood mitigation benefits provided by neighboring forests.

Using conservative values in the benefit transfer approach more than compensates for any potential overestimates of open space values due to substitution effects and double counting. In applying the benefit transfer approach, there is a range of studies and values to choose from. To avoid overstating values, this study applies the benefit transfer approach to open space values only when at least four previous studies are available. This avoids the possibility that a single

study could unduly influence the values reported in this study. The study also uses an average of the values in existing studies to provide a conservative value estimate.

Two additional caveats that concern the interpretation of the economic values estimated in this study: First, the benefit estimates produced by this study represent different types of value. For example, the property-tax revenues generated by open space differ from the willingness to pay values attributable to recreational use of open space and should not be added together to produce a single number representing the aggregate value of open space in the study area. Second, the benefit estimates produced by this study take into account the range of land covers, economic activities, recreational activities, and ecosystem services generated by open space. Because these factors vary significantly from area to area, benefit estimates should not be used to infer the value of specific open space parcels.

1.3   OVERVIEW OF OPEN SPACE IN THE STUDY AREA

Open space is any piece of public or private land that is undeveloped (has no buildings or other built structures). Based on this definition, 91 percent of the 10-county study region (4,838 square miles) is open space. However, only 15 percent of this open space (747 square miles) is protected from development as public land or privately held land enrolled in a conservation program. Open space can be categorized using two key characteristics: cover type and ownership.

Cover type refers to the vegetation and land uses that describe a piece of open space. Figure 2 shows the distribution of cover types across the study area. Over half of the 4,838 square miles of open space in the study area is covered in deciduous (for example oak, maple, and hickory) and evergreen (for example pine and cedar) forest (see Figure 3). Over a third is agricultural land used as pasture and for growing crops. The remainder is divided between

developed open space (parks, golf courses, cemeteries, and large residential lots), shrubland

(more than 20% of total vegetation is less than 5 meters tall), and wetlands (areas where the soil

or substrate is periodically saturated with or covered with water). Developed open space

encompasses a wide variety of open space where impervious surfaces account for less than 20

percent of the total land cover. By this definition, developed open space includes lawns, local

parks, greenways, Civil War sites, and urban gardens. Specific examples of developed open

space in the study area are Shelby Bottoms Nature Center and the Nashville Zoo.
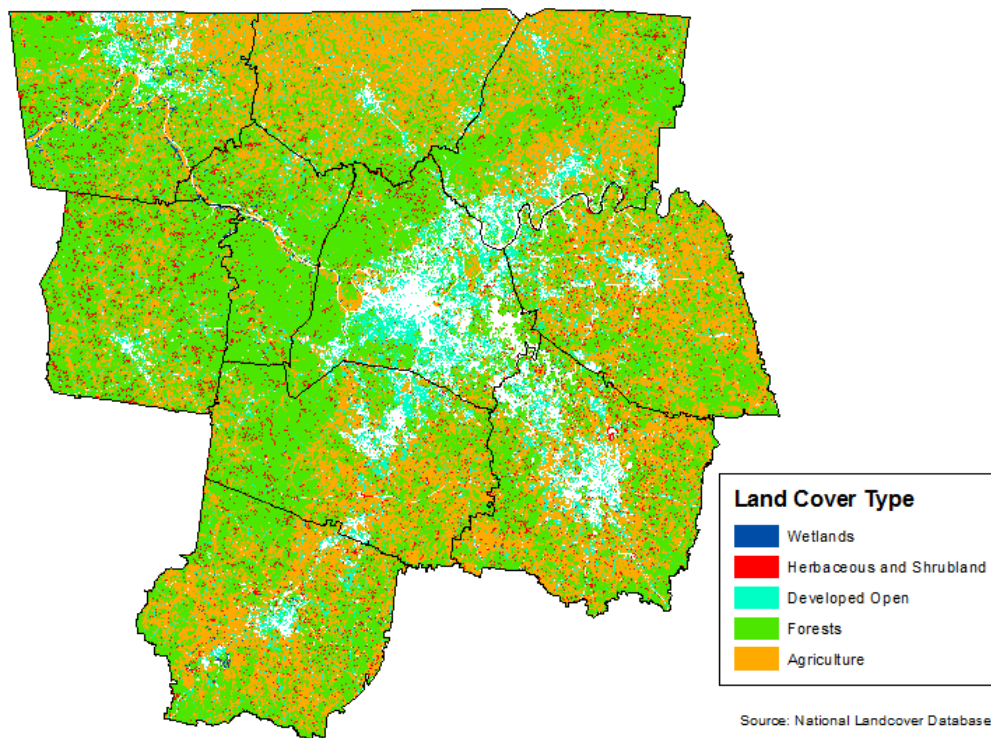
Figure 2. Open space land cover types in the ten-county study region

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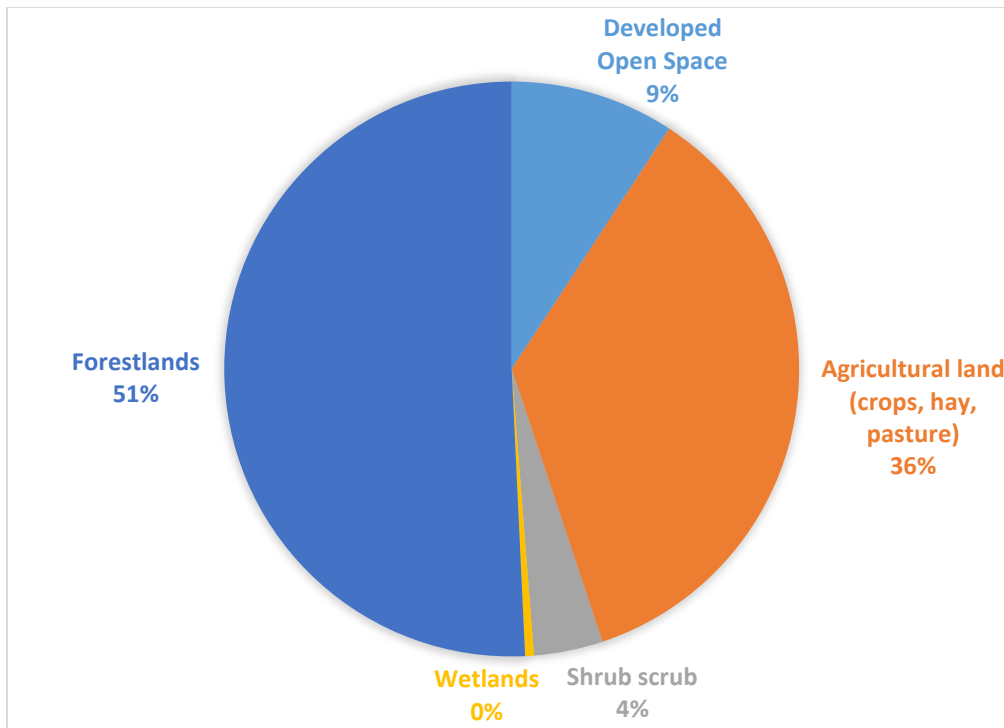
Figure 3. Total open space by cover type

Ownership refers to the balance of public versus private open-space ownership. Figure 4 shows the distribution of public open space and privately held open space. The vast majority of open space in the state (approximately 85 percent) is privately owned (see Figure 5). Less than 1 percent of this privately owned open space has been protected from future development through a conservation easement with a non-profit land trust such as the Nature Conservancy, participation in the USDA's Conservation Reserve Program, or some other sale of development rights. A diverse collection of properties fall into this category including Aubrey Preston Farm in Williamson County, Rippavilla Plantation in Spring Hill, and numerous private hunting preserves and working farms throughout the state. Fifteen percent of the open space is publicly protected (lands owned or administered by the federal, state, or local governments) as national parks, national recreation areas, wild and scenic rivers, state parks, state natural areas, state forests, wildlife management areas, or municipal parks and greenways. Many of these areas

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represent some of Tennessee's most prized natural assets and engines for tourism development. Federally administered open space includes the Fort Campbell Military Reservation, Natchez Trace Parkway and Scenic Trail, and Stones River National Battlefield. Prominent examples of state administered open space includes Radnor Lake State Natural Area, Cedars of Lebanon State Forest, Montgomery Bell State Park, and Cheatham Wildlife Management Area. Examples of local open space include the JC Poole Recreational Area in Ashland City, the Wilson County Fairgrounds, Warner Parks, Beaman Park, and the Hermitage.
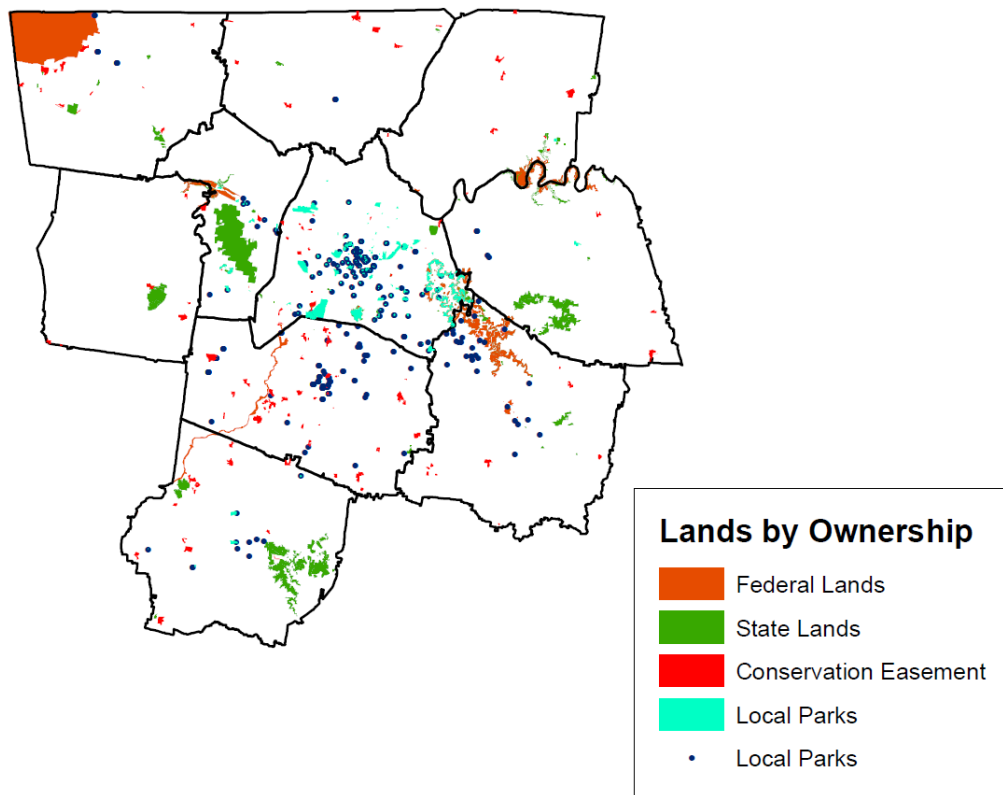
Figure 4. Public and private open space in the ten-county study region

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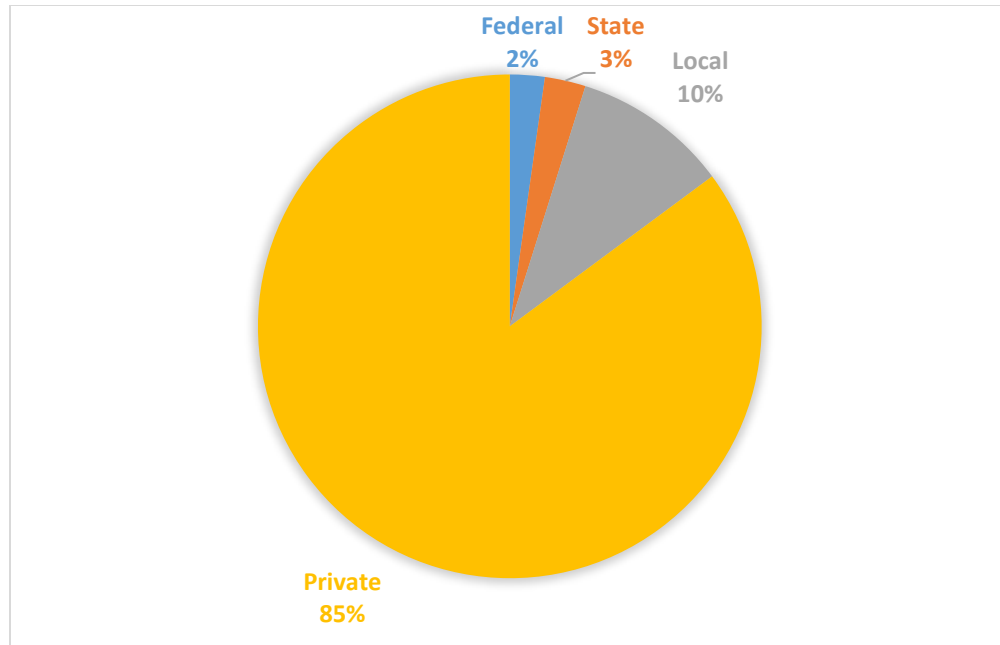
Figure 5. Total open space by ownership

The 4,838 square miles of open space is evenly spread across the ten counties (see Figure 6). Table 2 shows a breakdown of open space by county. Mainly because of their size, the most open space is in Maury County (593 square miles) while the least is in Cheatham County (299 square miles). Dickson County boasts the largest coverage of open space, over 98 percent. In contrast, only 74 percent of the more urban Davidson County is covered in undeveloped open space. While there is less open space in Davidson County than in neighboring counties, more of the open space that does exist (nearly 35 percent) is protected as public land (federal, state, local lands) or privately owned open space protected from future development by the sale or donation of development rights though only 1 percent of the protected open space in Davidson County is privately owned open space protected by the sale or donation of development rights. By comparison, over 14 percent of the protected open space in Williamson County is privately protected open space.

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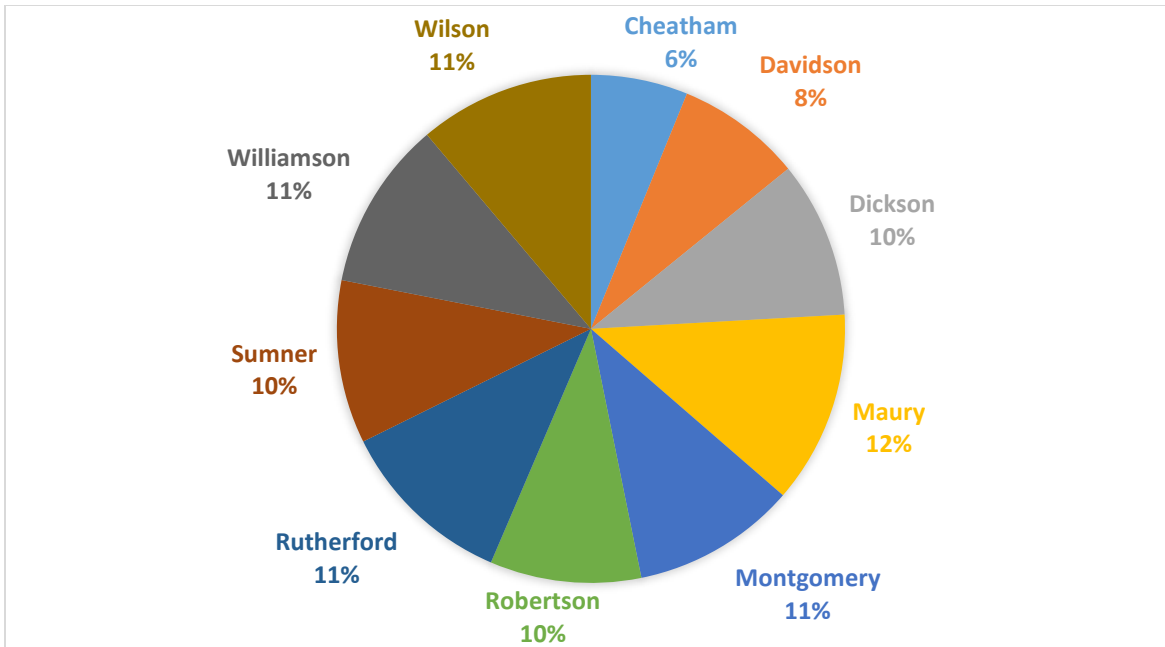
Figure 6. Total open space by county

Table 2. Open space compared to total land area by county

County	Total Area (mi^2)	Open Space (mi^2)	% Open Space	Protected Open (mi^2)	% Protected
Cheatham	307	299	97%	54	18%
Davidson	525	386	74%	135	35%
Dickson	491	482	98%	34	7%
Maury	615	593	96%	72	12%
Montgomery	544	505	93%	116	23%
Robertson	476	466	98%	39	8%
Rutherford	624	544	87%	105	19%
Sumner	543	503	93%	60	12%
Williamson	584	520	89%	65	13%
Wilson	583	540	93%	67	12%
TOTAL	**5,292**	**4,838**	**91%**	**747**	**15%**

There are also differences in certain types of open space across counties. Tables 3 and 4 present a breakdown of the different types of open space by county. Davidson County is home

to a relatively large amount of open space administered by local government. A relatively large amount of state administered open space is located in Cheatham County while Montgomery County contains more federally administered open space than any other county in the study area. In terms of cover types, Robertson County contains the most agricultural open space (pasture, cropland). Farms in this county have some of the most highly productive soils in the state according to a 2012 Department of Agriculture Soil Survey. Montgomery County contains the largest amount of wetlands owing to the large number of wetlands in and around Clarksville. Not surprisingly, Davidson County contains the most developed open space.

This section summarizes the open space data used in this study. This data is drawn from a variety of sources including the National Land Cover Database and the National Conservation Easement Database. More details on the open space data used in this study is available in Technical Appendix A.

Table 3. Square miles of open space ownership type and county

County	Federal	State	Local	Private	TOTAL
Cheatham	3	35	16	245	**299**
Davidson	11	12	111	253	**386**
Dickson	2	7	23	449	**482**
Maury	2	27	39	525	**593**
Montgomery	67	4	42	393	**505**
Robertson	0	0	36	430	**466**
Rutherford	18	16	70	440	**544**
Sumner	0	5	52	445	**503**
Williamson	4	0	52	464	**520**
Wilson	1	20	44	474	**540**
TOTAL	**108**	**127**	**483**	**4,119**	**4,838**

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Table 4. Square miles of open space by land cover type and county

County	Developed Open Space	Agricultural Land	Shrub Scrub	Wetlands	Forestlands	TOTAL
Cheatham	13	47	13	4	221	**299**
Davidson	92	50	16	2	226	**386**
Dickson	23	104	32	1	323	**482**
Maury	37	240	26	3	287	**593**
Montgomery	42	158	21	8	278	**505**
Robertson	35	277	7	1	146	**466**
Rutherford	59	226	33	3	224	**544**
Sumner	51	197	14	1	240	**503**
Williamson	51	183	0	1	286	**520**
Wilson	44	244	27	2	224	**540**
TOTAL	**447**	**1,725**	**187**	**24**	**2,455**	**4,838**

2.   RECREATION AND HEALTH

Open space in the ten-county region contributes to physical well-being and helps lower health-care costs by providing a multitude of free and low-cost recreational activities to the general population. This section estimates the economic values that residents capture from using open space for recreation. These estimates include 1) the value users would be willing to pay to engage in recreational activities on open space and 2) the economic value of avoided health-care costs due to exercise on open space in the ten-county region. The value of recreational use captures the values residents gain from recreational activities irrespective of the health benefits associated with physical activity and is analyzed using the benefit transfer approach (Rosenberger and Loomis 2001). The health-care costs avoided due to physical activity are estimated using surveys of Tennessee residents' participation in strenuous and moderate exercise on open space. If residents include the value of health benefits when they state a willingness to

pay for recreation, there is the possibility for double-counting the health-care costs avoided. The effect of double-counting will be minimal due to precautions taken elsewhere in the study (see caveats in section 1.2).

2.1 METHODOLOGY

The recreational-use value focuses mainly on publicly owned land (e.g., national parks, state parks and natural areas). Farmland and conservation areas are not included in the recreational portion of this chapter since most of these areas do not allow public access and virtually no data is available for those areas that do allow public access. The only exception is hunting, which takes place on both public and private land. The number of hunting permits sold is used to gauge hunting activity in the study area. Unfortunately, there is no readily available data on where hunting takes place. Therefore, the estimated recreational-use value for hunting includes both public and private land. The economic value of recreational use on open space is based on the notion of "willingness to pay" (WTP). WTP asks people how much money they are willing to pay to participate in various recreational outdoor activities. These values represent what visitors would be willing to spend in the private market for the activities they enjoy on publicly owned open space and approximate the average the difference between the total amount that consumers are willing and able to pay and the total amount they actually pay (i.e., consumer surplus) for each recreational activity. Our estimates draw from Loomis (2005), which compiles responses from surveys conducted across different regions that estimated people's WTP for different recreational activities. The estimated WTP values from Loomis (2005) are used to estimate recreational values of open space in this section. Since these estimates do not represent actual transactions, they should not be viewed as income generated by recreation on open space (those values will be addressed in Chapter 4). Instead, the total value presented in this section

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are estimates of the amount residents would be willing to pay to engage in recreation if that service were not provided for free or at low-cost on publicly owned open space (or a combination of public and private open space in the case of hunting).

Health-care cost savings include direct and indirect medical cost savings, direct and indirect workers' compensation cost savings, and lost productivity cost savings. Individuals who are physically active on open space are typically healthier and avoid a number of costly health ailments. They also tend to take less sick leave and are more productive because of these health benefits. It follows that recreational activity on public open space (including parks and trails) generates savings by avoiding the health-related costs that would arise if people were not able to use these areas for recreation. The savings are a result of physical activity on open space, and they are derived from estimating the per-capita economic consequences of physical *in*activity. These savings accrue to individuals in the form of lower insurance premiums and out-of-pocket medical expenses; to employers in the form of reduced insurance premiums, fewer worker absences, and greater worker productivity; and to insurance companies in the form of avoided claims. The total estimates of health-related cost savings in this section quantify the value of recreation on the Cumberland Region's existing open space. If recreational opportunities were lost through development of existing open space, residents would likely find other recreational opportunities to replace at least some of the activity they currently enjoy there.

It is worth noting that estimates of recreational and health values of open space are tied to the number of visitors and the number of residents in the region, not to the amount of protected open space. For example, a small heavily used local park with a greenway will generate larger recreational-use values and avoided health-care costs than a large, infrequently used natural area. Also, recreational-use benefits and health savings are estimated based on the amount of existing

open space. Estimates of the recreational-use benefits and health savings provided by the region's open space provided in this report will be overstated if residents seek out recreational experiences and exercise in other areas when open space id developed. The effect of these substitution effects will be minimal due to precautions taken elsewhere in the study (see caveats in section 1.2).

More details and further information about the methodology in this section are available in Technical Appendices B and C.

2.2   BENEFITS FROM RECREATIONAL USE

Over $1.3 billion in benefits accrue annually to residents who participate in recreational activities on public open space in the Cumberland Region. This estimate is equivalent to $1,913 in recreational-use benefits per household per year. This value represents the additional amount of money that residents would be willing to spend in the private market to participate in recreational activities they currently enjoy on public open space. This value also encompasses a variety of recreational activities in national and state parks and hunting on federal and state wildlife management areas.

Table 5 shows a breakdown of recreation values for each state and federal protected open space tracts. There are two national parks, three U.S. Army Corps of Engineers recreation sites, and nine state parks within the ten-county study area. National parks are managed by the National Park Service (NPS) and state parks are managed by The Tennessee Department of Environment and Conservation (TDEC). In total, these parks provide over $1.2 billion in benefits per year resulting from participants' recreational activities. These values were calculated by multiplying the average willingness-to-pay values across the different activities provided by each park by the number of visitors per year for the most recent year available (more

details below). These values indicate the amount of money that visitors are willing to pay to participate in an activity beyond what they must already pay. This includes values for many recreational activities on open space that are fee-based.

Table 5. Economic value of recreational activity on protected open space ($M per year)

Park	County	Number of Visitors per year	Economic Value $M per year
Dunbar Cave State Park	Montgomery	586,382	$44.38
Port Royal State Historic Park	Robertson	573,632	$56.11
Montgomery Bell State Park	Dickson	740,080	$59.74
Harpeth River State Park	Cheatham and Davidson	499,222	$48.83
Bicentennial Capitol Mall State Park	Davidson	312,674	$14.75
Radnor Lake State Park	Davidson	731,555	$56.91
Long Hunter State Park	Davidson and Rutherford	908,771	$67.46
Cedars of Lebanon State Park	Wilson	844,762	$49.99
Bledsoe Creek State Park	Sumner	487,292	$40.64
J. Percy Priest Lake	Davidson, Rutherford, and Wilson	3,271,505	$242.85
Cheatham Lock and Dam	Cheatham	1,059,374	$78.64
Old Hickory Lock and Dam	Sumner and Davidson	5,306,094	$393.86
Stones River National Battlefield	Rutherford	346,213	$19.08
Natchez Trace Parkway and National Scenic Trail[3]	Williamson and Maury	5,891,315	$46.37
TOTAL		**21,558,871**	**$1,219.60**

Sources: Loomis, 2005; www.nps.gov; www.tnstateparks.com/; www.fred.stlouisfed.org; http://www.corpsresults.us/recreation/reccalculate.cfm

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[3] The total visitation number was divided by seven and then multiplied by WTP because about 1/7 of the Natchez Trace lies in the study area.

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Loomis (2005) compiled average WTP per person per day by activity (including picnicking, swimming, fishing, boating, hiking, general recreation, etc.) and by region (Southeast, Northeast, Pacific coast, etc.) in 2004 dollars. Values for the southeast region are utilized here. Total visitation and the recreational opportunities provided by each state park are listed on TDEC's website. Unfortunately, no data exists for the types of activities each visitor engaged in on their visit, so an average WTP for recreation was found for each park by averaging the WTP values for all recreation activities provided by the park. For each state park, the average WTP for all the activities it provides is multiplied by the total number of visitors per year to obtain the total annual economic value.[4] This is equivalent to assuming visitors were evenly divided among recreational activities or engaged in every activity the park provided. A similar procedure was used to identify the recreational-use value for national parks except that WTP for "general recreation" was used to calculate their annual economic value instead of an average of WTP values for specific recreation activities. All economic values are inflated to 2016 dollars using the consumer price index (CPI).[5]

A total of 101,562 hunting permits of all classes were sold in 2016 within the ten-county region.[6] While hunting is clearly a valued recreational pursuit on the regions' open space, there is little information about where hunting takes place. Some hunting takes place on private land. Hunting also takes place on wildlife management areas managed by the state and federal government. According to the 2011 National Survey of Fishing[7], Hunting and Wildlife-

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[4] Visitation data is available at www.tnstateparks.com. Total visitor information is not available for Cedars of Lebanon State Park and Port Royal State Historic Park on TDEC's website. Their visitor numbers are predicted by their size and distance to Nashville using information of other parks, see the appendix for more details.
[5] CPI was obtained from fred.stlouisfed.org.
[6] Data obtained from Tennessee Wildlife Resources Agency via personal communication.
[7] U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

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Associated Recreation report, 87% of hunting in the East South Central region occurred on private land.[8] However, visitation data for these areas is limited. To capture the value of hunting recreation, we use hunting permits sold in the area as a proxy for the amount of hunting that takes place in the ten-county study region. As a result, the county-level values associated with hunting reflect the values where residents live. In contrast, the recreational-use values associated with public parks reflect the values where the recreational activity takes place.

The 2011 National Survey of Fishing, Hunting and Wildlife-Associated Recreation report revealed that on average, hunters enjoyed 21 hunting days per year. Multiplying permits sold by the average hunting days per year suggests that over 2.1 million hunting days originate within the ten-county region. According to Loomis (2005), the WTP for hunting per person per day is $35.36. Multiplying the number of hunting days originating within the ten-county region by $45.56 (the inflated WTP for hunting per person), we obtain the economic value of hunting on open space for the study area (Table 6).[9]

Table 6. Economic value of hunting on open space (in $M)

County	Number of Permits sold in 2016	Economic Value ($M)
Cheatham	4,219	$4.04
Davidson	18,414	$17.62
Dickson	4,975	$4.76
Maury	7,282	$6.97
Montgomery	12,256	$11.73
Robertson	5,306	$5.08
Rutherford	16,507	$15.79
Sumner	11,700	$11.19
Williamson	10,356	$9.91
Wilson	10,547	$10.09
TOTAL	**101,562**	**$97.17**

Sources: TWRA, Loomis (2005), FWS

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[8] The East South Central region includes Alabama, Kentucky, Mississippi, and Tennessee.
[9] Economic value of hunting is inflated with the CPI.

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2.3   HEALTH-CARE COST SAVINGS

A number of health problems can be alleviated or prevented with physical activity. This section estimates the health-related cost savings resulting from physical activities on open space in the ten-county study area. As shown in Table 7, total health-related cost savings amount to $466 million dollars per year from physical activities on open space. Total health-related cost savings include three components: direct and indirect medical costs, direct and indirect workers' compensation, and lost productivity.[10]

Table 7: Total Health-Related Cost Savings by Open Space Type and Country ($M per Year)

	Direct Medical Care Costs Savings	Indirect Medical Care Costs Savings	Direct Workers Compensation Costs Savings	Indirect Workers Compensation Costs Savings	Lost Productivity	Total
Cheatham	$1.18	$3.53	$0.02	$0.08	$5.04	$9.86
Davidson	19.94	59.82	0.34	1.36	79.59	161.05
Dickson	1.44	4.31	0.02	0.10	5.30	11.18
Maury	2.39	7.16	0.04	0.16	9.39	19.14
Montgomery	5.18	15.53	0.09	0.35	21.51	42.65
Robertson	1.94	5.83	0.03	0.13	8.53	16.47
Rutherford	8.08	24.25	0.14	0.55	37.51	70.54
Sumner	4.68	14.05	0.08	0.32	22.17	41.30
Williamson	5.24	15.73	0.09	0.36	41.79	63.21
Wilson	3.35	10.06	0.06	0.23	16.91	30.61
Total	**$53.43**	**$160.28**	**$0.91**	**$3.64**	**$247.74**	**$466.00**

Sources: (Chenoworth and Bortz 2005;Graefe, et al. 2009); CDC State Indicator Report

Physical inactivity exacts a high toll on health and quality of life and increases the demand for health care (Rosenberger, et al. 2005). Research demonstrates the importance of physical activity in reducing morbidity and mortality from chronic diseases (Pratt, et al. 2000).

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[10] Mean estimates are included in this table. For min and max estimates, see Appendix C.

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Benefits of being physically active include lower incidence of cardiovascular diseases, diabetes, depression, certain cancers, and obesity (Cohen, et al. 2006). The link between recreational access and participation in physical activities is also well established (Roemmich, et al. 2006;Roux, et al. 2007). Thus, the positive impact on health outcomes for residents of physical activity made possible by open space in the Cumberland region is substantial.

The Centers for Disease Control and Prevention (CDC) recommends that adults participate in at least 150 minutes of moderate-intensity aerobic physical activity per week.[11] According to the CDC State Indicator report, 39 percent of Tennessee residents meet this guideline and are considered physically active. Applying this percentage to the 1.76 million population of the ten-county study area in Middle Tennessee, we obtain an estimate of 444,000 residents that are physically active according to the CDC.[12] Estimates of health-related cost savings in this study are based on this number of physically active individuals[13] but do not assume that all of their exercise activities occur in open space.

Estimating total health-care cost savings for the study area without over-estimating it is challenging but can be done by applying data from studies from similar areas to the estimated number of physically active residents in this area. According to the CDC, having a park within a half mile is linked to higher levels of moderate-to-vigorous physical activity, and 17.5 percent of Tennessee's population lives within a half mile of a park (Merriam, et al. 2017). The percentage of their physical activity occurring in parks is unknown, but a 2009 Pennsylvania outdoor recreation survey found that 35 percent of the population lives within a half mile of a park and 41

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[11] Centers for Disease Control and Prevention. State Indicator Report on Physical Activity, 2014. Atlanta, GA: U.S. Department of Health and Human Services, 2014.

[12] U.S. Census Bureau. Quickfacts data. (Washington, DC: U. S. Census Bureau, 2009).

[13] Our study area is more urban than the state as a whole, but although differences in activity levels between urban and rural areas have been investigated, this research has not consistently found that individuals in urban areas are more active than individuals living in rural areas (Fan, et al. 2014;Martin, et al. 2005;Parks, et al. 2003).

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percent of residents' physical activity, on average, occurs in a park or on a trail (Graefe, et al. 2009). With half as much of Tennessee's population within a half mile of a park (17.5 percent versus 35% in Pennsylvania), half as much of residents' physical activities are likely to occur in parks (20.5 percent versus 41 percent in Pennsylvania). This study, therefore, estimates that 20.5 percent of the total health-related cost savings from physical activity in Tennessee can be attributed to open space. Thus, the costs reported below are calculated by multiplying the per capita estimate by the total number of individuals that are physically active due to open space (444,000 physically active individuals × 0.205 = 91,020 individuals that are physically active due to open space).

Medical Cost Savings

The first component of health-care cost savings is medical cost, which is estimated to be $213.7 million per year for the study area. This estimate includes both direct and indirect medical cost savings. Direct medical costs refer to the costs of actually treating the illnesses or medical conditions caused or exacerbated by physical inactivity, which include cardiovascular diseases, diabetes, depression, and certain cancers as well as obesity. These costs include preventive, diagnostic, and treatment services incurred at hospitals and other medical facilities. Utilizing inflation-adjusted estimates of average per-capita annual savings in the ten-county study area (Pratt, et al. 2000), the physical activity that takes place on open space in the study area saves residents a total of $53.4 million in medical costs .

Indirect medical costs are based on the diminished quality of life, such as pain and suffering from medical conditions and shorter life expectancy, resulting from adverse health conditions due to physical inactivity. Based on existing research, each dollar of direct medical costs generates three dollars in indirect medical costs (Chenoweth and Sugerman 2005);

therefore, savings in indirect medical costs are estimated to be three times the direct costs or $160.3 million per year.

Workers' Compensation Cost Savings

The second component of health-care cost savings is workers' compensation. Individuals can be eligible to collect workers' compensation payments when injuries occur in the workplace. Research has shown that physical *in*activity can increase the risk of suffering strains and sprains and the duration of the recovery period (Chenoworth and Bortz 2005). The total reduction in workers' compensation costs, including both direct and indirect costs, is estimated at $4.5 million per year for the study area.

Estimates of the average per-worker cost of workers' compensation payments as a result of physical inactivity range from $6 to $12 (Chenoworth and Bortz 2005). With a median per-worker estimate of $10, direct workers' compensation cost savings amount to $0.9 million per year resulting from workers' participation in physical activities on protected open space.

Employers incur administrative costs, or indirect workers' compensation costs, when workers claim compensation payments. Examples of indirect workers' compensation costs included training replacement employees, accident investigation and implementation of corrective measures, repairs of damaged equipment and property when workers claim compensation payments.[14] Research estimates the ratio of indirect compensation costs to direct compensation costs to be 4:1 (Chenoweth and Sugerman 2005). In other words, each dollar of direct workers' compensation cost generates four dollars in indirect medical costs. Using the ratio, it is estimated that employers avoided $3.6 million per year in indirect workers' compensation cost due to worker's participation in physical activities on open space.

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[14] www.osha.gov

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Lost Productivity Cost Savings

The third component of health-care cost savings lies in lost productivity costs incurred by businesses. There are two ways an employee's physical inactivity can lead to lost productivity. The first is not being present or attending to duty or work (i.e., absenteeism). The second is being at work when they should be at home, either because they are ill or because they are too tired to be effective (i.e., presenteeism).

Lost productivity costs for the study area are estimated by multiplying estimated average hours lost per year due to absenteeism and presenteeism by the median salary paid to workers and the number of workers in each county (Chenoworth and Bortz 2005). This method produces a total of $247.7 million per year in savings that result from workers participating in physical activities on protected open space in the ten-county study region.[15]

3.   ECOSYSTEM SERVICES

The natural landscapes that cover open space in Middle Tennessee provide a variety of environmental benefits to residents and businesses that call the region home. This section draws on well-known research techniques to place a dollar value on seven types of ecosystem services provided by open space: water supply, water quality, flood mitigation, wildlife habitat, pollination, air pollution removal, and carbon sequestration and storage. These valuable services arise naturally and automatically from open space. Replicating or replacing these services would be costly. These types of ecosystem services are often referred to as green infrastructure due to their ability to offset other more traditional forms of infrastructure such as storm water systems or flood walls. The analysis that follows estimates the value of these services.

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[15] These avoided costs are calculated by multiplying the per capita estimate by the total number of physically active population (444,000) and this 20.5 percent number to reflect cost savings attributed to open space

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3.1   METHODOLOGY

Estimates in this section are based on existing studies that estimate the continuous flow of value created by the ecosystem services water supply, water quality, flood mitigation, wildlife habitat, pollination, air pollution removal, and carbon sequestration and storage (Costanza, et al. 2006;Nowak, et al. 2006;Nowak, et al. 2007). The quality of these services and the values placed on them vary depending on the type and amount of land cover present in an area. Geographic information system (GIS) data is used to inventory the type and amount of land cover present on open space in the ten-county region. Values associated with each of the ecosystem services were applied to the land-cover inventory to produce total value estimates for the ten-county region. Dollar values approximating the economic value of each of these ecosystem services are based on peer-reviewed studies that value these services on a per acre basis. These total values represent either 1) the costs avoided in the ten-county region by not having to artificially replace the ecosystem services currently provided by open space or 2) the damages that would be caused if open space did not provide these ecosystem services. A full explanation of estimates and the methodologies used is presented in Technical Appendix D. Mean estimates are presented in this section of the report, but low and high estimates are presented in the appendix to reflect the variation in water supply value estimates.

3.2   SUMMARY OF ECOSYTEM SERVICE VALUES

The ten-county study area is characterized by nearly 3 million acres of open space ranging from forests and wetlands to agricultural fields and urban parks. Together, these open space areas contribute an estimated $3.2 billion in annual cost savings and economic benefits through the provision of seven ecosystem services: water supply, water quality, flood mitigation, wildlife habitat, pollination, air pollution removal, and carbon sequestration. Table 8 shows where these ecosystem service benefits are located in the ten-county study region. The

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allocation of ecosystem service benefits across the study area depends on the amount and type of open space in each county. For example, the counties with the largest ecosystem service values (Montgomery, Maury, Dickson, and Williamson) do not all have the most open space. All dollar values in Table 8 are annual and recurring. In addition to the annual ecosystem service benefits in Table 8, forested open space also stores an estimated $2.5 billion in carbon. In other words, if all of the trees in the ten-county region were burned, the carbon stored in their tissue released into the atmosphere would cause $2.5 billion in damages.

Table 8. Total ecosystem service values ($M per year) by county

	Water supply	Waste assimilation	Flood mitigation	Wildlife habitat	Pollination	Air pollution removal	Carbon sequestration	**Total**
Cheatham	$28.9	$9.2	$19.5	$135.4	$24.7	$29.3	$7.1	**$254.0**
Davidson	33.0	8.4	98.8	136.7	25.4	30.0	7.2	**339.5**
Dickson	38.1	12.3	22.2	193.7	37.9	42.7	10.3	**357.2**
Maury	38.2	15.6	39.4	182.1	39.6	38.1	9.2	**362.2**
Montgomery	40.2	14.5	52.5	192.8	33.4	36.8	8.9	**379.1**
Robertson	18.0	9.1	30.6	137.5	23.5	19.4	4.7	**242.7**
Rutherford	30.1	12.8	57.3	147.2	31.9	29.6	7.1	**316.0**
Sumner	32.6	11.6	45.2	158.2	32.7	31.8	7.7	**319.7**
Williamson	34.1	12.9	44.5	174.9	37.3	37.9	9.1	**350.6**
Wilson	31.1	13.3	39.5	139.3	33.6	29.7	7.1	**293.6**
Total	**$324.4**	**$119.5**	**$449.6**	**$1597.8**	**$320.0**	**$325**	**$78**	**$3214.7**

Source: Costanza et al. (2006), Nowack et al. (2006), Nowack et al. (2007), Baker Center calculations

Water Supply

A variety of ecosystem functions work together on open space to provide for continuous recharge of fresh, clean water. The soil and canopy cover of open space helps store water, replenish streams and reservoirs and recharge underground aquifers by preserving natural runoff patterns, enhancing water retention in the soil, enhancing natural recharge, and preventing siltation of waterbodies that alter surface water flow patterns and instream storage volumes. If this important ecosystem service were to fail, costly investments would be required to import

water from outside the region. These types of ecosystem services are known as green infrastructure due to their ability to offset more costly built infrastructure such as traditional "gray" storm water systems. Water supply services are correlated with the amount of forest, wetlands, and riparian areas in a region (Costanza, et al. 2006). Over 1.6 million acres of open space have been associated with this type of ecosystem service. The more those land cover types are present, the greater the water supply benefits provided.

Thanks to the abundant forests, wetlands, and riparian areas, the ten-county study area realizes over $324 million in annual cost savings from water supply services provided by open space. Table 9 provides the value of water supply services by county and by land cover type.

Table 9. Water supply service benefits by land cover and county

	Acres	Forests	Wetlands	$M per year Open freshwater	Riparian buffers	Total
Cheatham	147,488	$23.1	$3.5	$1.2	$1.0	**$28.9**
Davidson	161,023	23.6	1.6	5.8	2.0	**33.0**
Dickson	209,552	33.6	1.0	0.4	3.0	**38.1**
Maury	189,877	30.0	3.2	0.6	4.4	**38.2**
Montgomery	186,810	29.0	7.5	1.2	2.5	**40.2**
Robertson	95,158	15.2	0.6	0.1	2.1	**18.0**
Rutherford	149,388	23.3	2.5	1.2	3.0	**30.1**
Sumner	164,622	25.0	0.6	3.7	3.3	**32.6**
Williamson	185,829	29.8	0.6	0.3	3.3	**34.1**
Wilson	153,667	23.4	1.5	3.1	3.1	**31.1**
Total	**1,643,415**	**$256.1**	**$22.9**	**$17.6**	**$27.8**	**$324.4**

Source: Costanza et al. (2006), Baker Center calculations

Water Quality

Forests, wetlands, and pastures serve as a buffer between polluting activities and water supplies. The complex of soil, water, and vegetation that makes up these land-cover types work to filter and mitigate several types of waste including pathogens, excess nutrients, metals, and sediments from entering the water supply. Nearly 2.5 million acres of forests, wetlands, and

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pasture in the ten-county region of Middle Tennessee work to provide safe, clean drinking water. The water-quality enhancements provided by open space save the ten-county region over $120 million each year. This service is driven largely by the amount of forest, wetlands, and pasture in the ten-county region. The more of these types of open space, the larger the water quality benefits provided by open space. Without the water quality benefits these types of open space provide, residents of the ten-county region would be forced to make costly investments to expand existing water filtration and treatment facilities. These services are also important for ensuring that groundwater wells, a primary source of household drinking water in many parts of the region, are a safe and reliable source of water. Table 10 presents a breakdown of the regional benefit derived from water quality services by county and land cover type.

Table 10. Waste assimilation service benefits by land cover and county

	Acres	Forests	Wetlands	Pasture	**Total**
		\$M per year			
Cheatham	166,616	$6.2	$1.9	$1.0	**$9.2**
Davidson	171,578	6.4	0.8	1.1	**8.4**
Dickson	267,383	9.1	0.6	2.7	**12.3**
Maury	315,748	8.1	1.8	5.7	**15.6**
Montgomery	241,128	7.8	4.1	2.6	**14.5**
Robertson	199,711	4.1	0.3	4.7	**9.1**
Rutherford	260,521	6.3	1.4	5.1	**12.8**
Sumner	256,511	6.8	0.3	4.5	**11.6**
Williamson	285,166	8.0	0.3	4.5	**12.9**
Wilson	283,565	6.3	0.8	6.1	**13.3**
Total	**2,447,927**	**$69.1**	**$12.4**	**$37.9**	**$119.5**

Source: Costanza et al. (2006), Baker Center calculations

Flood mitigation

Many types of open space work to mitigate the effect of extreme flooding. The types of soils and vegetation present on wetlands, riparian buffers, and urban greenspaces work to reduce the risk of damaging floods by trapping and holding stormwater. Over 320,000 acres of open

space have been associated with flood mitigation services. These types of ecosystem services are known as green infrastructure due to their ability to offset more costly built infrastructure such as traditional "gray" storm water systems. Were the ten-county study area to be devoid of these types of open space, residents and local governments would be forced to make costly investments to expand and improve existing stormwater infrastructure systems. Replacing the flood mitigation services provided by open space in the ten-county region would cost $450 million each year. Table 11 shows the types of open space responsible for these benefits and how these benefits are distributed across counties.

Table 11. Flood mitigation service benefits by land cover and county

	Acres	Wetlands	Riparian buffer	Urban greenspace	**Total**
Cheatham	11,488	$7.6	$0.0	$11.9	**$19.5**
Davidson	71,664	3.4	0.1	95.4	**98.8**
Dickson	16,680	2.3	0.1	19.8	**22.2**
Maury	27,926	7.0	0.2	32.3	**39.4**
Montgomery	32,582	16.2	0.1	36.2	**52.5**
Robertson	22,774	1.3	0.1	29.2	**30.6**
Rutherford	40,899	5.5	0.1	51.7	**57.3**
Sumner	34,068	1.3	0.2	43.8	**45.2**
Williamson	33,515	1.4	0.2	43.0	**44.5**
Wilson	28,916	3.3	0.1	36.1	**39.5**
Total	**320,512**	**$49.2**	**$1.3**	**$399.2**	**$449.6**

Source: Costanza et al. (2006), Baker Center calculations

(header: $M per year)

Wildlife habitat

Many types of open space in the study region are known to serve as habitat for a diverse array of plants and animals. Contiguous areas of forest and wetlands harbor species that people value for hunting, wildlife viewing, and aesthetic benefits. Even cropland can provide forage opportunities for species such as deer and turkey. It is important to note that the values presented in this section differ from the other ecosystem service values since these values are not an

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avoided cost. Values in this section estimate the amount of money that people would be willing to pay to preserve wildlife on open space in the study region. Specifically, the values reported in this section area based on minimum willingness-to-pay values from the research literature (Costanza, et al. 2006). As a result, the estimates reported in this section should be viewed as a conservative estimate of the benefits derived from the preservation of wildlife habitat on open space. Using these minimum willingness-to-pay values reveals that wildlife habitat provided by open space in the ten-county study area has an estimated value of nearly $1.6 billion. Table 12 provides the wildlife habitat values by county and type of open space.

Table 12. Wildlife habitat service benefits by land cover and county

	Acres	$M per year			
		Cropland	Forest	Wetlands	Total
Cheatham	149,202	$4.3	$130.8	$0.3	**$135.4**
Davidson	149,346	2.9	133.7	0.1	**136.7**
Dickson	210,797	3.1	190.5	0.1	**193.7**
Maury	200,609	12.1	169.8	0.2	**182.1**
Montgomery	216,589	28.3	163.9	0.6	**192.8**
Robertson	155,424	51.1	86.3	0.0	**137.5**
Rutherford	162,692	14.9	132.1	0.2	**147.2**
Sumner	173,728	16.4	141.7	0.0	**158.2**
Williamson	190,589	6.0	168.8	0.0	**174.9**
Wilson	152,633	6.9	132.3	0.1	**139.3**
Total	**1,761,609**	**$146.0**	**$1450.1**	**$1.7**	**$1597.8**

Source: Costanza et al. (2006), Baker Center calculations

Pollination

One critical ecosystem service provided by open space is the support of bees and other insects that pollinate crops and other vegetation. The plants that grow on cropland, forest, and pasture have been shown to provide important habitat to sustain natural insect populations in addition to providing food and raw materials for the wood products industry. Healthy, intact

insect populations move pollen from plant to plant to aide in reproduction. Without these pollination services, residents and farmers would have to engage in costly trucking of bee hives into agricultural fields to ensure that agricultural production in the region could continue. The total annual cost to replace the pollination services provided by open space in the ten-county region is $320 million. Table 13 shows the types of open space responsible for these benefits and how these benefits are distributed across counties.

Table 13. Pollination service benefits by land cover and county

	Acres	Cropland	Forest	Pastures	Total
		\$M per year			
Cheatham	169,504	$0.0	$23.0	$1.7	**$24.7**
Davidson	174,032	0.0	23.5	1.9	**25.4**
Dickson	270,414	0.0	33.4	4.5	**37.9**
Maury	328,202	0.1	29.8	9.6	**39.6**
Montgomery	270,330	0.3	28.8	4.4	**33.4**
Robertson	260,803	0.5	15.2	7.9	**23.5**
Rutherford	276,752	0.1	23.2	8.6	**31.9**
Sumner	275,916	0.2	24.9	7.6	**32.7**
Williamson	292,019	0.1	29.6	7.6	**37.3**
Wilson	290,852	0.1	23.2	10.3	**33.6**
Total	**2,608,826**	**$1.4**	**$254.5**	**$64.0**	**$320.0**

Source: Costanza et al. (2006), Baker Center calculations

Air Pollution Removal

Poor air quality is common in many parts of the study area. Particulate matter, ozone, sulfur dioxide, and other regional pollutants can cause a variety of respiratory ailments including asthma, damage buildings and plants, and give rise to unhealthy and unsightly smog. Trees mitigate air pollution through botanic respiration processes that remove pollutants from the air. This analysis includes benefits derived from the removal of five different pollutants: ozone (O_3), particulate matter (PM-10), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).

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The ten-county study region contains over 1.6 million acres of forests that provide pollution removal services. Trees remove different pollutants at different rates. For example, trees are very efficient at removing particulate matter. A single acre of forested open space removes over 30 pounds of particulate matter (PM-10) per year. However, a single acre of forested open space removes only 1.8 pounds of carbon monoxide per year. Table 14 presents the tree-cover acreage and amount of pollutants removed by county. The greatest pollution removal benefits occur in Dickson County because of the large number of forested acres in that county. The variation in pollution removal amounts reflects varying ability of trees to remove different pollutants.

Table 14. Estimated pollution removal amounts (tons)

	Forested acres	O_3	PM-10	NO_2	SO_2	CO	**Total**
Cheatham	141,728.0	1,868.8	2,087.4	910.3	633.2	117.0	**5,616.7**
Davidson	144,864.0	1,910.2	2,133.6	930.4	647.2	119.6	**5,741.0**
Dickson	206,406.4	2,721.7	3,040.0	1,325.7	922.2	170.4	**8,180.0**
Maury	183,955.2	2,425.6	2,709.3	1,181.5	821.9	151.9	**7,290.2**
Montgomery	177,625.6	2,342.2	2,616.1	1,140.9	793.6	146.6	**7,039.4**
Robertson	93,529.6	1,233.3	1,377.5	600.7	417.9	77.2	**3,706.6**
Rutherford	143,168.0	1,887.8	2,108.6	919.5	639.7	118.2	**5,673.8**
Sumner	153,542.4	2,024.6	2,261.4	986.2	686.0	126.8	**6,084.9**
Williamson	182,905.6	2,411.8	2,693.9	1,174.8	817.2	151.0	**7,248.6**
Wilson	143,385.6	1,890.7	2,111.8	920.9	640.6	118.4	**5,682.4**
Total	**1,571,110.4**	**20,716.5**	**23,139.5**	**10,091.0**	**7,019.5**	**1,297.0**	**62,263.6**

Source: Nowack et al. (2006), Nowack et al. (2007), U.S. Forest Service (2010), Baker Center calculations

The economic benefit of the pollution removal amounts in Table 14 depends on how harmful each of these pollutants is to human health and ecosystem function. For example, a ton of ozone causes negative impacts that total $6,752 annually while a ton of carbon monoxide causes only $959 in negative impacts. Using these per-ton external costs of pollutants and the total amount of pollution removed in Table 14, it is estimated that trees on open space in the ten

county study area annually provide $325 million in air pollution removal benefits. If all the

forested open space in the ten-county region were developed, residents would experience an

additional $325 million in pollution-related impacts annually. Table 15 presents the benefits

generated for the removal of each pollutant.

Table 15. Estimated pollution removal benefits ($M per year)

	O_3	PM-10	NO_2	SO_2	CO	Total
Cheatham	$12.62	$9.41	$6.15	$1.05	$0.11	**$29.33**
Davidson	12.90	9.62	6.28	1.07	0.11	**29.98**
Dickson	18.38	13.70	8.95	1.52	0.16	**42.72**
Maury	16.38	12.21	7.98	1.36	0.15	**38.07**
Montgomery	15.81	11.79	7.70	1.31	0.14	**36.76**
Robertson	8.33	6.21	4.06	0.69	0.07	**19.36**
Rutherford	12.75	9.51	6.21	1.06	0.11	**29.63**
Sumner	13.67	10.19	6.66	1.13	0.12	**31.78**
Williamson	16.28	12.14	7.93	1.35	0.14	**37.86**
Wilson	12.77	9.52	6.22	1.06	0.11	**29.68**
Total	**$139.88**	**$104.31**	**$68.13**	**$11.60**	**$1.24**	**$325.17**

Source: Nowack et al. (2006), Nowack et al. (2007), U.S. Forest Service (2010), Baker Center calculations

Carbon Sequestration and Storage

In addition to alleviating the impacts of regional pollutants like ozone and sulfur dioxide,

forested open space also helps reduce the impacts of atmospheric greenhouse gases linked to

climate change. Table 16 presents estimates of the tons of carbon sequestered and stored by

trees on forested open space in the ten-county study area. Table 17 shows where these benefits

accrue as well as a total estimate of these ecosystem service values for the entire study area.

Through the natural process of photosynthesis, trees mitigate the impacts of climate change by

removing (sequestering) atmospheric carbon from carbon dioxide. A growing tree pulls carbon

from the air. Every year, new tree growth on an acre of forested open spaces sequesters 2,555

pounds of carbon. The benefits of sequestering carbon are encapsulated in a concept known as

the social cost of carbon (Sims 2014). According to the EPA, the social cost of carbon is an estimate of the economic damages associated with a small increase in carbon emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction. Using a $43 per-ton value for the social cost of carbon, it is estimated that the value of this sequestered carbon is over $78 million per year. This estimate measures the monetary damages associated with the carbon that was sequestered in forested open space. These monetary damages include the impacts of atmospheric carbon on various aspects of the broader economy such as changes in agricultural productivity, human health, property damage form increased flood risk, damages from sea level rise and more frequent storms, energy availability constraints in the industry, changes in needs for heating and cooling, and threats to consumers from price increases. Because this carbon is taken out of the air, these monetary damages are avoided simply by the presence of forested open space.

In addition to removing carbon from the atmosphere, trees also store carbon in their above- and below-ground tissues, which is another way trees regulate the amount of carbon in the atmosphere and counteract carbon emissions from human sources such as the burning of fossil fuels. As long as the trees are alive, the carbon they store is kept out of the atmosphere. Based on dendrology studies of the carbon storage abilities of different trees species in different growing regions, forested areas in the ten-county study region are storing a total of nearly 58 million tons of carbon. Using a $43 per-ton value for the social cost of carbon, if the carbon currently stored in trees on forested open space in the ten-county study region were released into the atmosphere, it would cause $2.5 billion in damages. Since this carbon is currently stored and these damages are being avoided, this represents an additional benefit of forested open space. Unlike the other ecosystem service benefit estimates in this report, carbon storage is a one-time

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benefit and not a continuous, flow of benefits. Thus, carbon sequestration is reported in millions

of dollars per year, but carbon storage is reported in total millions of dollars in Table 17.

Table 16. Estimated carbon storage and sequestration amounts (tons)

	carbon sequestration	carbon storage
Cheatham	164,268	5,185,110
Davidson	167,903	5,299,841
Dickson	239,233	7,551,366
Maury	213,211	6,729,990
Montgomery	205,875	6,498,422
Robertson	108,404	3,421,775
Rutherford	165,937	5,237,793
Sumner	177,961	5,617,339
Williamson	211,994	6,691,590
Wilson	166,189	5,245,753
Total	**1,820,974**	**57,478,978**

Source: Nowack et al. (2006), Nowack et al. (2007), U.S. Forest Service (2010), Baker Center calculations

Table 17. Estimated carbon storage and sequestration benefits

	carbon sequestration ($M per year)	carbon storage ($M)
Cheatham	$7.06	$222.96
Davidson	7.22	227.89
Dickson	10.29	324.71
Maury	9.17	289.39
Montgomery	8.85	279.43
Robertson	4.66	147.14
Rutherford	7.14	225.23
Sumner	7.65	241.55
Williamson	9.12	287.74
Wilson	7.15	225.57
Total	**$78.30**	**$2471.60**

Source: Nowack et al. (2006), Nowack et al. (2007), U.S. Forest Service (2010), Baker Center calculations

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4.   ECONOMIC ACTIVITY

The open space values presented in the preceding sections of the report describe non-market benefits that arise outside the formal economies in Cheatham, Davidson, Dickson, Maury, Montgomery, Robertson, Rutherford, Sumner, Williamson, and Wilson counties. However, open space also generates significant economic benefits in the study area from the agriculture, forestry, and tourism industries. These industries are heavily dependent on the amount and quality of open space such as forests, croplands, and pasture. For example, 2.6 million U.S. residents utilized open space to participate in wildlife-related recreation (fishing, hunting, and wildlife-watching) in Tennessee in 2011 (U.S. Department of the Interior 2011). Everyday operations create jobs and income for residents and increase local as well as state tax revenues. The analysis presented here enriches the discussion above and summarizes the economic impacts of the agriculture, forestry, and tourism industries for the study area in 2015.

4.1   AGRICULTURE AND FORESTRY INDUSTRIES

The agriculture and forestry impact analysis focuses on current economic impacts as measured by output, earnings, and employment. These three economic measures capture the broad benefits to each county and the 10-county regional economy and its residents. The impacts can be captured by the Regional Input-Output Modeling System (RIMS II), which is a tool widely used by investors, planners, and elected officials to objectively assess the potential economic impacts of various projects.[16] Sales tax revenue is a fourth economic impact measure that is estimated from impacts valued by the RIMSII framework. There are three main

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[16] The RIMS II modeling system multipliers that are used here are acquired from the U.S. Bureau of Economic Analysis. Documentation is available at https://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf. Accessed November 1, 2017.

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components of the impact analysis: (1) the combined direct effects of the agriculture and forestry industries, (2) the indirect (i.e. supply chain) and multiplier (or ripple) effects, and (3) the total effects.

The University of Tennessee's Institute of Agriculture provides a concise description of the data used here (Menard, et al. 2016) from the Impact Analysis for Planning (IMPLAN) database (Olson and Lindall 1999).[17] "IMPLAN (Version 3.0) utilizes a National Trade Flows Model (NTFM) (doubly-constrained gravity model) to estimate a new set of regional purchase coefficients and other trade data that predict local purchases based on a region's characteristics (Lindall, et al. 2006)." In other words, the IMPLAN model provides direct measures of economic activity, including the annual value of goods and services produced by an industry.

Agriculture and forestry industry sales are the ultimate source of economic benefits and represent the *final demand* that drives the impact analysis. Direct impacts measure the response of a given industry to a change in final demand for that industry. Here, the *direct effects* are derived from the sales associated with farms, forest products, furniture and related products, and agriculture and forestry manufacturing. Sales of agricultural and forestry products from the study area allow both industries to provide jobs and income to employees. In addition, the agriculture and forestry industries have *indirect economic effects*, which account for employment and income generated by purchases of goods and services from manufacturers, service providers, and other vendors. These supplier firms in turn hire workers, generate income for workers, and earn profits. Through direct and indirect effects, the agriculture and forestry industries provide income to households that spend and re-spend such income within the local and state economies, known

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[17] The IMPLAN modeling system multipliers are acquired from the Agri-Industry Modeling & Analysis Group (AIM-AG) at the University of Tennessee's Institute for Agriculture. Documentation is available at http://aimag.ag.utk.edu/pubimpact.html. Accessed September 2017.

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as *multiplier effects*. This study uses RIMS II multipliers to quantify the *total economic effects* of the agriculture and forestry industries in each county and for the entire 10-county region.[18] Total effects are the sum of the direct effects, the indirect effects, and the multiplier effects.

The overall value of economic impact multipliers for individual counties tends to be smaller than those for the entire state due to a phenomenon called *leakage*. Leakages of spending dissipate overall economic impacts for small local economies as well as the aggregate 10-county region. For example, dealers and vendors that supply inputs to either the agriculture- or forestry-related companies, as well as the companies themselves that produce these inputs, may not exist in an individual county or even in the neighboring county. Additionally, the set of retailers and commercial establishments where employees from both the agriculture and forestry industries and supplier firms would purchase consumer products may be limited in that same county. Thus, consumer spending (and sales tax revenue) will spill over to nearby metropolitan areas, other regions or through the Internet. As a result, there are significant leakages of spending that have little or no impact on the local economy or even the 10-county regional economy. Multipliers for bigger regions tend to be larger since there is less spending leakage. Thus, economic impact analysis of the agriculture and forestry industries for the 10-county region will generally capture larger impacts than the sum of individual county economic impacts. Technical Appendix E provides a detailed description of the methodology behind the impact analysis in this section.

The combined agriculture and forestry industries in the 10-county region generated a total output of $16.4 billion in 2015. Recall that multipliers for regions, like the 10-country region, are larger than the multipliers for individual counties because of leakages. The estimate for the ten-

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[18] A user-friendly explanation of this type of analysis, including the RIMS II multipliers, can be found in the Tennessee Department of Tourism Development, "Economic Impact of Traveler Spending in Tennessee for 2015," Appendix E. The tourism impacts are discussed more fully below.

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county region is greater than the sum of the county estimates to the extent that money generated by the agriculture and forestry industries in each county is spent outside that county. The regional estimate accounts for the amount of that money that is spent outside the county but inside the region. Table 18 below illustrates this phenomenon. The total impact for any economic benefit (output, earnings, sales tax revenue, or employment) for the 10-county region is larger than the sum of the 10 counties. Davidson County produced the largest agriculture and forestry industry related outputs in the study area with $6.9 billion, while Rutherford County created the second largest output at $1.6 billion. The 10-county region saw total earnings associated with the agriculture and forestry industries of $5.2 billion. Again, Davidson County and Rutherford County saw the largest total earnings benefits, but Robertson County was a close third at $280.3 million. Total employment related to the agriculture and forestry industries in the 10-county region amounted to over 177,900 jobs in 2015. The total sales tax revenue collected from agriculture and forestry activities in the area totaled over $271.8 million. Table 18 summarizes the total economic benefits of the agriculture and forestry industries in 2015 for all 10 counties individually and collectively.

In order to better understand the output benefits of the agriculture and forestry industries in each county and 10-county region, the $16.4 billion total in Table 18 is broken down in Table 19 to show the direct and the indirect and multiplier benefits separately for each county. The direct output from agriculture and forestry activity in the 10-county region was $8.8 billion. For every dollar spent on agriculture and forestry output, another 86 cents is generated in the 10-country region by indirect impacts and multiplier effects for a total from those two impacts of $7.6 billion, which brings the grand total to the $16.4 billion for total output as shown in Table 18. Davidson County and Rutherford County have the largest output benefits related to the

agriculture and forestry industries. Maury County has the largest individual county implied multiplier: for every dollar spent on agriculture and forestry output, an additional 66 cents is generated within Maury County.[19]

Table 18. Summary of Total Economic Benefits of the Agriculture and Forestry Industries, FY15

County	Output	Earnings	Sales Tax Revenue	Employment
Cheatham	$156,042,236	$43,975,143	$2,285,608	1,742
Davidson	$6,928,170,079	$1,876,923,327	$97,553,090	69,772
Dickson	$403,044,274	$107,932,652	$5,609,800	3,997
Maury	$397,670,568	$133,956,725	$6,962,401	4,976
Montgomery	$537,935,347	$134,909,269	$7,011,909	4,901
Robertson	$1,035,890,386	$280,294,998	$14,568,333	10,577
Rutherford	$1,560,019,572	$500,065,475	$25,990,903	18,478
Sumner	$528,250,299	$146,070,663	$7,592,023	5,373
Williamson	$367,492,134	$77,120,515	$4,008,339	2,819
Wilson	$1,243,545,720	$126,827,244	$6,591,846	4,631
10-County Region[20]	$16,398,819,382	$5,229,929,434	$271,825,582	177,903

Table 19. Output Benefits of the Agriculture and Forestry Industries, FY15

County	Direct	Indirect & Multiplier	Total
Cheatham	$124,699,114	$31,343,122	$156,042,236
Davidson	$4,463,020,633	$2,465,149,446	$6,928,170,079
Dickson	$261,022,132	$142,022,142	$403,044,274
Maury	$239,293,900	$158,376,668	$397,670,568
Montgomery	$378,161,931	$159,773,416	$537,935,347
Robertson	$734,621,932	$301,268,454	$1,035,890,386
Rutherford	$1,037,695,528	$522,324,044	$1,560,019,572
Sumner	$333,228,386	$195,021,913	$528,250,299
Williamson	$262,851,108	$104,641,026	$367,492,134
Wilson	$967,777,516	$275,768,203	$1,243,545,720
10-County Region	$8,802,372,186	$7,596,447,196	$16,398,819,382

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[19] The implied multiplier can be found for each county and the 10-county region by dividing the total output benefit by the direct output benefit. The implied multiplier describes the impact each dollar spent on the agriculture and forestry industry has as it creates indirect and multiplier effects throughout the county or region.

[20] The 10-county region's total economic benefits are not the sum of the benefits for the individual counties. Each county and region have a unique set of multipliers that capture the total benefits of the agriculture and forestry industries.

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4.2   TOURISM INDUSTRY

According to the Tennessee Department of Tourist Development,[21] tourism activity in Tennessee in 2015 generated $17.8 billion in direct tourist spending, $3.5 billion in worker income and paychecks, $524.1 million in local county tax revenue, $963.1 million in state tax revenue, and 151,800 jobs. The tourism report breaks down direct state spending by county. Unfortunately, tourism does not have a unique sectoral identity (i.e. NAICS designation), nor does it have its own Standard Occupation Code that defines jobs and their duties. Instead, tourism ripples across a number of economic sectors, including retail trade and leisure and hospitality services. Because tourism is not a unique sector, it is not clear what percent of money spent on retail trade and leisure as well as hospitality services was spent by travelers versus the local community. The tourism report attempts to estimate such percentages and assign the money spent across several sectors as money spent by travelers or by the local community. The food sector enjoyed $5.7 billion in sales and accounted for nearly one third (32 percent) of the state's domestic travel expenditures and was the largest domestic-traveler spending sector. Domestic-traveler spending in 2015 on lodging ranked second (21 percent of domestic total) with more than $3.7 billion spent. Domestic expenditures on auto transportation totaled $3.1 billion or 17 percent of the domestic total.

The tourism report does not estimate indirect and multiplier impacts at the county level. Instead, they utilize RIMS II multipliers to find the total output, earnings, and employment impacts inclusive of indirect and multiplier effects at the state level. Since the tourism report

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[21] Unless otherwise indicated, the data that follow on tourism are taken from an annual report published by the Tennessee Department of Tourist Development: "The Economic Impact of Travel on Tennessee Counties – 2015." Nashville, TN.

does provide direct as well as total output, earnings, and employment impacts inclusive of indirect and multiplier effects at the state level, it is possible to estimate the total impacts of local tourism activity by county and region. Each county's share of statewide indirect and multiplier effects is assumed to be the same as its share of statewide direct effects. A step-by-step explanation behind the methodology used in this section can be found in Technical Appendix E.

Total impacts for output, income, and employment for 2015 are summarized in Table 20 for each county and for the 10-county region. Davidson County accounted for almost 32 percent of direct statewide traveler spending in Tennessee in 2015, so total output, accounting for indirect and multiplier impacts, for Davidson County amounted to almost $9.6 billion. For the ten-county region ($12.1 billion), Davidson County provides almost 80 percent ($9.6 billion) of total output. Williamson County accounts for the second largest total output benefit related to tourism in the ten-county region at $692.8 million. Cheatham County (0.1 percent), Davidson County (32 percent), Dickson County (0.4 percent), Maury County (0.7 percent), Montgomery County (1 percent), Robertson County (0.3 percent), Rutherford County (2 percent), Sumner County (0.8 percent), Williamson County (2 percent), and Wilson County (0.8 percent) lay claim to over 40 percent of direct traveler spending in Tennessee. The 10-county region saw a total earnings impact of $2.5 billion and total employment at over 100 thousand jobs in 2015.

The amounts in Table 20 include indirect and multiplier impacts, as well as direct impacts. A breakdown of the direct, indirect and multiplier, and total impacts of tourism by county and region for output, earnings, and employment are found in Tables 21, 22, and 23. Beginning with Table 21, for every dollar spent directly on tourism in the ten-county region, an additional 69 cents in output was generated throughout the state through indirect and multiplier effects. Applying that ratio to the 10-county region to the output totals from Table 20 produces

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the breakdown for the counties and the region in Table 21.

Table 20. Summary of Total Economic Benefits of the Tourism Industry, FY15

County	Output	Earnings	Employment
Cheatham	$36,489,530	$7,579,720	303
Davidson	$9,592,781,918	$1,992,642,760	79,638
Dickson	$106,887,499	$22,203,007	887
Maury	$197,579,923	$41,041,922	1,640
Montgomery	$346,001,043	$71,872,422	2,872
Robertson	$84,484,311	$17,549,346	701
Rutherford	$533,847,051	$110,892,384	4,432
Sumner	$228,215,608	$47,405,662	1,895
Williamson	$692,828,710	$143,916,554	5,752
Wilson	$243,381,621	$50,555,994	2,021
10-County Region	$12,062,497,213	$2,505,659,771	100,141

Table 21. Output Benefits of the Tourism Industry, FY15

County	Direct	Indirect & Multiplier	Total
Cheatham	$21,630,000	$14,859,530	$36,489,530
Davidson	$5,686,340,000	$3,906,441,918	$9,592,781,918
Dickson	$63,360,000	$43,527,499	$106,887,499
Maury	$117,120,000	$80,459,923	$197,579,923
Montgomery	$205,100,000	$140,901,043	$346,001,043
Robertson	$50,080,000	$34,404,311	$84,484,311
Rutherford	$316,450,000	$217,397,051	$533,847,051
Sumner	$135,280,000	$92,935,608	$228,215,608
Williamson	$410,690,000	$282,138,710	$692,828,710
Wilson	$144,270,000	$99,111,621	$243,381,621
10-County Region	$7,150,320,000	$4,912,177,213	$12,062,497,213

Nearly $1.6 billion in direct earnings is attributed to tourism in the 10-county region for 2015. Of that, Davidson County provided the highest amount at $1.3 billion while Cheatham County saw $3.6 million in earnings related to tourism. The total earnings benefits for the 10-county region were $2.5 billion. This suggests that for every dollar earned in earnings from travel expenditures in the region, an additional 62 cents in earnings is created across the state. A breakdown of the earnings benefits associated with tourism for the counties and the region for

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2015 is displayed in Table 22.

Travel expenditures for 2015 provided direct employment for just over 70 thousand individuals in the 10-county region, shown in Table 23. Adding indirect and multiplier effects to the direct effects shows that tourism related expenditures employed 100,141 individuals across the state. This means that for every person employed directly by tourism activity, an additional 0.43 jobs were created in 2015. Davidson County accounted for the highest direct employment at over 59 thousand jobs while Williamson County had the second highest direct employment with 3,000 jobs.

Table 22. Earnings Benefits of the Tourism Industry, FY15

County	Direct	Indirect & Multiplier	Total
Cheatham	$3,610,000	$3,969,720	$7,579,720
Davidson	$1,323,010,000	$669,632,760	$1,992,642,760
Dickson	$10,820,000	$11,383,007	$22,203,007
Maury	$15,610,000	$25,431,922	$41,041,922
Montgomery	$32,840,000	$39,032,422	$71,872,422
Robertson	$6,630,000	$10,919,346	$17,549,346
Rutherford	$48,100,000	$62,792,384	$110,892,384
Sumner	$20,950,000	$26,455,662	$47,405,662
Williamson	$64,680,000	$79,236,554	$143,916,554
Wilson	$24,560,000	$25,995,994	$50,555,994
10-County Region	$1,550,810,000	$954,849,771	$2,505,659,771

Table 23. Employment Benefits of the Tourism Industry, FY15

County	Direct	Indirect & Multiplier	Total
Cheatham	140	163	303
Davidson	59,440	20,198	79,638
Dickson	540	347	887
Maury	700	940	1,640
Montgomery	1,530	1,342	2,872
Robertson	290	411	701
Rutherford	2,330	2,102	4,432
Sumner	970	925	1,895
Williamson	3,000	2,752	5,752
Wilson	1,080	941	2,021
10-County Region	70,020	30,121	100,141

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The tourism report details both direct state and direct local tax receipts associated with travel spending. State tax receipts cover state sales and excise taxes as well as taxes on personal and corporate income. Local tax receipts include sales and property tax revenue. Table 24 shows the state and local tax receipts for each county and the 10-county region. These are only direct numbers as the tourism report does not detail the indirect or multiplier impacts that would produce additional revenues. Travel spending in 2015 was responsible for collecting almost $375.1 million in state tax receipts for the 10-county region. At the local level, the tourism industry generated nearly $180.6 million for the region. Table 24 displays the state and local tax receipts collected from traveler spending in 2015 for each county and region.

Table 24. Tax Revenue Benefits of the Tourism Industry, FY2015

County	State Tax Receipts	Local Tax Receipts
Cheatham	$1,270,000	$750,000
Davidson	$285,470,000	$147,450,000
Dickson	$3,800,000	$1,580,000
Maury	$7,220,000	$2,480,000
Montgomery	$12,880,000	$3,980,000
Robertson	$3,280,000	$1,370,000
Rutherford	$19,400,000	$6,890,000
Sumner	$8,410,000	$3,150,000
Williamson	$24,670,000	$8,560,000
Wilson	$8,660,000	$4,340,000
10-County	$375,060,000	$180,550,000

The economic impacts of tourism presented here are an upper bound for the economic impact of open space in each county and region. For instance, the economic benefits of the tourism industry in the ten county region captures the economic impact of visitors to state and national parks in the region. But it also captures spending not directly related to open space (i.e. expenditures like visitor spending at the Opryland in Davidson County). The vast range of activities enjoyed on open space makes estimating the economic impact of open space tourism

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difficult. Fortunately, a 2011 U.S. Fish & Wildlife Service report details the amount of money spent in Tennessee (for example food and lodging, transportation and equipment purchases) on three activities closely associated with open space: hunting, fishing, and wildlife-related recreation.[22] According to this report, all expenditures related to fishing, hunting and wildlife-watching in Tennessee totaled $2.5 billion in 2011. Nearly nine percent of the total open space in the state of Tennessee is in the ten-county study region. If expenditures related to fishing, hunting, and wildlife-watching are proportional to the amount of open space in an area, the ten-county region generated over $219 million in direct spending related to these activities. By comparison, the ten-county study region generated $7.2 billion in direct tourist spending in 2015. However, fishing, hunting, and wildlife-viewing are not the only activities associated with open space. The region's open space also attracts boaters, rock climbers, cyclists, and hikers who also generate direct and indirect economic impacts through their spending related to these activities. It is also reasonable to believe that the region's open space contributed to the enjoyment of visitors to seemingly unrelated tourism destinations such as the Grand Ole Opry or a Nashville Predators hockey game. Thus, $219 million should be viewed as a lower bound for the amount of direct spending related to tourism activity on open space. The actual direct economic impact of tourism activity on open space in the ten-county region likely lies between $7.2 billion and $219 million.

The benefits found in the U.S. Fish & Wildlife Service report complements the economic benefits presented in this analysis; however, the impacts are not additive. Adding each set of benefits would double-count and overestimate the economic benefits of tourism related to open

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[22] U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. census Bureau. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Available at: https://www.census.gov/programs-surveys/fhwar.html. Accessed January 15, 2018.

space. The same is true for a report produced by The Outdoor Industry Association, which details consumer spending, wages and salaries, state and local tax revenue, and direct jobs associated with outdoor recreation in Tennessee.[23]

5.   PROPERTY VALUES

A home's value is the sum of the values associated with the home's characteristics. When homeowners decide to buy or sell a house, they determine how much they would be willing to pay to buy the home or willing to accept to sell the home. These assessments are based on the number of bedrooms in the home, the school district that the house belongs to, the tax rate that the owner needs to pay, and the surrounding open space. Changing these structural or neighborhood characteristics will raise or lower the total value of a home.

In this section, we focus on the impact of open space on home values in our ten-county study area. Specifically, we estimate the property value impacts of proximity to open space. Research suggests that proximity to certain types of open space increases a home's value while proximity to other types can decrease a home's value (Geoghegan, et al. 2003;Irwin 2002;Irwin and Bockstael 2001;Lutzenhiser and Netusil 2001;Shultz and King 2001;Smith, et al. 2002;Walsh 2007). For example, Shultz and King (2001) find a negative relationship between home prices and neighborhood parks but a positive relationship between home prices and large natural areas. The impact of open space on property values can also vary depending on geographic location. For instance, Irwin (2002) find that public open space enhances property values in Central Maryland but Smith, et al. (2002) find that public open space detracts from home values in Research Triangle, North Carolina.

[23] Outdoor Industry Association. Tennessee's Outdoor Recreation Economy. Available at: https://outdoorindustry.org/resource/tennessee-outdoor-recreation-economy-report/. Accessed January 15, 2018.

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In the ten-county study area, anecdotal evidence suggests that individual homeowners in the study area are willing to pay more for a home that is in close proximity to a community park or greenway (Lewis 2017). However, on average, are all homeowners willing to pay more for this proximity? If this open space premium on housing values exists on average, how much more are they willing to pay, does this open space premium vary across the study area, and are homeowner willing to pay more for certain types of open space than others? Moreover, since the open space would increase the value of the nearby houses, it should also increase the property tax revenues collected by counties and local governments. If so, it becomes critical to understand how much local property tax revenues declines when open space is developed for other purposes.

5.1   METHODOLOGY

To analyze the impact of open space, we utilize the hedonic pricing model. The hedonic price model is a popular technique used by economists to disaggregate the price of an item into its individual characteristics. For this report, we use a hedonic price model to decompose the observed value of homes in the ten-county study area into their individual characteristics such as square footage, acreage, number of bedrooms, quality of neighborhood, and proximity to open space. The study isolates the effect of proximity to open space on home values from all other characteristics that influence home values. For example, two homes may be 20 meters from forested open space but one home may have two bedrooms and the other may have three. To capture variation across the study area, we apply the hedonic price model to each county. Total property value impacts reported in this section of the report reflect the aggregate impact produced from the ten county-level hedonic price models.

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Isolating the effect of open space on property values is challenging since much of the open space in the study area is under private ownership with no restrictions on development. If open space can be developed as residential land use, then open space parcels are subject to the same economic forces that determine nearby residential property values. Thus a negative relationship between proximity to open space and a home's value could signal that open space detracts from home values or could signal that development pressure in an area is driving up home values and encouraging development of unprotected open space parcels. To account for the fact that economic forces influence both home values and the location of open space (what economists refer to as endogeneity), we utilize a state-of-the-art, two-stage regression techniques (Irwin 2002).

Calculations were performed using a map of all open space parcels and a database of approximately half a million residential property appraisals collected from county tax assessor's offices. The variety of sources used to compile the open space database allows us to characterize open space based on type (agricultural, forest, wetlands) and ownership type (state agency, federal agency, private landowner).[24] The shape files for open space are from the Tennessee Wildlife Resources Agency (TWRA)[25]. We also get local parks and greenway layers from TWRA for Davidson County. For all other counties local parks and greenways were obtained from the Tennessee Recreation and Parks Association. The GIS layers for parcels are from county Property Assessor's Offices and the Tennessee Comptroller of the Treasury.

The open space cover types were determined using the National Land Cover Database

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[24] All the map layers are evaluated using ArcMap.

[25] Those files include conservation easement land (from the national conservation easement database), unprotected open space (from the National Land Cover Database 2011), public land, federal owned open space (DoD, NPS, USACE), state owned open space (state forests, TWRA land, and TDEC land), and local parks layers for Davidson county.

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(NLCD) 2011 which is produced by the Multi-Resolution Land Characteristics Consortium. We used five main groups of land cover type: agricultural lands, herbaceous shrublands, developed open space, wetlands, and forested lands. Agricultural lands include pasture/hay land as well as cultivated crops. Herbaceous shrublands include areas dominated by shrub or herbaceous vegetation (generally greater than 80% of total vegetation). Developed open space are areas with some constructed materials, but primarily grass lands (impervious surfaces account for 20% or less of the area). The vast majority of developed open space in the ten-county study area are large residential lots. Wetlands included both woody and herbaceous wetlands, where the soil is periodically saturated or covered with water. Lastly, forested lands included deciduous, evergreen, and mixed forests.

Further information on the data and methodology used in the hedonic analysis as well as summary statistics and regression results for each county are available in Technical Appendix F.

5.2   SUMMARY OF PROPERTY VALUE IMPACTS

Homes in the study region received a measurable increase in their value as they get closer to open space. Overall, a house is more valuable the closer it is to certain types of open space. How much open space adds to home values depends on the type of open space (for example forest, agricultural land) in the vicinity of the house. Eliminating all five types of open space would lower total residential property values in the ten-county study area by $15 billion. In other words, all forests, wetlands, agricultural lands, shrub-scrub, and developed open space in the ten-county region increases the total value of the housing stock in the ten counties in Middle Tennessee by $15 billion. This represents an average property value increase of $30,535 due to the presence of the current stock of open space. The current open space in the ten-county region

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adds sixteen percent to the average home value.[26] While complete elimination of all open space in the region is an extreme scenario, it highlights the total economic impact of open space on property values in the region.

The impact of open space varies by county due to differences in the number of houses, average home value, and other economic characteristics across counties (see Table 25). Half of the impact of open space on property values occurs in Cheatham County where property values are enhanced by proximity to agricultural land and forests. Davidson County ranks second in total impact due to its large number of residential parcel. Montgomery County ranks third in total impact due to the positive impact of shrub-scrub and developed open space on property values. The impact of open space on property values is less than $1 billion in Maury and Sumner counties due to their relatively low property values, smaller number of homes, and the relatively small number of open space types that add to home values in these counties.

Table 25. Total economic impact of open space on property values

County	Residential Parcels	Median Home Value	Total Impact on Property Values
Cheatham	12,017	166,900	$7,607,706,403
Davidson	144,349	215,800	2,864,780,550
Dickson	14,737	142,500	1,322,471,642
Maury	27,277	129,800	297,587,220
Montgomery	53,409	138,400	2,010,705,867
Robertson	20,969	140,400	0
Rutherford	72,284	153,220	0
Sumner	50,289	175,900	22,488,832
Williamson	60,462	399,600	1,151,175,516
Wilson	39,069	219,000	-166,330,143
Total	**494,862**		**$15,110,585,888**

Sources: County tax assessor's offices, Baker Center calculations

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[26] These estimates of the property value impacts of open space are a conservative estimate. Impacts were determined from regression output using a 5% significance level cutoff. In other words, open space was only deemed to have an impact on property values if the 95 percent confidence interval of the marginal impact did not contain 0. If a 10% significance level is used, property value impacts will be roughly double the impacts reported. For more information, see Technical Appendix F.

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The open space contribution to a home's value would also increase the property tax revenues collected by local governments (see Table 26). Increased home values attributable to open space would directly increase the property tax that residents pay to county and municipal governments and school districts. The elimination of open space would lead to $118 million annual loss in property tax revenues. In other words, $118 million in property tax revenues in the ten county study area is due to the current stock of open space in the region.

Table 26. Total impact of open space on property tax revenues

County	Total Impact on Property Values	Effective Tax Rate	Property Tax Revenues Attributable to Open Space
Cheatham	$7,607,706,403	0.75%	$57,057,798
Davidson	2,864,780,550	0.79%	22,631,766
Dickson	1,322,471,642	0.77%	10,183,032
Maury	297,587,220	0.93%	2,767,561
Montgomery	2,010,705,867	0.92%	18,498,494
Robertson	0	0.96%	0
Rutherford	0	0.86%	0
Sumner	22,488,832	0.85%	191,155
Williamson	1,151,175,516	0.70%	8,058,229
Wilson	-166,330,143	0.76%	-1,264,109
Total	**$15,110,585,888**		**$118,123,926**

Sources: Tennessee Comptroller website, Baker Center calculations

To better understand the results in Tables 25 and 26, Table 27 shows impact of different land cover types on property values. Of the eight counties where open space impacts property values, there is at least one type of open space that increases property values. Greater proximity to developed open space (for example large residential lots, municipal parks, golf courses) is associated with an increase in home values in four out of the ten counties. Being 1 meter closer to developed open space in these counties is associated with a $53 to $620 increase in the median home value. Prominent examples of developed open space include golf courses, the

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Wynnewood State Historic Site in Castalian Springs, JC Poole Recreational Area in Ashland City, Chickasaw Trace Park near Columbia. These results are consistent with previous findings that suggest proximity to parks and golf courses increase home values in Knox County Tennessee (Cho, et al. 2009). Greater proximity to wetlands is associated with an increase in property values in five out of the ten counties. Being 1 meter closer to wetlands in these counties is associated with a $5 to $55 increase in the median home value. Greater proximity to agricultural land (pasture, cropland) is associated with an increase in property values in three out of the ten counties. Being 1 meter closer to agricultural lands in these counties is associated with a $58 to $615 increase in the median home value.

Table 27. Property value impact from being 1 meter closer to open space by cover type

County	Agriculture	Forest	Shrub	Wetland	Developed Open Space
Cheatham	$320	$4,657	-$579	$0	$0
Davidson	$615	-$311	$382	-$31	-$292
Dickson	-$93	$0	$0	$15	$620
Maury	$58	$115	$169	$23	$53
Montgomery	-$150	-$586	$653	-$32	$528
Robertson	$0	$0	$0	$0	$0
Rutherford	$0	$0	$0	$0	$0
Sumner	$0	$0	$0	$5	$0
Williamson	$0	$0	$0	$35	$178
Wilson	$0	-$93	$0	$55	$0

Greater proximity to forest or shrub-scrub is associated with an increase in property values in four of the ten counties and decreases property values in four counties. For instance, being 1 meter closer to undeveloped forested open space in Cheatham County is associated with an increased property value of over $4,000. But in neighboring Davidson County, being 1 meter closer to undeveloped forested open space is associated with a $311 decrease in the median

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home value. This result is also consistent with previous findings that suggest greater proximity to forests increases home values in rural areas but decreases home values in more suburban areas. For example, being 1 meter closer to deciduous forests (the dominant type of forest in the study area) have been shown to decrease home values in Knox County, Tennessee by $78 (Cho, et al. 2009;Cho, et al. 2008). However, these results should not be interpreted as a signal that forests detract from home values. The vast majority of the developed open space parcels that were found to add to home values were covered by forests. This suggests that forests with certain developed amenities such as trails, picnic areas, and playgrounds are valuable to homeowners The negative values associated with undeveloped forested open space may be due to restricted views or concerns over trees falling on structures.

Public and private protected open space have a slight impact on property values (see Table 28). While the study region is home to many federal (Fort Campbell Military Reservation, Natchez Trace Parkway and Scenic Trail, and Stones River National Battlefield) and state (for example Radnor Lake State Natural Area, Cedars of Lebanon State Forest, Montgomery Bell State Park, and Cheatham Wildlife Management Area) protected areas that attract tourists and generate recreation values, they do not appear to impact nearby property values in most counties. Proximity to private protected open space has a small positive impact on property values in Davidson County. Being 1 meter closer to private protected open space in Davidson County increases home values by nearly $5.

Table 28. Property value impact from being 1 meter closer to open space by ownership type

County	Price	Public	Private
Cheatham	$166,900	$0	$0
Davidson	$215,800	$0	$5
Dickson	$142,500	$0	$0
Maury	$129,800	-$2	$0
Montgomery	$138,400	$0	$0
Robertson	$140,400	$0	$0
Rutherford	$153,200	$0	$0
Sumner	$175,900	$0	$0
Williamson	$399,600	-$10	$0
Wilson	$219,000	$0	$0

Open space does not have a statistically significant impact on property values in Rutherford and Robertson Counties. In Wilson County, the total impact of open space on property values is negative. Proximity to wetlands add to property values but this positive impact of open space is outweighed by the negative effect of forests on property values. While an analysis performed at the county-level is unable to identify a positive relationship between property values and open space in these counties, that does not imply that developing open space in these counties will not have an effect on property values. There will certainly be high-value open space parcels in these counties that add value to neighboring homes even if these localized effects do not emerge when aggregated up to the county level.

Results also suggest that proximity to open space has a greater influence on property values than the quantity of open space. The relationship between the proximity to open space and home values may differ depending on the type and size of the open space. For instance, proximity to agriculture land will add more to home values in Dickson, Robertson, and Maury County when the agriculture land is small in area. Likewise, proximity to forested open space will have a smaller negative impact on home values in Robertson and Williamson Counties when

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the forest parcel is larger in size. These results suggest that homeowners prefer proximity to smaller farms and forested areas.

The open space impacts on property values in this section of the report could be tempered somewhat if homeowners substitute large backyards for proximity to open space. Homeowners that value open space may choose to privately provide open space by purchasing a home with a large lot instead of locating near existing open space (Thorsnes 2002). This substitution could explain the lack of a positive relationship between property values and open space in in Robertson, Rutherford, and Wilson Counties. Adding an additional acre to the size of a residential lot in these three counties increases home values by $650 to $885. These estimates may represent the potential development value of an additional acre of land in these counties. However, if these estimates reflect the benefits provided by the private open space in ones backyard, then residents in Robertson, Rutherford, and Wilson Counties may value open space more than the results in Tables 25 and 26 would suggest.

The results in the report are derived from county-level models which allow the coefficients on open space variables to vary across counties. This approach captures heterogeneity in the housing stock, housing density, socioeconomic characteristics, and open space availability across counties but taking this approach also assumes that the relevant housing market is equal to the county. For example, someone considering a home in Wilson County will only consider purchasing other homes in Wilson County. Alternatively, the person considering a home in Wilson County may also be willing to purchase a home in any of the other ten counties in the study area. In this case, a regional model in which a single open space coefficient is estimated for the entire study area would be more appropriate. Results from a comparable regional model are presented in Technical Appendix F.

6.   CONCLUSION

The 4,838 square miles of open space in the ten-county study region in Middle Tennessee generate clear benefits. Homeowners, businesses, and governments in the ten-county region enjoy quantifiable economic value from open space in a variety of ways. This study demonstrates that open space:

- helps residents and businesses avoid nearly $214 million per year in direct and indirect medical costs

- provides residents $873 in recreational-use benefits per household per year

- helps businesses avoid $4.5 million in workers' compensation costs and $248 million per year in lost productivity costs

- saves local governments and utilities more than $3.2 billion a year in costs associated with environmental services such as drinking water filtration and flood control

- generates $28 billion in annual spending and contributes an estimated 278,000 jobs to the regional economy.

- increases homeowner property values by an average of $30,000 per household

- generates $118 million in property tax revenues

These estimates should help elected leaders, policy makers, and the public make more informed decisions about future development and dispel arguments that undeveloped open space contributes nothing to local economies.

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