Ecosystem Services and Southern Wetland Forests:

Baseline Value and Future Prospects

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Executive Summary

Some 35 million acres of wetland forests provide valuable ecosystem services for people living in the U.S. South[1] and beyond. These services include water filtration, carbon sequestration and local climate regulation, waste assimilation, protection from extreme events, and recreational opportunities that, when measured in monetary terms, represent more than $503.8 billion per year in market and non-market value. How much of this value will be available in the future hinges on how much of this forest remains and how it is managed.

We consider the allocation those 35 million acres of wetland forest to various land use/land management categories in two future scenarios and estimate the ecosystem service value in each, in addition to the 2016 baseline. In both the "business-as-usual" ("BAU") and the "Conservation" scenario, some wetland forest acreage will be converted to non-forested uses, some will be placed in protective designations and managed primarily for biodiversity and other non-commodity values, while other areas will remain available for timber harvest. Among these latter areas, some land will be in more intensive forest management, including plantations, some will be managed under under "ecological forestry" standards, and some some may continue in a state of benign neglect. Overlapping all areas except those converted to non-forest uses, are streamside-management zones with widths as currently defined in state-by-state regulations for the baseline and BAU scenario, but expanded to 150' in the conservation scenario.

Wetland forests in each of the land use/land management categories will produce an array of ecosystem services, but not all at the same rate per acre. Land converted to urban/developed uses, for example, will provide less in the way of flood damage protection or recreational opportunities than the natural forests they replace. And wetland forest land allocated to more intensive forest management will produce more timber, but perhaps less carbon storage, water supply, or protection from extreme events, like flooding.

To the extent possible, our scenarios incorporate spatially explicit information on likelihood of conversion, proposals for expansion of protected areas, and the geographic reach of forest management regulations (specifically streamside management zones). Other facets of the baseline conditions and future scenarios, however, can only be applied to estimates of residual acreage–that is, acreage not geographically tied to any particular cause or type of land use/forest management change. Our procedures and techniques, primarily spatial analysis using ArcGIS[2], for allocating wetland forests to land use/land management categories are described in detail in the Spatial Analysis Methods section below.

With acreage estimates in hand, we proceed to estimate the economic value of these forests today and in the plausible future scenarios, we apply the "benefits transfer method" ("BTM") to the areas identified in each scenario. According to this method, acreage is multiplied by per-acre ecosystem service values gleaned from existing literature, including the TEEB ("The Economics of Ecosystems and Biodiversity") database (Van der Ploeg, Wang, Gebre Weldmichael, & De Groot, 2010). These source studies typically provide a range of value-per-acre estimates for various sets or arrays of ecosystem services for one or more land cover type(s).

Unfortunately little literature exists regarding the differential ecosystem service productivity–that is, the per-acre values–for different management regimes within a land cover type. It is difficult to speculate on just how much more (or less) water supply, timber, or recreational value would be provided to different management types within the forest, and especially, the wetland forest land use/land cover category. We can, however, speculate with some confidence regarding the relative productivity of different management types. Land managed for conservation purposes, where commercial resource extraction including timber harvest is

[1] For purposes of this study, this region comprises Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Missouri, Kentucky, and Tennessee. See maps, below.
[2] We are grateful to ESRI and its Conservation GIS Program for generous support in the form of the ArcMap used in this analysis.

prohibited, would produce no raw material (timber) value, whereas land in the “ecological forestry” category and “intensive forestry” would provide more raw materials.

To overcome this limitation in the available data while still developing estimates of ecosystem service value, we have used the available ranges of ecosystem service productivity estimates and assigned different values from within those ranges to to our land management types on an ecosystem service-by-ecosystem service basis. We describe the details of these assignments under Ecosystem Service Valuation in the Methods section, below.

The internal logic of this method, which we believe corresponds to likely real-world outcomes, is that differences among the scenarios in terms of total ecosystem service value are driven by differences in the number of acres allocated to different land-use/land-management categories, and by differences in ecosystem services productivity among the land-use/land-management categories.

In brief, we estimate a fairly low level of conversion of wetland forests to non-forest uses and, due to potential implementation of land protection priorities, an increase in overall ecosystem service value in both the business-as-usual and conservation scenarios. Ecosystem service value is further boosted in the conservation scenario due to an expansion of streamside management zones.

Conversion of wetland forests to urban open space and urban developed areas would mean a loss of 407,334 wetland forest acres in the business-as-usual scenario and a loss of 362,937 acres in the conservation scenario. Additional acreage in each scenario would be converted from wetland forest to pine plantation, leaving 34.4 and 34.5 million acres as wetland forests in the BAU and conservation scenarios, respectively. (See Table 1.)

Table 1. Summary of Land-Use/Land Management Elements of Baseline, Business-as-Usual, and Conservation Scenarios, with Acreage and Estimated Ecosystem Service Value

Land Use / Land Management Category	Allocated Wetland Forest Acreage and Ecosystem Service Value (2016$)		
	Baseline	Business as Usual	Conservation
Totals[a]:	**35.1 million acres (all wetland forest)** **ESV: $503.8 billion**	**35.1 million acres (34.4 mm acres are wetland forest)** **ESV: $526.9 billion**	**35.1 million acres (34.5 mm acres are wetland forest)** **ESV: $549.1 billion**
Protected Areas	Protected Areas Database: GAP category 1 and 2 lands, which are permanently protected from development and managed for values other than commodities. Vegetation management for the purposes of maintaining or enhancing other resource values is permitted. Commodity harvest is not permitted.		
	Baseline Protection: 2,812,908 acres Total Ecosystem Service Value: $51.1 billion		
Added to Protected Areas	n/a	Southeast Conservation Adaptation Strategy ("SECAS") Blueprint: 50% of "high" priority areas	SECAS Blueprint: 100% of "high" areas
		6,476,416 acres $118.1 billion	12,952,832 acres $236.3 billion
Converted to non-forest use	n/a	Areas at >50% risk of urbanization by 2050 (SLEUTH projections)	
		407,334 acres $1.4 billion	362,937 acres $1.3 billion
Streamside Management Zones ("SMZs")	Width varies by state[3]. Harvest may be permitted within SMZs.		150' for permanent/ intermittent streams. No harvest in SMZs.
	70,874 acres w/in protected areas; 1,740,732 acres outside protected areas ESV outside protected areas: $31.6 billion	377,953 acres w/in protected areas 1,415,374 acres outside protected areas ESV outside protected areas: $25.7 billion	2,216,129 acres w/in protected areas 3,704,284 acres outside protected areas ESV outside protected areas: $67.3 billion

Table 1 continues on the next page.

[3] For some states, the recommended SMZ width is a function of the slope. We are not including that variation in our model.

Table 1, continued.

Land Use / Land Management Category	Allocate Wetland Forest Acreage		
	Baseline	Business as Usual	Conservation
Ecological Forestry (outside SMZ)	Areas under management that meets certification standards. Scenario-specific SMZ in effect. Expect less timber value, more of other ecosystem service values.		
	453,776 acres ESV: $8.3 billion	890,188 acres ESV: $16.2 billion	1,032,274 acres ESV: $18.8 billion
Intensive Forestry (outside SMZ)	Forestry emphasizes fiber production. Scenario-specific SMZ in effect. No other distinguishing restrictions. Expect more timber value, less of other ecosystem service values.		
	7,826,391 acres ESV: $9.1 billion	5,845,378 acres ESV: $6.8 billion	4,667,465 acres ESV: $5.5 billion
Plantation Forestry (outside SMZ)	Wetland forests that have been drained and planted in (typically) pine and managed for fiber commodities. Scenario-specific SMZ in effect. Expect more timber value, less of other ecosystem service values.		
	0 acres, ESV: $0	307,651 acres ESV: $359.6 million	245,646 acres $287.1 million
Benign Neglect	Residual Category for acreage left after other allocations are made.		
	22,235,017 acres ESV: $403.7 billion	16,913,573 acres ESV: $307.1 billion	9,290,466 acres ESV: $168.7 billion

Note:

a. Because we track the disposition and ecosystem service production from all acres in our baseline scenario, the total acreage in all land use/land management categories stays constant. The lower wetland forest acreage estimates (in parentheses on the “Totals” line for the BAU and conservation scenarios) are total acreage less acreage converted to urban uses and acreage converted to plantation forestry.

Collectively, these 35.1 million acres generate or support $503.8 billion per year in diverse ecosystem services. Due to increases in conservation land, on which productivity gains for non commodity ecosystem services more than offset the loss of timber value, annual ecosystem service delivery increases to $526.9 billion per year in the BAU scenario and $549.1 billion per year in the conservation scenario. In each scenario, approximately 20% of total ecosystem service value is due to aesthetic value. Protection from extreme events, water flow regulation, and food supply about 15% each, and water supply and waste treatment contribute up 11.7 and 11.2 %, respectively, of the total. The balance of ecosystem service value is delivered as air purification, climate regulation, erosion control, pollination, raw materials (timber), recreation, and soil formation. (See Table 2.)

Table 2. Annual Ecosystem Service Value in Baseline, Business-as-Usual, and Conservation Scenarios, in millions of 2016 dollars.

	Baseline (2016)	Business as Usual (2050)	Conservation (2050)
Ecosystem Service	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)
Total:	**503,850.0**	**526,873.0**	**549,121.6**
Aesthetic Value	101,893.1	106,982.9	111,729.7
Air Quality	4,262.2	4,332.5	4,407.2
Climate Regulation	12,438.8	13,338.4	13,888.2
Erosion Control	1,947.1	2,031.2	2,118.0
Protection from Extreme Events	77,151.4	80,623.6	84,068.8
Food	70,682.5	73,955.5	77,278.3
Pollination	2,079.1	2,172.8	2,268.5
Raw Materials	1,370.8	1,652.9	1,976.5
Recreation	24,135.4	25,689.9	26,778.2
Soil Formation	18,794.9	18,576.5	18,600.3
Waste Treatment	56,215.5	58,810.1	61,446.2
Water Supply	59,135.1	61,981.6	64,738.4
Water Flow Regulation	73,744.0	76,725.2	79,823.4

Differences between the baseline and future scenarios arise due to differences among the number of acres in each land use/land management category and assumptions about the relative ecosystem service productivity of each land use category.

Contents

Acronyms and Definitions

Baseline Scenario: The extent of wetland forests and their allocation among land use/land management categories, based on the most recent spatial data. (See Baseline, page 11, for details.)

Business-as-Usual Scenario: The projected allocation of wetland forests (as identified in the Baseline) among various land use/land management categories in the year 2050 if current trends continue and one half of the acreage identified as "high priority" for conservation is placed into a protective status. (See See Business-as-Usual, page 12, for details).

BTM: Benefit Transfer Method, a method for estimating the value of ecosystem services in a study region based on values estimated for similar resources in other places

Conservation Scenario: The projected allocation of wetland forests (as identified in the Baseline) among various land use/land management categories in the year 2050 with greater conservation efforts than those in the Baseline and Business-as-Usual Scenarios. (See Conservation, page 12 for details)

Ecological Forestry: Areas under management that meet certification standards with an emphasis on supporting and protecting native ecosystem health and production.

Ecosystem Services: Benefits people derive from ecosystems. Specifically, and as modeled in this report, they comprise the monetary value of various benefits that, were they not provided by nature, people would have to provide for themselves. Please see table 5 for a list of the specific services included in this study.

GAP 1&2: U.S. Geological Survey's Gap Analysis Program, provides information and designations for areas that are currently protected for biodiversity.

Protected Status: Areas which are permanently protected from development and managed for values other than commodities which includes GAP 1&2 areas as well as scenario specific portions of the SECAS protection designation (100% of "High" SECAS priority for the Conservation Scenario, and 50% of the "High" SECAS priority for the BAU Scenario).

SECAS: Southeast Conservation Adaptation Strategy, a multi-state, multi-agency effort to create and share restoration and protection designations for the Southeast United States and the Caribbean.

SMZ: Streamside Management Zones consist of land on either side of permanent or intermittent streams designated by the U.S. Geological Survey. Each scenario provides different widths and land uses permitted in the SMZ (state specific widths in the BAU and Baseline scenarios, and 150 feet in the Conservation Scenario) (U.S. Geological Survey, 2017).

About the Authors

Spencer Phillips, PhD has been conducting and directing applied research into the relationships between natural resource stewardship, environmental quality, and human well-being for more than 25 years. He was a staff economist first at the White House Council on Environmental Quality during the first Bush Administration, and then at The Wilderness Society, where he later served as Vice President for Ecology and Economics Research. Dr. Phillips founded Key-Log Economics to help ensure that sound, independent economic research is available to those working to solve the critical environmental problems of our time. He is also a lecturer in economics, natural resource policy, and GIS analysis at the undergraduate and graduate level. Phillips holds a B.A. in economics from the University of Virginia and an M.S. and Ph.D. from Virginia Tech.

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Key-Log Economics remains solely responsible for the content of this report, the underlying research methods, and the conclusions drawn. We have used the best available data and employed appropriate and feasible estimation methods but nevertheless make no claim regarding the extent to which these estimates will match the actual magnitude of economic effects experienced under future scenarios for regional wetland forest conservation and management.

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Study Objectives

The wetland forests of the southern United States support biodiversity, sequester and store carbon, filter drinking water, protect people and property from losses in floods and storms, and otherwise provide value to people. Over the course of centuries, millions of acres of these forests have been drained and converted for use as cropland, for plantation forestry, and for housing and other developed uses (Dahl, 2011). The pace of conversion has slowed in recent decades as land protection efforts have prioritized areas with higher ecological values and as water-quality-based restrictions on wetland conversion have come into effect. Today, wetland forest protection may be even more important as a means of ensuring the continued provision of ecosystem services that will be needed more as climate change increases the need for services wetland forests are well suited to provide, such as protection against extreme weather events, and as places to sequester and store carbon or to preserve "critical natural capital" (Farley, 2012) that might otherwise be lost regionally or globally.

Information about the potential economic benefits of wetland forest conservation can help inform decisions about whether, where, and by what means to pursue that conservation. Our objective is to provide initial estimates of those benefits and a starting framework for future analysis as new information becomes available that can also be "down-scaled" to assess ecosystem service value at a sub-regional, state, or even project level using more detailed information about specific forest composition and other local conditions.

Our method, has three primary steps. First, we use GIS analysis and other data to identify the current extent and location of wetland forests across the U.S. South and to estimate how these areas are allocated among several land use/land management categories. This step provides our "baseline scenario" to for comparison to two possible future scenarios. Second, we develop those two future scenarios–labeled "business-as-usual" and "conservation"–and estimate the allocation of wetland forest acreage to the same array of land use/land management categories. (We selected 2050 as a timeframe for these scenarios in part for the availability of projections regarding potential conversion to non-forested uses and because the 30+ years between now and then may provide sufficient time to attain other conservation objectives embodied in the scenarios.) Third, we apply the benefits-transfer method ("BTM") to develop estimates of the annual value of 13 ecosystem services delivered by the areas areas identified as wetland forests in the baseline. Differences in ecosystem service value between the baseline and future scenarios arise due to projected differences in the number of acres allocated to the various land use/land management categories as well as too differences among the land-use/land management categories in terms of per-acre ecosystem-service productivity.

Scenarios

The question of how much ecosystem service value wetland forests provide, or could provide in the future, depends on the extent of these forests and the use or management to which they are subject.is tied to questions of how extensive these forests are now, how they are used now, and how that extent and use may change in the future. We define the extent of wetland forests and their allocation to land use/land management categories for three scenarios: Baseline (i.e., current conditions); Business-As-Usual, or BAU; and Conservation.

Please refer to Table 1, above, which lays these scenarios out schematically and provides the estimated acreage and and ecosystem service value for each scenario and in each land-use/land-management category. Details on the spatial analysis conducted to evaluate each scenarios, along with sample maps, are provided under Spatial Analysis Methods, below

Baseline

Following the method outlined by the Natural Resources Defense Council (2015), we use satellite data to identify the current extent and location of wetland forests. Specifically, wetland forests are defined here as those areas identified as “woody wetlands” in the National Land Cover Database that are also identified both as as “forests” in data from the U.S. GAP program and as “tree-dominated” in the USDA Forest Service’s LANDFIRE program (Fry, et al., 2011; National Gap Analysis Program, 2015; and LANDFIRE Program, 2017). Some 35.1 million acres meet these criteria.

Further GIS analysis using additional information from the GAP program, specifically the Protected Areas Database, identifies the extent to which wetland forest acreage is already protected. “Protected” is defined for our purposes as being classified as an area in GAP status 1 or 2. As defined by the program,

> Status 1 [areas have] permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.
>
> Status 2 [areas have] permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

In contrast to GAP Status 3 lands, these Status 1 and 2 lands are not “subject to extractive uses of either a broad, low-intensity type (e.g., logging, OHV recreation) or localized intense type (e.g., mining) (National Gap Analysis Program, 2015, metadata).”

Streamside Management Zones are classified as areas surrounding permanent and intermediate streams designated by the U.S. Geological Survey (U.S. Geological Survey, 2017). SMZ width in the Baseline Scenario corresponds with the state specific SMZs that are in effect today, and the ability to harvest materials out of these areas remains in place. Wetland forests that fall within these SMZ’s are subject to harvesting as long as they do not fall within the designated protected areas of GAP Status 1 and 2.

To define areas designated as ecological forestry and benign neglect, canopy cover was used as a defining factor. We identified these areas as those with 66% or higher canopy cover. Certified acreage was collected from the Forest Stewardship Council and we found that ~2% of region’s forests are under certified forestry of one sort or another (Forest Stewardship Council, 2016). We defined Ecological forestry acreage within the Baseline Scenario as 2% of unprotected area, which also had 66% canopy coverage. Benign neglect is the total unprotected wetland forest acreage with 66% canopy closure, less the ecological forestry portion. Intensive forestry, where areas of wetland forest are more likely to be managed intensively for timber, are defined as areas with less than 66% canopy coverage and that fall outside of protected GAP 1 and 2 areas.

Business-as-Usual

The BAU Scenario projects where wetland forests could be (from a land-use/land-management perspective) in 2050 in our study region. This projection is relative to the Baseline Scenario.

Some areas in the BAU scenario are likely to be converted to non-forest (urban) uses by the year 2050. Acreage within these areas are allocated to “urban developed” and “urban open space”, which are the subcategories for which distinct ecosystem service values are available, according to the current distribution of those sub-categories across the region (Belyea & Terando, 2014).

Protected areas increase in the BAU scenario. We assume that 50% of the high priority areas identified by SECAS will be added to the region's GAP 1 and 2 lands by 2050. We foresee no changes in the size or accessibility to harvesting of the SMZs in the BAU Scenario. We assume an increase in the Ecological forestry percentage to 5%, gaining new area from the benign neglect category. We further assume that 5% of the remaining wetland forest areas (i.e., areas that would otherwise be intensively managed for timber) are converted to pine plantations, effectively leaving the wetland forest type.

Conservation

This Scenario also defines where wetland forests could be in 2050 relative to the baseline. The Conservation Scenario entails greater protection and more careful stewardship of wetland forests compared to the BAU Scenario.

The areas that are likely to be converted to non-forest uses by 2050 remain the same in the Conservation Scenario, but the protected lands are increased to include all high-priority lands identified in SECAS as well as the currently protected (GAP 1 and 2) lands.

In the Conservation Scenario SMZs are increased to 150 feet on both sides of permanent and intermittent streams in every state, and SMZs are, effectively, a no-harvest zone. We also assume that 10% of the region's wetland forests are, by 2050, under ecological forestry in the Conservation Scenario, reducing the number of acres falling under the more intensive management categories as well as benign neglect. As in the BAU, scenario, we assume that 5% of the land outside protected areas, not in an SMZ, not converted to urban uses, and not in ecological forestry or benign neglect would be put into pine plantations.

Methods

Estimation of ecosystem service value requires two general steps:

1. Allocate total wetland forest acreages to one of eight land-use/land-management categories for which one would expect differing productivity for different ecosystem services. We perform this allocation for the baseline and the two future scenarios, BAU and Conservation.

2. Multiply acreage in each land-use/land-management category by the ecosystem service value per acre for each of [13] individual ecosystem services. For those ecosystem services which have, based on literature review, higher or lower productivity would be expected, we have applied land use-specific factors to the acreage each land use. For example, raw materials (i.e., timber), and climate regulation are two services for which productivity would be expected to differ between conservation areas and areas managed intensively for timber.

The result is a three-dimensional dataset with dollar-value estimates of ecosystem services for 13 ecosystem services harbored or produced within 8 land uses under the 3 scenarios (including the baseline). These atomized value estimates can then be summed in any dimension and compared to illuminate, for example, how total climate regulation value varies between the BAU and Conservation scenarios. In Appendix 1, we present state-by-state estimates of ecosystem service value of wetland forests.

Methods for Land Allocation

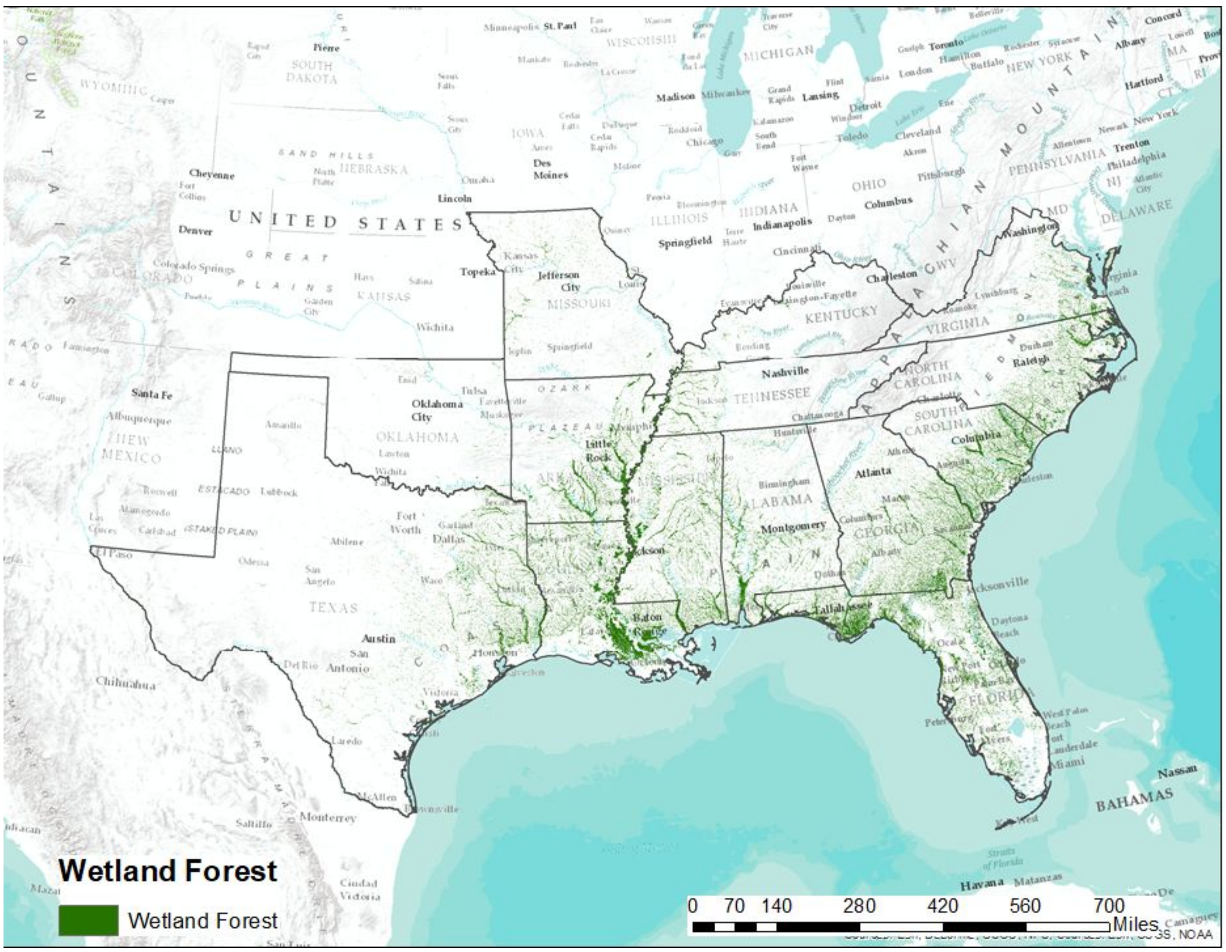
This project relied heavily on GIS analysis to identify and to calculate the area associated with each of the land use/land management scenarios scenarios (Baseline, Business as Usual, and Conservation). In addition to the land cover information used to identify wetland forest areas, we examined four separate attributes (Protected

Area, Urban Development, Streamside Management Zones, Canopy Cover) for each pixel in each scenario. Based on these attributes, we assigned each pixel to a single LULM category for each scenario.

Wetland Forests

The first step of the data analytics for this study entailed designating which areas should be considered wetland forest within the study region. Without knowing which areas were wetland forests, no ecosystem service data could be connected to those forests. By using a combination of the National Land Cover Database (U.S. Geological Survey, 2014), the National Gap Analysis Program (National Gap Analysis Program, 2015), and the LANDFIRE program (LANDFIRE Program, 2017), wetland forests were successfully defined for our study region (Figure 1). Once a wetland forest map layer was produced, it could be used to define all of the other land use allocations. This layer is the foundation for the ecosystem service values, and the bedrock of this study.

Figure 1: Wetland forests and in the U.S. South



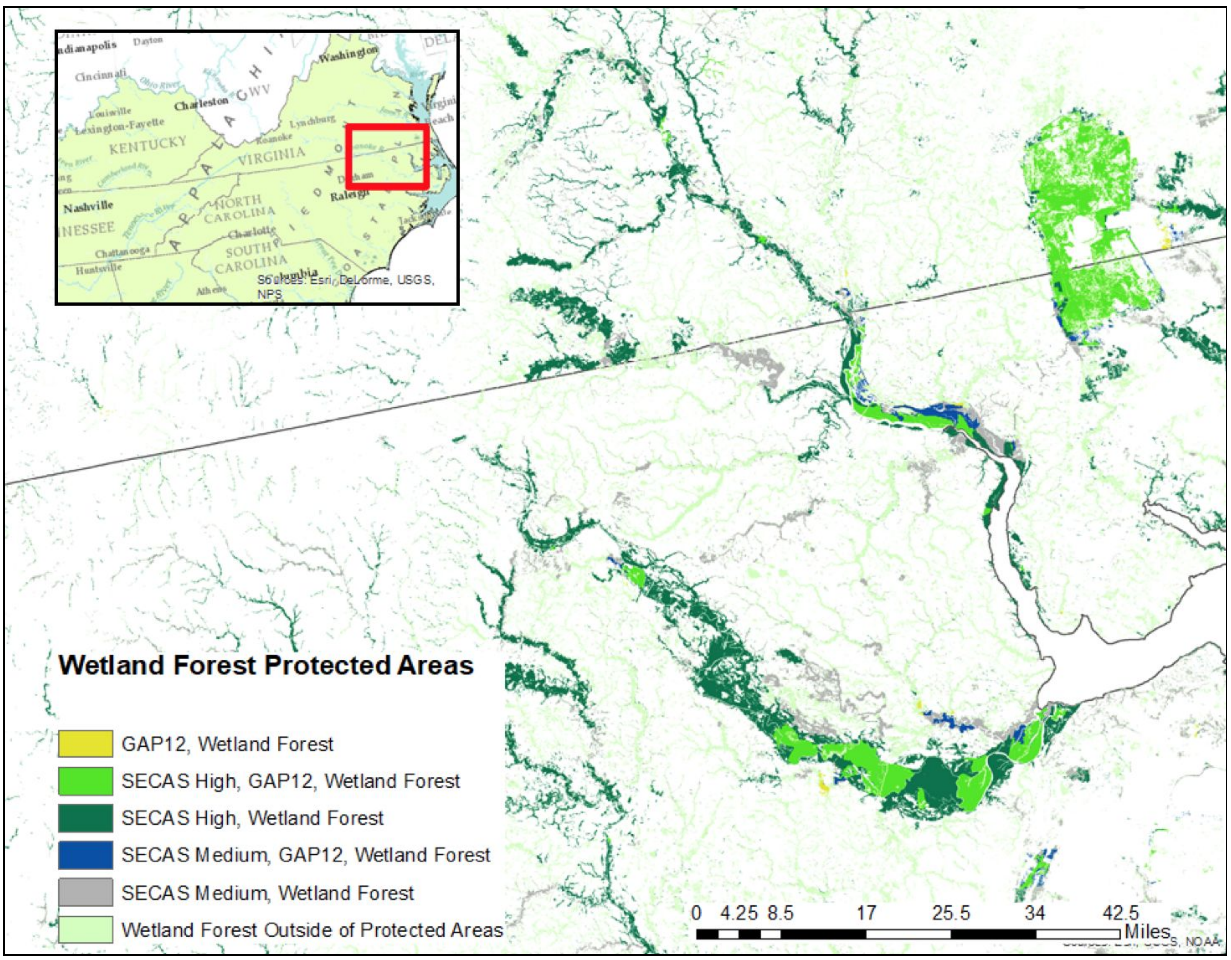
Sources:U.S. Geological Survey, 2014; National Gap Analysis Program, 2015; LANDFIRE Program, 2017

Protected Areas

Under each of the conservation scenarios, protected areas consist of both GAP 1 and 2 lands, and Southeast Conservation Adaptation Strategy ("SECAS") blueprint areas. GAP 1 and 2 lands are permanently protected from development and managed for values other than commodities. SECAS areas are designated as having either "high" or "medium" conservation value. For the BAU scenario, the GAP 1 and 2 lands as well as 50% of the SECAS high areas are considered protected going forward. In the Conservation scenario, the GAP 1 and 2 lands and 100% of the SECAS High areas are considered protected. For this report the SECAS "medium" designation (outside of GAP 1 and 2 lands) is added for context but does not fall within either conservation scenario's protection.

GIS data layers were obtained for both GAP 1 and 2 (National Gap Analysis Program, 2015), and SECAS (Snider, 2016). Each layer was altered to fit the study region and then combined to indicate all the areas that have protection from GAP 1 and 2, SECAS, or both. Once the protection areas were defined, the wetland forest data from the National Land Cover Database (Fry et al, 2011) was added to produce the area of wetland forest under each protection designation (Figure 2).

Figure 2: Wetland forest within protected areas



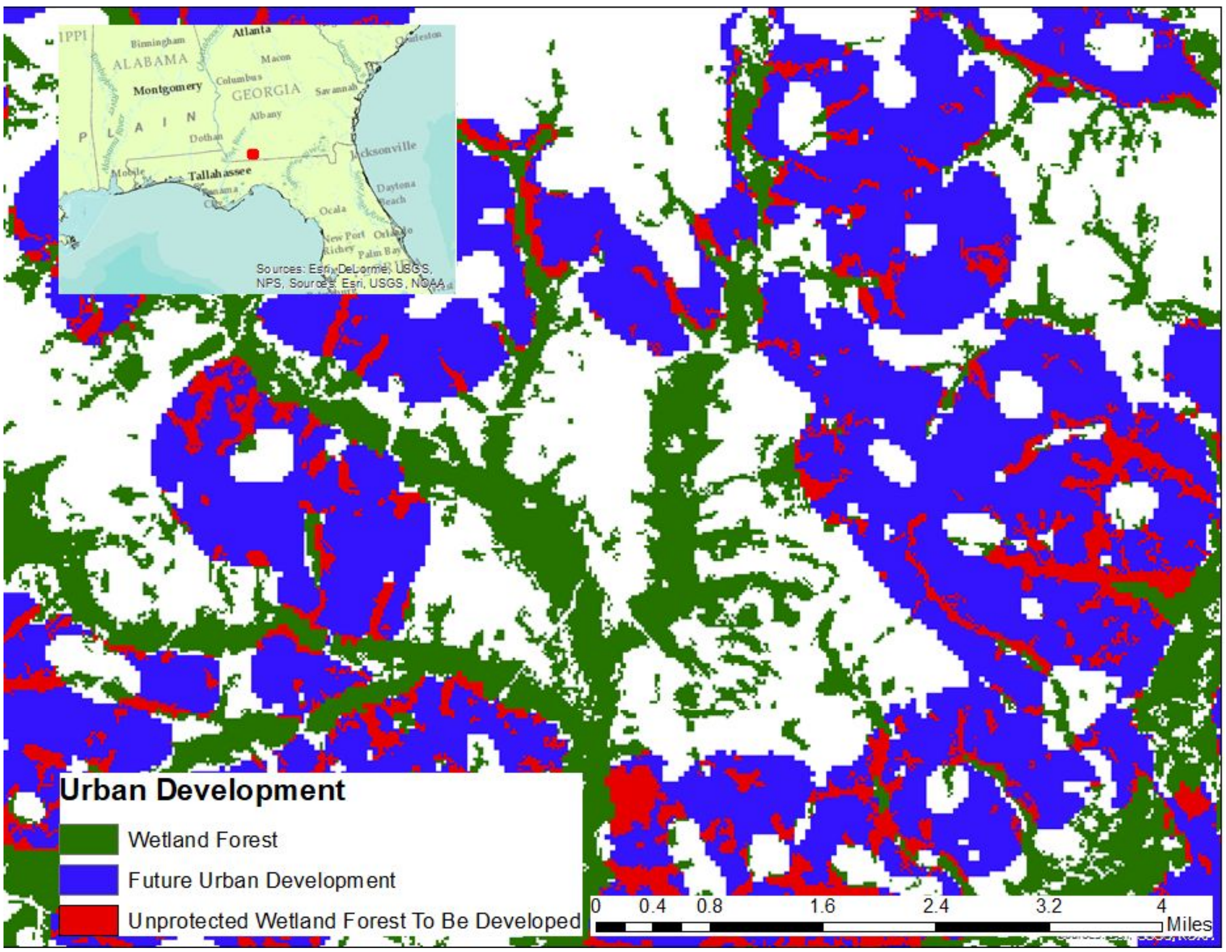
Source: U.S. Geological Survey, 2014; National Gap Analysis Program, 2015; Snider, 2016; LANDFIRE Program, 2017

Urban Development

One thing that is almost a certainty when producing future scenarios is human expansion. Urban development is crucial to understand when creating the BAU and Conservation scenarios. To account for this future development a SLEUTH (Slope, Land use, Excluded, Urban, Transportation and Hillshade) database was aligned with the study region to predict areas that had a probability of 50% or greater of being developed by 2050 (Belyea & Terando, 2014) (Figure 3).

The urban development data layer was then cross-referenced with wetland forest data as well as streamside management zones, and protected areas. This produced areas of wetland forest, and streamside management zones that will be developed under each scenario. The assumption was made that unless the development falls within one of the designated protected areas created above, it will be converted into the urban land use designation and no longer supply ecosystem services. It should also be known that development areas that fall within streamside management zones were regarded as developed due to the fact that they are not protected at the time of this study. The urban land use designation contains 2 subcategories: "urban open space" and "urban developed". These subcategories were defined by the ratio of existing urban open space, and urban developed (U.S. Geological Survey, 2014).

Figure 3: Urban areas and potential urbanization before 2050
Areas with 50% or greater probability of conversion to urban uses by 2050, including areas identified as wetland forests.



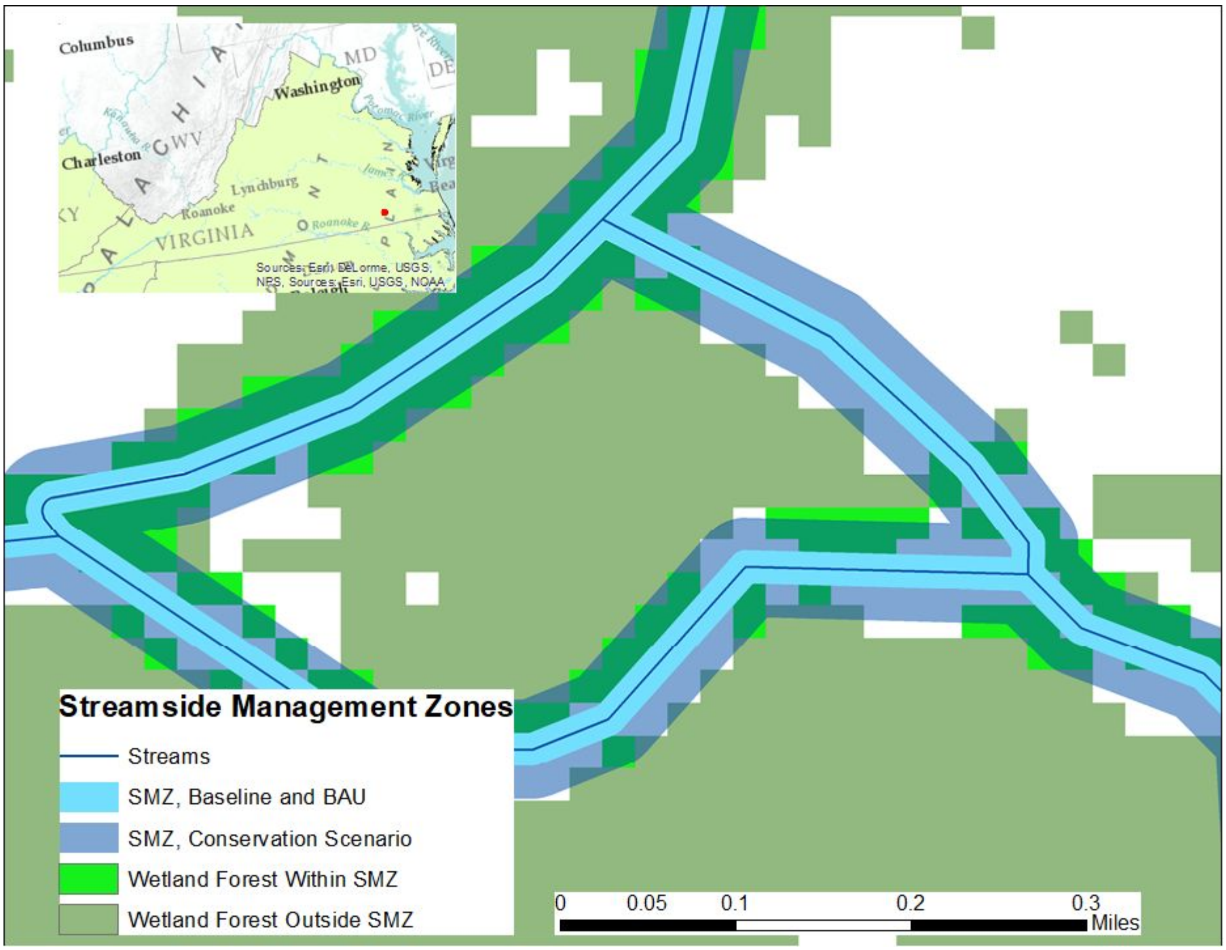
Sources:Belyea, 2014; Fry, 2011; NRDC 2015

Streamside Management Zones

One of the largest differences between the BAU and Conservation scenarios is the size of streamside management zones (SMZ). Under the BAU scenario, the SMZs are state specific on either side of a stream, and harvesting is permitted within these zones. Under the Conservation scenario the SMZs span 150 feet on either side of a stream and no harvesting is permitted.

To accomplish this, stream data was acquired from national hydrography data (U.S. Geological Survey, 2017) and buffers were created around the streams depending on the buffer size under each scenario (state specific (BAU) and 150 feet (Conservation)) (Figure 4). Once the SMZs were defined, the area within them was combined with the existing protection, wetland forest, and urbanization layers to find the area of each designation within the SMZ. This was done for both the state specific SMZs and the 150 Foot SMZs.

Figure 4: Streamside management zones, both BAU (State Specific) and Conservation (150 feet) scenarios
SMZ interactions with wetland forests within each conservation scenario, as well as the wetland forests outside of the SMZs to provide context.



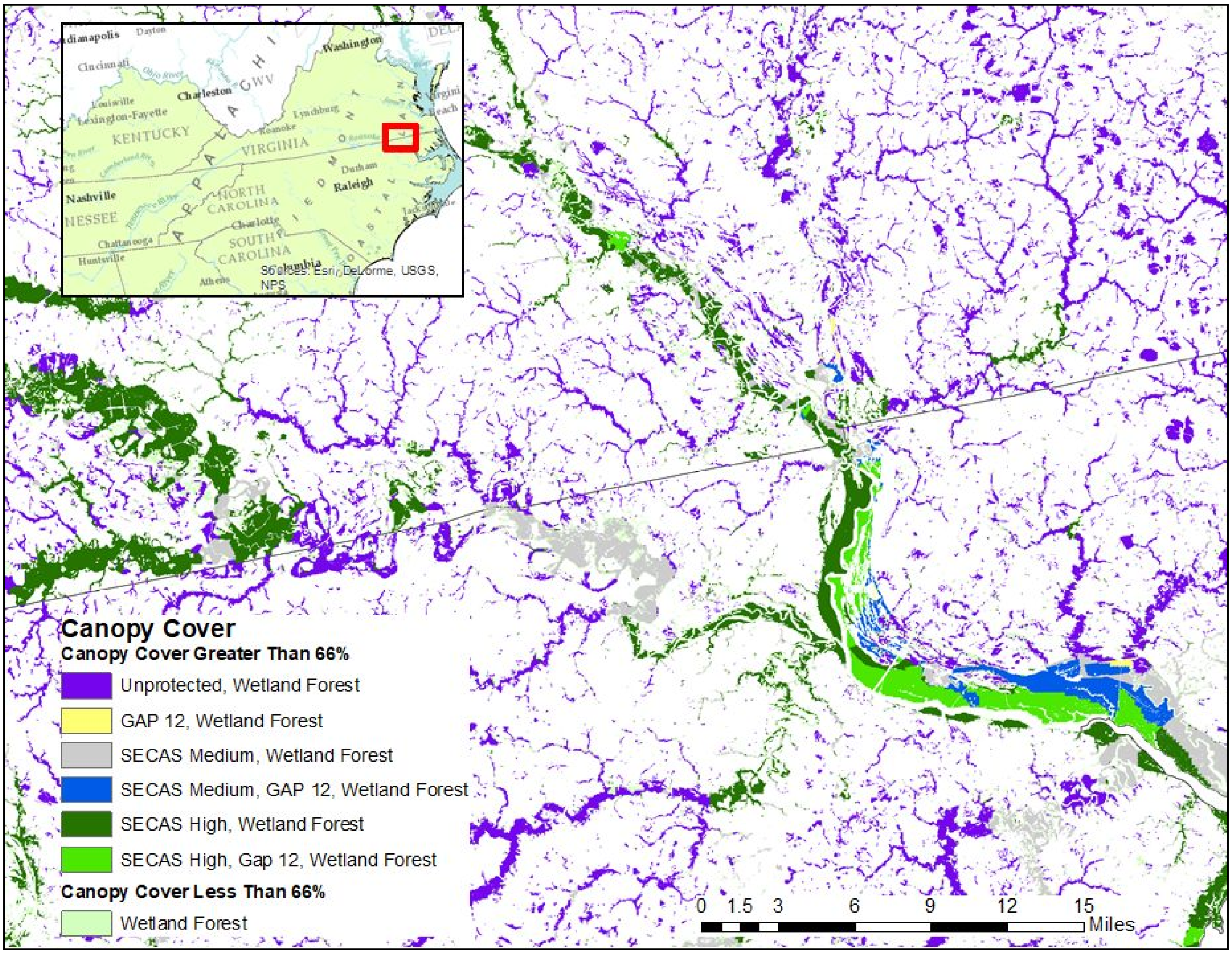
Sources:U.S. Geological Survey, 2014; National Gap Analysis Program, 2015; LANDFIRE Program, 2017

Canopy Cover

In this study, canopy cover was used to define ecological forestry, intensive forestry, and benign neglect land uses. Because data did not exist for all management areas, a combination of canopy cover certified forest percentage was used as a proxy for these designations.

Map layers were retrieved from the U.S. Geological Survey containing the canopy cover information for the United States (U.S. Geological Survey, 2013). This data was imported and contained to the study region and the pixels were resized to be compatible with the existing map layers. Once the layer had been processed it was combined with both the protection data above as well as the wetland forest data. This final map depicted all the protection designations as well as the wetland forests that fall within areas with greater than 66% canopy cover (Figure 5).

Figure 5: Wetland forests with greater than 66% canopy cover for each protection designation
Wetland forests under each protection (and potential protection) category where the canopy cover is greater than 66%. For context, wetland forests with less than 66% canopy cover are included.



Source: U.S. Geological Survey, 2014; National Gap Analysis Program, 2015; Snider, 2016; LANDFIRE Program, 2017; U.S. Geological Survey, 2013

To determine the amount of wetland forest converted to the ecological forestry, intensive forestry, and benign neglect land uses, certified forest data was obtained from the Forest Stewardship Council (Forest Stewardship Council, 2016), and the average percent of forests that were certified in the study region was found (2%). This study made the prediction that the area of certified forests would increase in the future (to 5% in the BAU scenario, and 10% in the conservation scenario). The average certified percentage was then applied to the area of wetland forest with greater than 66% canopy cover, and which fell outside of protected areas and SMZs for each conservation scenario, this area was designated as intensive forestry land use. The remaining unprotected area with greater than 66% canopy cover was designated as benign neglect land use and unprotected wetland forests with canopy cover less than 66% was designated as intensive forestry land use. When applying these values to individual states, the percent of certified forest for each state was used to gain accurate state specific land use areas. For states that currently have large certified percentages (Arkansas - 6.66% & Louisiana - 4.53%) the BAU scenario percentage was raised to 7.5% certified forests by 2050 from the original 5%.

Contextual Information

While the data sets and methods described in the preceding section are sufficient to identify acres of wetland forest for assignment to land use/land management categories and, additional information about these areas provides additional context for the monetary values presented below. Specifically, we present estimates of average tree age and total carbon storage for the areas identified as wetland forests in the first step of our method.

Average Tree Age

Tree age is included in this study to provide an understanding of the average age difference between the protection designations. Average tree age provides some insight into the productivity of the forests, as well as the effectiveness of protection. Country wide data of tree ages was collected and contained to the study region (Pan et. al, 2011). The data was then combined with the wetland forest layers above to produce the age of wetland forests within the study region under each protection designation.

Table 3: Average Age (in Years) of Trees in Current Wetland Forest areas, by Scenario and Land Use Management Group

		Outside Protected Areas		
Scenario:	In Protected Areas	In SMZs	Outside SMZs, Still in Wetland Forests	Converted to Urban Uses (a)
Baseline	45.6	32.9	29.9	0.0
BAU	44.4	32.4	30.2	37.9
Conservation	43.5	30.4	30.6	36.5

Carbon Storage

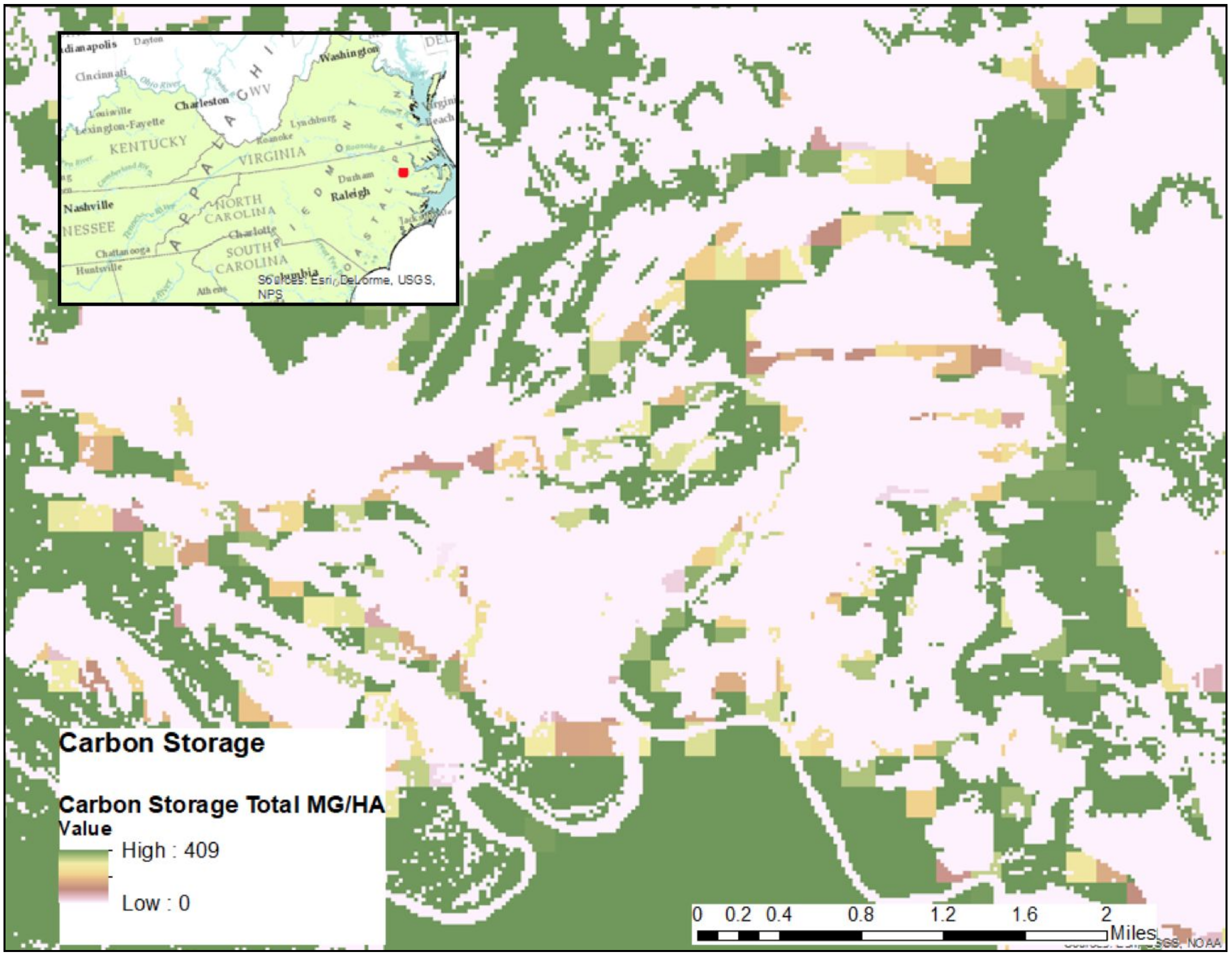
Carbon sequestration and storage is an important component of the “climate regulation” ecosystem service for which we develop dollar-valued estimates, below. As a side note to that calculation, we have also estimated total carbon storage in all stocks[4] for the land use/land management categories in each scenario (Table 4). Not that we have not estimated how those carbon stocks may change with shifts of acres among the land use/land management categories. Carbon stores on acres allocated to protected areas, for example, may be assumed to be secure. Stores on acres likely to be developed or managed more intensively for timber would be at risk of losing carbon stocks in the future scenarios.

To obtain these estimates, we clipped USDA Forest Service data (Wilson et. al., 2013) to the study region, resampled to 30-meter resolution, and combined the resulting layer with our existing layers defining land use/land management categories (i.e., all wetland forests areas, protected areas by scenario, SMZs by scenario, and wetland forest areas converted to urban uses in the BAU and Conservation scenarios). The estimates do not represent the carbon that would be stored in those categories in the future scenario, but rather the carbon stored in those areas today that may or may not survive the transition to the future land use/land management category. For example, wetland forests converted to urban uses are likely to lose carbon from some stocks in the short run and a diminished capacity to sequester carbon in the long run. Conversely, carbon stocks on areas

[4] These stocks are in live trees (above and below ground), down and standing dead trees, litter, soil organic carbon, and forest understory carbon.

allocated to protected areas are likely to see their stored carbon remain intact and, perhaps, increase with time. Figure 6 displays carbon stocks per hectare for a small area in eastern North Carolina, and Table 4 presents these estimates in tabular form.

Figure 6: Carbon storage in wetland forests (Mg/ha)



Source: U.S. Geological Survey, 2014; National Gap Analysis Program, 2015; LANDFIRE Program, 2017; Wilson et. al., 2013

Methods for Ecosystem Service Valuation

As noted, we use the benefits transfer method, or "BTM"," in which per-unit-area ecosystem service productivity estimates (expressed in dollars per acre per year) from a selection of existing studies of appropriate "source areas" are applied to area estimates in the "policy area." In the current case, the policy area consists of land that, at least in the baseline case, is wetland forests that is then allocated to various land use/land management categories identified, mapped, or modeled as described above.

Ideally, there would be studies of source areas that provide per-acre estimates of ecosystem service productivity for wetland forests (as distinct from other forests or other wetlands) and, within the wetland forest land use, for different management types (protected, SMZs, in ecological or intensive forestry, etc.). Moreover, one would prefer to have a robust set of these estimates for the full range of ecosystem services of interest in the policy

Table 4: Carbon Storage (megagrams) in Current Wetland Forests, by Scenario and Land Use/Land Management Group

Scenario:	In Protected Areas (Mg)	Outside Protected Areas		
		In SMZs (Mg)	Outside SMZs, Still in Wetland Forests (Mg)	Converted to Urban Uses (a) (Mg)
Baseline	1,480,688,562	70,453,967	-1,440,387,997	0
BAU	1,499,760,100	56,288,738	-1,445,954,649	660,343
Conservation	1,518,831,639	151,866,233	-1,562,532,344	2,589,004

Notes:
a. This column shows estimates of pre-conversion carbon storage in these areas. Carbon storage in areas converted to urban open space and other urban uses will likely be much smaller after conversion.

area (see Table 5, above). However, and as noted briefly in the Executive Summary, such a rich set of per-acre ecosystem service values is not available in the literature. There are estimates specific to forests and to wetlands, but few specific to wetland forests.

Moore, et al. (2011), and Schmidt, Moore, and Alber (2014), do find that for non-timber ecosystem services, the productivity of wetland forests can be greater than for upland forests. Moreover, it stands to reason that conservation areas, SMZs, and ecological forestry areas that, almost by definition, are managed for a range of ecosystem service values beyond timber, would have higher ecosystem service productivity then areas in intensive, timber-focused forest management. The exception, of course, is the ecosystem service value of raw materials, especially timber, for which intensive forest management would be expected to be more productive.

These insights suggest the assumptions we employ in this study to bridge the gap between available data and the objective of estimating the ecosystem service value of *wetland* forests in alternative land use/land management categories in our scenarios. Specifically, we make the following assumptions regarding the relative ecosystem service productivity of the various land use/land management classes in our scenarios:

- Protected areas, areas in benign neglect, and SMZs in the conservation scenario (none of which experience active timber management) produce more value per acre per year of most ecosystem services than areas open to timber harvest. The exception is raw material, for which ecosystem service productivity is zero.
- SMZs in the baseline and BAU scenarios, in which timber harvest is possible, will produce less value for most ecosystem services each year than protected (and other no-harvest) areas, but more raw material/timber value than those areas. Raw material/timber value will be less in SMZs in these scenarios than for areas outside SMZs and available for timber harvest.
- Areas allocated to ecological forestry produce more of most ecosystem service value per acre than areas allocated to intensive forestry or pine plantations. Intensive forestry areas and pine plantations produce more raw material value than areas in ecological forestry.
- No assumptions are necessary for areas converted to urban open space and other urban uses: each of those land use/land management categories has its own set of per-acre ecosystem service productivity estimates.

Table 5. Description of Ecosystem Services Included in the Study

Provisioning Services[a]
Food Production: The harvest of agricultural produce, including crops, livestock, and livestock by-products; the food value of hunting, fishing, etc.
Raw Materials: Fuel, fiber, fertilizer, minerals, and energy.
Water Supply: Filtering, retention, storage, and delivery of fresh water—both quality and quantity—for drinking, watering livestock, irrigation, industrial processes, hydroelectric generation, and other uses.
Regulating Services[a]
Air Quality: Removing impurities from the air to provide healthy, breathable air for people.
Climate Regulation: Storing atmospheric carbon in biomass and soil as an aid to the mitigation of climate change, and/or keeping regional/local climate (temperature, humidity, rainfall, etc.) within comfortable ranges.
Erosion Control: Retaining arable land, stabilizing slopes, shorelines, riverbanks, etc.
Pollination: Contribution of insects, birds, bats, and other organisms to pollen transport resulting in the production of fruit and seeds. May also include seed and fruit dispersal.
Protection from Extreme Events: Preventing and mitigating impacts on human life, health, and property by attenuating the force of winds, extreme weather events, floods, etc.
Soil Formation: Creation of soil, inducing changes in depth, structure, and fertility, including through nutrient cycling.
Waste Treatment: Improving soil and water quality through the breakdown and/or immobilization of pollution.
Water Flows: Regulation by land cover of the timing of runoff and river discharge, resulting in less severe drought, flooding, and other consequences of too much or too little water available at the wrong time or place.
Cultural Services[a]
Aesthetic Value: The role that beautiful, healthy natural areas play in attracting people to live, work, and recreate in a region.
Recreation: The availability of a variety of safe and pleasant landscapes—such as clean water and healthy shorelines—that encourage ecotourism, outdoor sports, fishing, wildlife watching, hunting, etc.

Notes:
a. Descriptions follow Balmford (2010, 2013), Costanza et al. (1997), Reid et al. (2005), and Van der Ploeg, et al. (2010).

Table 6, below, embodies these assumptions and states more explicitly, which part of the range of available ecosystem service productivity estimates we have applied in making our estimates of aggregate value per year. We draw the range of candidate ecosystem-service-productivity values from from the TEEB database (Van der Ploeg, et al., 2010), from additional studies identified in Phillips and McGee (2014, 2016), and from further literature review undertaken to update those earlier sets of productivity estimates.

Table 6. Rubric for Applying Ecosystem Service Productivity Values, by Land Use/Land Management Category, Scenario, and Ecosystem Service Group.

"Average" means "Average of the range of available values for combinations of ecosystem service and land use. "Minimum" means the minimum of the same range, and "Maximum" means the maximum of the range. Candidate values for all land use/land management categories except "converted to non-forest use" were drawn from source studies of forests and wetlands. Values for "Converted to non-forest use" are drawn from source studies of urban open space and and of other urban land. (Urban open space and Other urban land have separate estimates.)

Land Use / Land Management Category	Ecosystem Service Productivity (value per acres per)					
	Baseline		Business as Usual		Conservation	
	Raw Materials	Other Ecosystem Services	Raw Materials	Other Ecosystem Services	Raw Materials	Other Ecosystem Services
Protected Areas	*0*	*Average*	*0*	*Average*	*0*	*Average*
Added to Protected Areas	*0*	*Average*	*0*	*Average*	*0*	*Average*
Converted to non-forest use	*0*	*Average*	*0*	*Average*	*0*	*Average*
SMZs outside protected areas	*Minimum*	*Average*	*Minimum*	*Average*	*0*	*Average*
Ecological Forestry (outside SMZ)	*Average*	*Average*	*Average*	*Average*	*Average*	*Average*
Intensive Forestry (outside SMZ)	*Maximum*	*Minimum*	*Maximum*	*Minimum*	*Maximum*	*Minimum*
Plantation Forestry (outside SMZ)	*Maximum*	*Minimum*	*Maximum*	*Minimum*	*Maximum*	*Minimum*
Benign Neglect	*0*	*Average*	*0*	*Average*	*0*	*Average*

From the full list of available estimates, and keeping with standard BTM practice, we selected individual per-unit-area estimates that came from study areas that are substantially like our policy area. So for example, we eschewed estimates from studies focused on resources in lower-income countries as well as those for exceptionally high income areas in the U.S. We also avoided the oldest studies, some of which were published in the 1970s, and those with estimates that were grossly out of line (and larger than the norm) for similar pairings of land use and and ecosystem service. Remaining are 176 estimates of per-acre-per-year ecosystem service value covering all combinations of wetland forest and ecosystem service and, for urban areas, 6 of the 13 ecosystem services. (Where no productivity estimate is available, such as for soil formation in urban areas, no aggregate value estimate is possible, leading to some underestimation of total ecosystem service value for wetland forests that, according to our scenarios, are converted to urban uses.) The full list of the candidate values is provided in Appendix 2.

With the per-acre productivity proxies in hand, aggregate ecosystem service value for each scenario are calculated according to the formula:

$$ESV = \sum_{i,j} [(Acres_j) \times (\$/acre/year)_{i,j})]$$

Where:

$Acres_j$	the number of acres in land use/land management category (j) in the scenario
$(\$/acre/year)_{i,j}$	the dollar value of each ecosystem service (i) provided from each land use (j) each year. These values are drawn from the TEEB database and other sources listed in Appendix 2 and filtered through the rubric described by Table 6, above.

Differences in this aggregate ecosystem service between the baseline and alternative future scenarios can be interpreted as the benefits (since the changes are positive) of changes in land use and land management embodied in those scenarios.

Ecosystem Service Estimates

In our baseline case, 35.1 million acres of wetland forests generate $503.8 per year in ecosystem service value per year (2016$). (See Tables 7 and 8, below.) Most of these acres and most of this value is in areas currently unprotected from development and open to forest management. In the Business-as-Usual Scenario, in which we assume that half of SECAS-identified high priority conservation lands are placed into protective ownership/management, there is a shift of $118.1 billion per year in value into the protected areas category. In the Conservation scenario, there is a further shift of acreage, and therefore value, into the protected area category. Thus, by 2050, there could be as much as $287.3 billion provided by protected wetland forest areas.

Another important driver of differences among the scenarios is the SMZs outside of protected areas. This increase is due to the fact that the SMZs are wider in the conservation scenario. The the increase in value occurs despite the assumption of no commercial harvest within SMZs in that scenario. *forest* acres and lost ES value *derived from wetland forests*, relative to the baseline. Acres gained, and value generated on those newly urbanized acres, represent acres lost and (greater) value no longer generated by wetland forests.

Of the total ES value in all scenarios approximately 20% of total ecosystem service value is due to aesthetic value. Protection from extreme events, water flow regulation, and food production supply about 15% each, and water supply and waste treatment contribute up 11.7 and 11.2 percent, respectively, of the total. The balance of ecosystem service value is delivered as air purification, climate regulation, erosion control, pollination, raw materials (timber), recreation, and soil formation. (See Table 8.)

Table 7. Estimated Ecosystem Service Value for Wetland Forest in the U.S. South, by Land Use/Land Management Category and Scenario

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**35,068,824**	**503,850.0**	**35,068,824**	**526,873.0**	**35,068,824**	**549,121.6**
Protected Areas (GAP 1&2)	*2,812,908*	*51,075.5*	*9,289,324*	*169,201.9*	*15,765,740*	*287,328.3*
Protected in Baseline	2,812,908	51,075.5	2,812,908	51,075.5	2,812,908	51,075.5
Added in Scenario	0	0.0	6,476,416	118,126.4	12,952,832	236,252.8
Converted to Urban Uses	*0*	*0.0*	*407,334*	*1,425.7*	*362,937*	*1,270.3*
Urban Open Space	0	0.0	246,475	828.1	219,611	737.8
Urban Other	0	0.0	160,859	597.6	143,326	532.5
SMZs outside protected areas	*1,740,732*	*31,617.5*	*1,415,374*	*25,708.6*	*3,704,284*	*67,260.7*
SMZs w/in protected areas (a)	70,874	(a)	377,953	(a)	2,216,129	(a)
Available for timber harvest	*30,515,184*	*421,156.9*	*23,956,791*	*330,536.8*	*15,235,862*	*193,262.3*
Ecological Forestry	453,776	8,276.6	890,188	16,236.6	1,032,274	18,828.1
Intensive Forestry	7,826,391	9,146.8	5,845,378	6,831.6	4,667,465	5,454.9
Plantation Forestry	0	0.0	307,651	359.6	245,656	287.1
Benign Neglect	22,235,017	403,733.5	16,913,573	307,109.1	9,290,466	168,692.1

Notes:

a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.

Note that differences in ES value for both "converted to urban uses" and "plantation forestry" between the Baseline and the other scenarios does not suggest that conversion of land to those uses increases ES value. Rather, it is an artifact of the baseline situation in which all acres are wetland forests and none of that acreage has yet been converted. Acres gained, and ES value generated by urbanized acres actually represent lost *wetland* **Table 8. Estimated Ecosystem Service Value for Wetland Forest in the U.S. South, by Ecosystem Service and Scenario**

		Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)
Total:		**503,850.0**	**526,873.0**	**549,121.6**
	Aesthetic Value	101,893.1	106,982.9	111,729.7
	Air Quality	4,262.2	4,332.5	4,407.2
	Climate Regulation	12,438.8	13,338.4	13,888.2
	Erosion Control	1,947.1	2,031.2	2,118.0
	Protection from Extreme Events	77,151.4	80,623.6	84,068.8
	Food	70,682.5	73,955.5	77,278.3
	Pollination	2,079.1	2,172.8	2,268.5
	Raw Materials	1,370.8	1,652.9	1,976.5
	Recreation	24,135.4	25,689.9	26,778.2
	Soil Formation	18,794.9	18,576.5	18,600.3
	Waste Treatment	56,215.5	58,810.1	61,446.2
	Water Supply	59,135.1	61,981.6	64,738.4
	Water Flow Regulation	73,744.0	76,725.2	79,823.4

Conclusions

The study methods and ecosystem service value estimates presented here represent a first approximation of the value currently supplied by wetland forests in the U.S. South. Our model also shows that significant gains in economic value–which at its root reflects better conditions in natural systems–could be obtained through strategies to protect wetland forests already identified as high priorities for conservation and to manage key components (e.g., SMZs) of the majority of wetland forests that will remain part of the region's working landscape in ways that emphasize and enhance their important ecosystem service contributions.

An important lesson of this effort, however, is that there is much that is not known about the value of wetland forests, particularly in contrast to other forest types and, within the wetland forest type, among different management regimes. Our model has relied on what we regard as reasonable assumptions to develop estimates that are qualitatively sensible, but we would not be surprised to learn from future research that the ecosystem service value of particular areas or even the region as a whole is different than what we have estimated.

The most fruitful path, we imagine, for next research steps would involve downscaling our modeling approach to utilize spatial information on sub-classes of wetland forests, such as mangroves, or on smaller areas for which per-acre ecosystem service productivity would be influenced by proximity to population centers, infrastructure, and/or other natural resources for which wetland forests provide more or less of different ecosystem services than the broad ranges and averages employed in our method would suggest.

Meanwhile, it is our hope that this study will provide, at minimum, a means of advancing conversations about both how to ensure the future of wetland forest and the human values that depend on them and how to advance essential knowledge about the magnitude of those values for planning purposes.

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APPENDIX 1: State-by-State Estimates

(Tables begin next page)

For each of 14 states, Table xx-1 (where “xx” is the state abbreviation) shows acreage and ecosystem service value for each land use-land management category and for each scenario (baseline, business-as-usual, and conservation). Table xx-2 shows ecosystem service value, by ecosystem service, for each scenario. All dollar values reflect 2016 price levels, and all dollar-values are values generated per year.

Alabama

Table AL-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Alabama

Land use / Land Management Category	Baseline (2016) Acres	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Acres	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Acres	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**2,196,499**	**34,370**	**2,196,499**	**35,522**	**2,196,499**	**36,660**
Protected Areas (GAP 1&2)	*90,608*	*1,645*	*589,967*	*10,753*	*1,089,327*	*19,861*
Protected in Baseline	90,608	1,645	90,608	1,645	90,608	1,645
Added in Scenario	0	0	499,360	9,108	998,719	18,216
Converted to Urban Uses	*0*	*0*	*9,233*	*32*	*8,108*	*28*
Urban Open Space	0	0	5,587	19	4,906	16
Urban Other	0	0	3,646	14	3,202	12
SMZs outside protected areas	*138,055*	*2,507*	*111,085*	*2,018*	*317,625*	*5,767*
SMZs w/in protected areas (a)	1,982	(a)	28,281	(a)	211,097	(a)
Available for timber harvest	*1,967,835*	*30,218*	*1,486,213*	*22,719*	*781,439*	*11,003*
Ecological Forestry	45,514	830	61,738	1,126	59,359	1,083
Intensive Forestry	324,736	380	238,875	279	178,453	209
Plantation Forestry	0	0	12,572	15	9,392	11
Benign Neglect	1,597,586	29,008	1,173,027	21,299	534,234	9,700
Notes:						

a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.

Table AL-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Alabama.

	Baseline (2016)	Business as Usual (2050)	Conservation (2050)
Ecosystem Service	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)
Total:	**34,370**	**35,522**	**36,660**
Aesthetic Value	6,999	7,246	7,486
Air Quality	277	280	284
Climate Regulation	854	891	920
Erosion Control	133	137	142
Protection from Extreme Events	5,277	5,451	5,625
Food	4,855	5,021	5,188
Pollination	143	147	152
Raw Materials	59	89	118
Recreation	1,658	1,725	1,781
Soil Formation	1,177	1,172	1,173
Waste Treatment	3,861	3,992	4,125
Water Supply	4,061	4,201	4,341
Water Flow Regulation	5,017	5,170	5,326

Arkansas

Table AR-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Arkansas

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**2,491,063**	**37,430**	**2,491,063**	**38,852**	**2,491,063**	**40,272**
Protected Areas (GAP 1&2)	*459,387*	*8,341*	*891,769*	*16,228*	*1,324,152*	*24,114*
Protected in Baseline	459,387	8,341	459,387	8,341	459,387	8,341
Added in Scenario	0	0	432,383	7,886	864,765	15,773
Converted to Urban Uses	*0*	*0*	*3,126*	*11*	*3,006*	*11*
Urban Open Space	0	0	1,892	6	1,819	6
Urban Other	0	0	1,235	5	1,187	4
SMZs outside protected areas	*168,937*	*3,069*	*137,079*	*2,490*	*248,979*	*4,521*
SMZs w/in protected areas (a)	17,268	(a)	48,798	(a)	196,834	(a)
Available for timber harvest	*1,862,739*	*26,020*	*1,459,088*	*20,124*	*914,925*	*11,626*
Ecological Forestry	93,439	1,704	81,282	1,483	62,111	1,133
Intensive Forestry	459,759	537	356,561	417	279,123	326
Plantation Forestry	0	0	18,766	22	14,691	17
Benign Neglect	1,309,542	23,778	1,002,479	18,203	559,001	10,150
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table AR-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Arkansas.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**37,430**	**38,852**	**40,272**
Aesthetic Value	7,596	7,902	8,206
Air Quality	308	313	318
Climate Regulation	927	967	1,004
Erosion Control	145	150	156
Protection from Extreme Events	5,739	5,958	6,177
Food	5,270	5,480	5,691
Pollination	155	161	167
Raw Materials	86	106	126
Recreation	1,799	1,875	1,947
Soil Formation	1,335	1,333	1,333
Waste Treatment	4,191	4,357	4,525
Water Supply	4,408	4,584	4,760
Water Flow Regulation	5,470	5,665	5,861

Florida

Table FL-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Florida

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**5,361,255**	**80,797**	**5,361,255**	**84,664**	**5,361,255**	**88,306**
Protected Areas (GAP 1&2)	*665,867*	*12,091*	*1,776,665*	*32,351*	*2,887,464*	*52,611*
Protected in Baseline	665,867	12,091	665,867	12,091	665,867	12,091
Added in Scenario	0	0	1,110,798	20,260	2,221,597	40,521
Converted to Urban Uses	*0*	*0*	*100,699*	*352*	*87,675*	*307*
Urban Open Space	0	0	60,932	205	53,052	178
Urban Other	0	0	39,767	148	34,624	129
SMZs outside protected areas	*87,936*	*1,597*	*66,953*	*1,216*	*196,376*	*3,566*
SMZs w/in protected areas (a)	7,616	(a)	25,894	(a)	183,717	(a)
Available for timber harvest	*4,607,453*	*67,109*	*3,416,938*	*50,745*	*2,189,740*	*31,822*
Ecological Forestry	22,162	404	137,562	2,509	172,164	3,140
Intensive Forestry	974,316	1,139	632,413	739	444,693	520
Plantation Forestry	0	0	33,285	39	23,405	27
Benign Neglect	3,610,974	65,566	2,613,678	47,458	1,549,478	28,135

Notes:

a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.

Table FL-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Florida.

	Baseline (2016)	Business as Usual (2050)	Conservation (2050)
Ecosystem Service	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)
Total:	**80,797**	**84,664**	**88,306**
Aesthetic Value	16,405	17,272	18,045
Air Quality	664	676	688
Climate Regulation	2,003	2,177	2,263
Erosion Control	313	326	341
Protection from Extreme Events	12,392	12,968	13,532
Food	11,381	11,918	12,463
Pollination	334	350	365
Raw Materials	167	215	275
Recreation	3,886	4,178	4,350
Soil Formation	2,873	2,819	2,826
Waste Treatment	9,050	9,476	9,908
Water Supply	9,520	9,997	10,447
Water Flow Regulation	11,809	12,293	12,802

Georgia

Table GA-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Georgia

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**4,371,809**	**67,313**	**4,371,809**	**68,818**	**4,371,809**	**70,096**
Protected Areas (GAP 1&2)	*380,048*	*6,901*	*895,236*	*16,297*	*1,410,423*	*25,694*
Protected in Baseline	380,048	6,901	380,048	6,901	380,048	6,901
Added in Scenario	0	0	515,187	9,397	1,030,374	18,793
Converted to Urban Uses	*0*	*0*	*104,518*	*366*	*93,556*	*327*
Urban Open Space	0	0	63,243	212	56,610	190
Urban Other	0	0	41,275	153	36,946	137
SMZs outside protected areas	*124,486*	*2,261*	*105,636*	*1,919*	*608,374*	*11,047*
SMZs w/in protected areas (a)	2,228	(a)	18,186	(a)	229,345	(a)
Available for timber harvest	*3,867,275*	*58,152*	*3,266,420*	*50,236*	*2,259,457*	*33,028*
Ecological Forestry	12,943	236	136,583	2,491	178,778	3,261
Intensive Forestry	710,443	830	508,026	594	448,090	524
Plantation Forestry	0	0	26,738	31	23,584	28
Benign Neglect	3,143,889	57,085	2,595,073	47,120	1,609,005	29,216
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table GA-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Georgia.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**67,313**	**68,818**	**70,096**
Aesthetic Value	13,691	14,051	14,317
Air Quality	547	550	554
Climate Regulation	1,671	1,787	1,812
Erosion Control	261	265	270
Protection from Extreme Events	10,331	10,540	10,737
Food	9,498	9,681	9,873
Pollination	279	284	290
Raw Materials	122	144	179
Recreation	3,243	3,418	3,472
Soil Formation	2,343	2,287	2,293
Waste Treatment	7,552	7,697	7,850
Water Supply	7,944	8,127	8,284
Water Flow Regulation	9,832	9,986	10,166

Kentucky

Table KY-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Kentucky

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**179,959**	**1,911**	**179,959**	**2,155**	**179,959**	**2,399**
Protected Areas (GAP 1&2)	*16,211*	*294*	*49,201*	*896*	*82,191*	*1,498*
Protected in Baseline	16,211	294	16,211	294	16,211	294
Added in Scenario	0	0	32,990	602	65,980	1,203
Converted to Urban Uses	*0*	*0*	*1,237*	*4*	*955*	*3*
Urban Open Space	0	0	749	3	578	2
Urban Other	0	0	489	2	377	1
SMZs outside protected areas	*14,968*	*272*	*11,724*	*213*	*22,604*	*410*
SMZs w/in protected areas (a)	944	(a)	4,038	(a)	18,988	(a)
Available for timber harvest	*148,780*	*1,344*	*117,796*	*1,042*	*74,209*	*487*
Ecological Forestry	1,385	25	2,660	49	2,355	43
Intensive Forestry	79,897	93	61,363	72	48,126	56
Plantation Forestry	0	0	3,230	4	2,533	3
Benign Neglect	67,498	1,226	50,543	918	21,195	385

Notes:

a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.

Table KY-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Kentucky.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**1,911**	**2,155**	**2,399**
Aesthetic Value	375	428	481
Air Quality	20	20	21
Climate Regulation	46	53	59
Erosion Control	7	8	9
Protection from Extreme Events	289	327	365
Food	260	296	333
Pollination	8	9	10
Raw Materials	14	14	14
Recreation	89	102	115
Soil Formation	96	96	96
Waste Treatment	207	236	265
Water Supply	218	248	279
Water Flow Regulation	283	316	351

Louisiana

Table LA-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Louisiana

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**5,231,118**	**79,426**	**5,231,118**	**82,700**	**5,231,118**	**85,959**
Protected Areas (GAP 1&2)	*244,379*	*4,437*	*1,422,930*	*25,933*	*2,601,482*	*47,430*
Protected in Baseline	244,379	4,437	244,379	4,437	244,379	4,437
Added in Scenario	0	0	1,178,551	21,496	2,357,103	42,992
Converted to Urban Uses	*0*	*0*	*6,580*	*23*	*5,738*	*20*
Urban Open Space	0	0	3,982	13	3,472	12
Urban Other	0	0	2,599	10	2,266	8
SMZs outside protected areas	*242,374*	*4,402*	*185,232*	*3,364*	*301,813*	*5,480*
SMZs w/in protected areas (a)	14,782	(a)	71,362	(a)	290,402	(a)
Available for timber harvest	*4,744,365*	*70,587*	*3,616,375*	*53,380*	*2,322,086*	*33,029*
Ecological Forestry	173,394	3,163	216,916	3,956	178,356	3,253
Intensive Forestry	916,673	1,071	687,959	804	511,597	598
Plantation Forestry	0	0	36,208	42	26,926	31
Benign Neglect	3,654,297	66,353	2,675,292	48,577	1,605,206	29,147
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table LA-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Louisiana.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**79,426**	**82,700**	**85,959**
Aesthetic Value	16,134	16,833	17,527
Air Quality	650	661	672
Climate Regulation	1,970	2,060	2,144
Erosion Control	307	320	332
Protection from Extreme Events	12,183	12,684	13,185
Food	11,192	11,673	12,156
Pollination	329	343	357
Raw Materials	170	238	299
Recreation	3,822	3,993	4,157
Soil Formation	2,804	2,800	2,801
Waste Treatment	8,900	9,282	9,664
Water Supply	9,362	9,765	10,167
Water Flow Regulation	11,604	12,050	12,499

Mississippi

Table MS-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Mississippi

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**3,502,004**	**51,044**	**3,502,004**	**53,169**	**3,502,004**	**55,239**
Protected Areas (GAP 1&2)	*172,543*	*3,133*	*897,343*	*16,353*	*1,622,142*	*29,573*
Protected in Baseline	172,543	3,133	172,543	3,133	172,543	3,133
Added in Scenario	0	0	724,799	13,220	1,449,598	26,440
Converted to Urban Uses	*0*	*0*	*25,864*	*91*	*22,019*	*77*
Urban Open Space	0	0	15,650	53	13,324	45
Urban Other	0	0	10,214	38	8,696	32
SMZs outside protected areas	*164,550*	*2,989*	*134,712*	*2,447*	*467,321*	*8,485*
SMZs w/in protected areas (a)	3,956	(a)	32,549	(a)	278,565	(a)
Available for timber harvest	*3,164,910*	*44,923*	*2,444,085*	*34,278*	*1,390,522*	*17,104*
Ecological Forestry	37,123	677	92,455	1,686	91,067	1,661
Intensive Forestry	738,564	863	565,226	661	455,857	533
Plantation Forestry	0	0	29,749	35	23,992	28
Benign Neglect	2,389,223	43,382	1,756,654	31,897	819,605	14,882

Notes:

a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.

Table MS-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Mississippi.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**51,044**	**53,169**	**55,239**
Aesthetic Value	10,335	10,798	11,238
Air Quality	428	435	442
Climate Regulation	1,262	1,336	1,387
Erosion Control	197	205	213
Protection from Extreme Events	7,820	8,141	8,460
Food	7,170	7,474	7,782
Pollination	211	220	228
Raw Materials	129	168	207
Recreation	2,448	2,580	2,681
Soil Formation	1,877	1,863	1,865
Waste Treatment	5,702	5,943	6,188
Water Supply	5,998	6,259	6,515
Water Flow Regulation	7,468	7,747	8,034

Missouri

Table MO-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Missouri

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**692,427**	**7,736**	**692,427**	**8,362**	**692,427**	**8,986**
Protected Areas (GAP 1&2)	*103,782*	*1,884*	*191,341*	*3,481*	*278,899*	*5,078*
Protected in Baseline	103,782	1,884	103,782	1,884	103,782	1,884
Added in Scenario	0	0	87,558	1,597	175,117	3,194
Converted to Urban Uses	*0*	*0*	*1,216*	*4*	*1,176*	*4*
Urban Open Space	0	0	736	2	711	2
Urban Other	0	0	480	2	464	2
SMZs outside protected areas	*90,576*	*1,646*	*81,212*	*1,476*	*175,533*	*3,187*
SMZs w/in protected areas (a)	5,316	(a)	14,551	(a)	63,686	(a)
Available for timber harvest	*498,069*	*4,206*	*418,658*	*3,401*	*236,819*	*716*
Ecological Forestry	64	1	8,567	156	2,582	47
Intensive Forestry	284,763	333	234,950	275	200,446	234
Plantation Forestry	0	0	12,366	14	10,550	12
Benign Neglect	213,243	3,872	162,776	2,956	23,241	422
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table MO-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Missouri.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**7,736**	**8,362**	**8,986**
Aesthetic Value	1,526	1,663	1,798
Air Quality	77	79	81
Climate Regulation	186	204	220
Erosion Control	30	32	35
Protection from Extreme Events	1,173	1,271	1,369
Food	1,059	1,152	1,246
Pollination	31	34	37
Raw Materials	49	51	50
Recreation	361	395	427
Soil Formation	371	370	370
Waste Treatment	843	917	992
Water Supply	887	965	1,044
Water Flow Regulation	1,143	1,230	1,317

North Carolina

Table NC-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for North Carolina

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**2,415,774**	**26,939**	**2,415,774**	**29,526**	**2,415,774**	**32,063**
Protected Areas (GAP 1&2)	*161,613*	*2,935*	*520,080*	*9,473*	*878,548*	*16,011*
Protected in Baseline	161,613	2,935	161,613	2,935	161,613	2,935
Added in Scenario	0	0	358,467	6,538	716,935	13,077
Converted to Urban Uses	*0*	*0*	*33,857*	*118*	*30,092*	*105*
Urban Open Space	0	0	20,487	69	18,209	61
Urban Other	0	0	13,370	50	11,884	44
SMZs outside protected areas	*165,978*	*3,015*	*140,464*	*2,552*	*324,789*	*5,897*
SMZs w/in protected areas (a)	2,166	(a)	25,285	(a)	134,920	(a)
Available for timber harvest	*2,088,182*	*20,989*	*1,721,372*	*17,383*	*1,182,345*	*10,049*
Ecological Forestry	9,280	169	45,229	825	50,993	930
Intensive Forestry	996,395	1,164	775,953	907	638,796	747
Plantation Forestry	0	0	40,840	48	33,621	39
Benign Neglect	1,082,507	19,656	859,350	15,604	458,935	8,333
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table NC-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, North Carolina.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**26,939**	**29,526**	**32,063**
Aesthetic Value	5,315	5,889	6,437
Air Quality	267	275	284
Climate Regulation	649	742	806
Erosion Control	103	113	123
Protection from Extreme Events	4,085	4,483	4,881
Food	3,686	4,063	4,446
Pollination	109	120	131
Raw Materials	171	173	177
Recreation	1,258	1,423	1,550
Soil Formation	1,295	1,277	1,279
Waste Treatment	2,934	3,233	3,537
Water Supply	3,088	3,412	3,730
Water Flow Regulation	3,979	4,325	4,682

Oklahoma

Table OK-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Oklahoma

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**157,666**	**1,726**	**157,666**	**1,785**	**157,666**	**1,843**
Protected Areas (GAP 1&2)	*29,328*	*533*	*38,348*	*697*	*47,369*	*862*
Protected in Baseline	29,328	533	29,328	533	29,328	533
Added in Scenario	0	0	9,021	165	18,041	329
Converted to Urban Uses	*0*	*0*	*192*	*1*	*176*	*1*
Urban Open Space	0	0	116	0	106	0
Urban Other	0	0	76	0	69	0
SMZs outside protected areas	*13,246*	*241*	*12,372*	*225*	*32,909*	*598*
SMZs w/in protected areas (a)	1,257	(a)	2,121	(a)	9,031	(a)
Available for timber harvest	*115,092*	*953*	*106,754*	*862*	*77,212*	*383*
Ecological Forestry	67	1	2,170	40	1,724	31
Intensive Forestry	66,919	78	60,177	70	56,970	67
Plantation Forestry	0	0	3,167	4	2,998	4
Benign Neglect	48,106	873	41,239	749	15,520	282
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table OK-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Oklahoma.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**1,726**	**1,785**	**1,843**
Aesthetic Value	340	353	365
Air Quality	17	18	18
Climate Regulation	41	43	45
Erosion Control	7	7	7
Protection from Extreme Events	262	271	280
Food	236	244	253
Pollination	7	7	7
Raw Materials	11	12	12
Recreation	80	84	87
Soil Formation	84	84	84
Waste Treatment	188	195	202
Water Supply	197	205	212
Water Flow Regulation	255	263	271

South Carolina

Table SC-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for South Carolina

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**3,152,309**	**39,610**	**3,152,309**	**42,206**	**3,152,309**	**44,684**
Protected Areas (GAP 1&2)	*148,875*	*2,703*	*636,013*	*11,588*	*1,123,152*	*20,473*
Protected in Baseline	148,875	2,703	148,875	2,703	148,875	2,703
Added in Scenario	0	0	487,139	8,885	974,277	17,770
Converted to Urban Uses	*0*	*0*	*55,184*	*193*	*50,131*	*175*
Urban Open Space	0	0	33,392	112	30,334	102
Urban Other	0	0	21,793	81	19,797	74
SMZs outside protected areas	*127,572*	*2,317*	*108,973*	*1,980*	*320,677*	*5,823*
SMZs w/in protected areas (a)	2,652	(a)	19,749	(a)	130,952	(a)
Available for timber harvest	*2,875,863*	*34,589*	*2,352,139*	*28,444*	*1,658,349*	*18,213*
Ecological Forestry	40,803	744	75,606	1,379	95,749	1,746
Intensive Forestry	1,037,899	1,213	798,011	933	665,816	778
Plantation Forestry	0	0	42,001	49	35,043	41
Benign Neglect	1,797,161	32,632	1,436,521	26,084	861,741	15,647
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table SC-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, South Carolina.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**39,610**	**42,206**	**44,684**
Aesthetic Value	7,913	8,495	9,028
Air Quality	364	372	380
Climate Regulation	966	1,075	1,136
Erosion Control	152	162	172
Protection from Extreme Events	6,036	6,429	6,816
Food	5,488	5,857	6,230
Pollination	162	173	183
Raw Materials	180	189	206
Recreation	1,874	2,059	2,181
Soil Formation	1,689	1,660	1,663
Waste Treatment	4,367	4,659	4,955
Water Supply	4,595	4,918	5,228
Water Flow Regulation	5,824	6,159	6,506

Tennessee

Table TN-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Tennessee

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**626,865**	**7,829**	**626,865**	**8,295**	**626,865**	**8,754**
Protected Areas (GAP 1&2)	*106,375*	*1,932*	*189,466*	*3,447*	*272,558*	*4,963*
Protected in Baseline	106,375	1,932	106,375	1,932	106,375	1,932
Added in Scenario	0	0	83,092	1,516	166,183	3,031
Converted to Urban Uses	*0*	*0*	*5,793*	*20*	*5,009*	*18*
Urban Open Space	0	0	3,505	12	3,031	10
Urban Other	0	0	2,288	8	1,978	7
SMZs outside protected areas	*25,412*	*462*	*20,951*	*381*	*88,717*	*1,611*
SMZs w/in protected areas (a)	1,947	(a)	5,895	(a)	52,737	(a)
Available for timber harvest	*495,078*	*5,436*	*410,654*	*4,447*	*260,580*	*2,163*
Ecological Forestry	3,574	65	11,674	213	10,934	199
Intensive Forestry	209,175	244	168,318	197	143,680	168
Plantation Forestry	0	0	8,859	10	7,562	9
Benign Neglect	282,329	5,126	221,804	4,027	98,404	1,787
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table TN-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Tennessee.

	Baseline (2016)	Business as Usual (2050)	Conservation (2050)
Ecosystem Service	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)
Total:	**7,829**	**8,295**	**8,754**
Aesthetic Value	1,563	1,666	1,765
Air Quality	72	74	75
Climate Regulation	191	207	219
Erosion Control	30	32	34
Protection from Extreme Events	1,193	1,264	1,336
Food	1,084	1,152	1,221
Pollination	32	34	36
Raw Materials	36	38	40
Recreation	370	400	422
Soil Formation	336	333	333
Waste Treatment	863	916	971
Water Supply	908	966	1,023
Water Flow Regulation	1,151	1,214	1,278

Texas

Table TX-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Texas

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**3,761,857**	**53,850**	**3,761,857**	**56,302**	**3,761,857**	**58,730**
Protected Areas (GAP 1&2)	*166,676*	*3,026*	*924,912*	*16,856*	*1,683,147*	*30,686*
Protected in Baseline	166,676	3,026	166,676	3,026	166,676	3,026
Added in Scenario	0	0	758,235	13,830	1,516,471	27,660
Converted to Urban Uses	*0*	*0*	*16,340*	*57*	*14,813*	*52*
Urban Open Space	0	0	9,887	33	8,963	30
Urban Other	0	0	6,453	24	5,850	22
SMZs outside protected areas	*274,981*	*4,995*	*227,236*	*4,128*	*481,039*	*8,734*
SMZs w/in protected areas (a)	7,142	(a)	53,475	(a)	275,519	(a)
Available for timber harvest	*3,320,200*	*45,829*	*2,593,369*	*35,261*	*1,582,858*	*19,258*
Ecological Forestry	35,554	648	94,833	1,730	102,416	1,868
Intensive Forestry	851,179	995	661,877	774	530,766	620
Plantation Forestry	0	0	34,836	41	27,935	33
Benign Neglect	2,433,466	44,186	1,801,824	32,717	921,741	16,737
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table TX-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Texas.

	Baseline (2016)	Business as Usual (2050)	Conservation (2050)
Ecosystem Service	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)	Ecosystem Service Value per Year (millions of 2016$)
Total:	**53,850**	**56,302**	**58,730**
Aesthetic Value	10,887	11,417	11,935
Air Quality	457	464	473
Climate Regulation	1,329	1,405	1,467
Erosion Control	208	217	227
Protection from Extreme Events	8,245	8,619	8,994
Food	7,552	7,909	8,270
Pollination	222	232	243
Raw Materials	148	189	227
Recreation	2,579	2,718	2,840
Soil Formation	2,016	2,007	2,008
Waste Treatment	6,006	6,290	6,576
Water Supply	6,318	6,621	6,921
Water Flow Regulation	7,883	8,212	8,548

Virginia

Table VA-1. Acreage and Ecosystem Service Value, by Land Use/Land Management Category and Scenario for Virginia

Land use / Land Management Category	Baseline (2016)		Business as Usual (2050)		Conservation (2050)	
	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)	Acres	Ecosystem Service Value per Year (millions of 2016$)
Wetland Forest Total:	**927,924**	**13,870**	**927,924**	**14,523**	**927,924**	**15,131**
Protected Areas (GAP 1&2)	*67,211*	*1,220*	*266,047*	*4,847*	*464,883*	*8,474*
Protected in Baseline	67,211	1,220	67,211	1,220	67,211	1,220
Added in Scenario	0	0	198,836	3,627	397,672	7,253
Converted to Urban Uses	*0*	*0*	*43,496*	*152*	*40,483*	*142*
Urban Open Space	0	0	26,319	88	24,496	82
Urban Other	0	0	17,177	64	15,987	59
SMZs outside protected areas	*101,661*	*1,846*	*71,742*	*1,303*	*117,527*	*2,134*
SMZs w/in protected areas (a)	1,618	(a)	27,770	(a)	140,337	(a)
Available for timber harvest	*759,052*	*10,803*	*546,640*	*8,221*	*305,031*	*4,382*
Ecological Forestry	10,739	196	22,309	407	23,681	432
Intensive Forestry	175,436	205	95,436	112	64,812	76
Plantation Forestry	0	0	5,023	6	3,411	4
Benign Neglect	572,878	10,402	423,871	7,696	213,127	3,870
Notes:						
a. Acreage and ecosystem service value in SMZ's that are also within protected areas are included in the subtotals for Protected Areas. Acreage is provided here for reference.						

Table VA-2: Ecosystem Service Value of Wetland Forests, by Ecosystem Service and Scenario, Virginia.

Ecosystem Service	Baseline (2016) Ecosystem Service Value per Year (millions of 2016$)	Business as Usual (2050) Ecosystem Service Value per Year (millions of 2016$)	Conservation (2050) Ecosystem Service Value per Year (millions of 2016$)
Total:	**13,870**	**14,523**	**15,131**
Aesthetic Value	2,814	2,971	3,100
Air Quality	115	116	118
Climate Regulation	344	392	406
Erosion Control	54	56	58
Protection from Extreme Events	2,127	2,218	2,313
Food	1,952	2,033	2,125
Pollination	57	60	62
Raw Materials	31	35	46
Recreation	667	741	769
Soil Formation	497	474	476
Waste Treatment	1,552	1,617	1,689
Water Supply	1,633	1,713	1,788
Water Flow Regulation	2,027	2,096	2,182

Appendix 2: Candidate Ecosystem Service Productivity Values for Land-Use and Ecosystem Service Combinations

As explained under Methods Ecosystem Service Valuation, the benefit transfer method applies estimates of ecosystem service value from existing studies of "source areas" to the "policy area," which in this case comprises wetland forests in the the various land use/land management classes identified through spatial and other analysis. This application is done on a land-use-by-land-use basis. The table below lists all of the values from source area studies considered for our calculations. All values have been adjusted for inflation to reflect 2016 price levels. For source area values originally reported in currencies other than U.S. dollars, the values have been converted using exchange rates.

Biome	Ecosystem Service	Minimum 2016$ per acre per year	Maximum 2016$ per acre per year	Source
Forest	Aesthetic	62.66	850.48	Moore, R. (2011)
		4,501.06	18,392.66	Nowak, D J, Crane, D E, Dwyer, J F. (2002)
	Air Quality	227.48	227.48	Weber, Ted (2007)
	BioControl	2.57	2.57	Brenner-Guillermo, J. (2007)
	Climate	68.39	68.39	Brenner-Guillermo, J. (2007)
		57.67	57.67	Costanza, R, R d'Arge, S Farber, M Grasso, R deGroot, B Hannon, and M van den Belt. (1997)
		3.32	46.21	Earth Economics Database
		4.37	4.37	Hall, D.S. (2010)
		328.24	328.24	Flores, L., Harrison-Cox, J., Wilson, S., & Batker, D. (2013)
	Erosion	62.73	62.73	Brenner-Guillermo, J. (2007)
		3.14	36.59	Zhou, X, Al-Kaisi, M, Helmers, J M. (2009)
	Extreme Events	316.59	316.59	Moore, R. (2011)
		808.68	808.68	Weber, Ted (2007)
	Food	2,453.84	2,453.84	Kauffman, G., Homsey, A., McVey, E., Mack, S., and Chatterson, S. (2011)
	Pollination	205.67	205.67	Brenner-Guillermo, J. (2007)
		1.43	7.20	Costanza, R. Wilson, M.Troy, A.Voinov, A.Liu, S.D'Agostino, J. (2007)
		89.32	89.32	Weber, Ted (2007)
	Raw Materials	21.31	21.31	Hall, D.S. (2010)
		169.12	169.12	Weber, Ted (2007)
	Recreation	154.77	154.77	Brenner-Guillermo, J. (2007)
		1.31	4.62	De la Cruz, A. and J. Benedicto (2009)
		4.00	4.00	Haener, M K, Adamowicz, Wiktor L. (2000)
		3.78	3.78	Hall, D.S. (2010)
		37.64	46.13	Prince, R, Ahmed, E. (1989)
		2.82	510.93	Shafer, E L, Carline, R, Guldin, R W, Cordell, H K. (1993)

	Soil fertility	6.17	6.17	Brenner-Guillermo, J. (2007)
		20.25	20.25	Weber, Ted (2007)
	Waste	56.04	56.04	Brenner-Guillermo, J. (2007)
		8.78	8.78	De la Cruz, A. and J. Benedicto (2009)
		269.46	270.58	Zhongwei, Lui. (2006)
	Water	207.21	207.21	Brenner-Guillermo, J. (2007)
		48.04	48.04	De la Cruz, A. and J. Benedicto (2009)
		11.08	11.08	Hall, D.S. (2010)
		316.59	316.59	Moore, R. (2011)
		1,310.08	1,310.08	Weber, Ted (2007)
	Water Flows	233.18	233.18	Mates, William. (2007)
		808.68	808.68	Weber, Ted (2007)
Urban Open Space	Aesthetic	461.00	461.00	Johnston, Robert J, Mazzotta, Marisa J, Opaluch, James J, Grigalunas, Thomas A. (2001)
		1,751.15	3,027.76	Opaluch, J, Grigalunas, T, Mazzotta, M, Johnston, R, Diamantedes, J. (1999)
		1,019.96	1,340.58	Qiu, Z, Prato, T, Boehm, G. (2006)
	Air Quality	32.91	32.91	McPherson, E G, Scott, K I, Simpson, J R. (1998)
		195.01	195.01	McPherson, G. (1992)
	Climate	1,150.06	1,150.06	McPherson, G. (1992)
	Extreme events	319.88	605.26	Streiner, C, Loomis, J. (1995)
	Water Flows	8.44	8.44	McPherson, G. (1992)
		140.13	190.17	Trust for Public Land. (2010)
Urban Other	Climate	426.76	426.76	Brenner-Guillermo, J. (2007)
		69.81	69.81	Moore, R. (2011)
	Recreation	2,707.64	2,707.64	Brenner-Guillermo, J. (2007)
	Water	1.28	1,501.62	Moore, R. (2011)
	Water flows	7.71	7.71	Brenner-Guillermo, J. (2007)
Wetland	Aesthetic	38.99	38.99	Amacher, G.S., R.J. Brazee, J.W. Bulkley and R.A. Moll (1989)
		1,829.89	1,829.89	Gerrans, P. (1994)
		972.18	1,557.57	Johnston, Robert J, Mazzotta, Marisa J, Opaluch, James J, Grigalunas, Thomas A. (2001)
		5,993.29	14,207.18	Mazzotta, M. (1996)
		9.89	117.62	Moore, R. (2011)
		7,078.85	9,549.09	Opaluch, J, Grigalunas, T, Mazzotta, M, Johnston, R, Diamantedes, J. (1999)
		468.10	1,497.91	Thibodeau, Francis R, Ostro, Bart D. (1981)
	Air Quality	76.54	99.37	Jenkins, W A, Murray, B C, Kramer, R A, Faulkner, S P. (2010)
	Climate	159.91	159.91	Brenner-Guillermo, J. (2007)
		0.89	14.47	EarthEconomics Database
		218.26	218.26	Hughes, Zachary. (2006)
		80.12	584.73	Jenkins, A.W. (2009)
		637.40	637.40	Moore, R. (2011)
		63.55	4,929.88	Wilson, Sara. (2013)

	Erosion	179.84	179.84	Weber, Ted (2007)
	Extreme events	111.58	4,646.59	Brenner-Guillermo, J. (2007)
		308.38	308.38	Costanza, R, Farber, S C, Maxwell, J. (1989)
		282.63	282.63	Costanza, R, Farley J. (2007)
		2,189.84	2,189.84	Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruel, R.G. Raskin, P. Sutton and M. van den Belt (1997)
		8,543.79	8,543.79	Gupta, T.R. and J.H. Foster (1975)
		1,668.33	7,617.80	Leschine, Thomas M, Wellman, Katherine F, Green, Thomas H. (1997)
		864.22	864.22	Moore, R. (2011)
		6,241.32	6,241.32	Thibodeau, Francis R, Ostro, Bart D. (1981)
	Food	17,113.98	17,113.98	Aburto-Oropeza, O, Ezcurra, E, Danemann, G, Valdez, V, Murray, J, Sala, E. (2008)
		5.82	729.18	Batie, Sandra S, Wilson, James R. (1978)
		60.71	141.86	Bell, Frederick W. (1989)
		194.93	194.93	Gren, I.M. and T. Soderqvist (1994)
		3,371.29	3,371.29	Hamilton, L.S. and S.C. Snedaker (1984)
		826.69	826.69	Hughes, Zachary. (2006)
		1,030.72	1,030.72	Johnston, Robert J, Mazzotta, Marisa J, Opaluch, James J, Grigalunas, Thomas A. (2001)
	Raw materials	50.86	50.86	Everard, M. (2009)
		86.38	86.38	Kosz, M., B. Brezina and T. Madreiter (1992)
	Recreation	429.95	429.95	Anderson, Glen D, Edwards, Steven F. (1986)
		157.38	1,207.49	Bell, Frederick W. (1989)
		81.83	81.83	Bergstrom, John C, Stoll, John R, Titre, John P, Wright., Vernon L. (1990)
		1,740.48	1,786.24	Brenner-Guillermo, J. (2007)
		110.81	435.91	Costanza, R, Farber, S C, Maxwell, J. (1989)
		1,055.42	1,055.42	Creel, Michael, Loomis, John. (1992)
		89.28	1,008.24	Gren, I.M. and T. Soderqvist (1994)
		221.81	1,699.20	Jaworski, E, Raphael, C N. (1978)
		7.50	7.50	Jenkins, A.W. (2009)
		210.88	210.88	Kreutzwiser, R. (1981)
		212.40	212.40	Lant, C.L. and R.S. Roberts (1990)
		585.87	10,504.13	Thibodeau, Francis R, Ostro, Bart D. (1981)
		124.40	124.40	Whitehead, J C, Groothuis, P A, Southwick, R, Foster-Turley, P. (2009)
		657.53	4,261.90	Whitehead, J C. (1990)
	Soil fertility	2,149.72	2,149.72	Bystrom, O. (2000)
	Soil Formation	535.94	535.94	Weber, Ted (2007)
	Waste	67.95	6,398.80	Breaux, A, Farber, S, Day, J. (1995)
		1,064.85	1,064.85	Brenner-Guillermo, J. (2007)
		172.40	172.40	Gren, I.M. and T. Soderqvist (1994)
		558.63	558.63	Jenkins, W A, Murray, B C, Kramer, R A, Faulkner, S

				P. (2010)
		212.40	212.40	Lant, C.L. and R.S. Roberts (1990)
		4,620.66	4,620.66	Thibodeau, Francis R, Ostro, Bart D. (1981)
		11,031.50	11,031.50	Zhongwei, Lui. (2006)
	Water	1,961.57	2,440.78	Brenner-Guillermo, J. (2007)
		631.37	631.37	Creel, M, Loomis, J. (1992)
		18.44	18.44	Folke, C., & Kaberger, T.. (1991)
		211.98	849.20	Moore, R. (2011)
		18,861.26	18,861.26	Thibodeau, Francis R, Ostro, Bart D. (1981)
		1,310.08	1,310.08	Weber, Ted (2007)
	Water flows	3,793.57	3,793.57	Brenner-Guillermo, J. (2007)
		3,974.86	3,974.86	Leschine, T.M., K.F. Wellman and T,H. Green (1997)
		4,389.53	4,389.53	UK Environment Agency (1999)