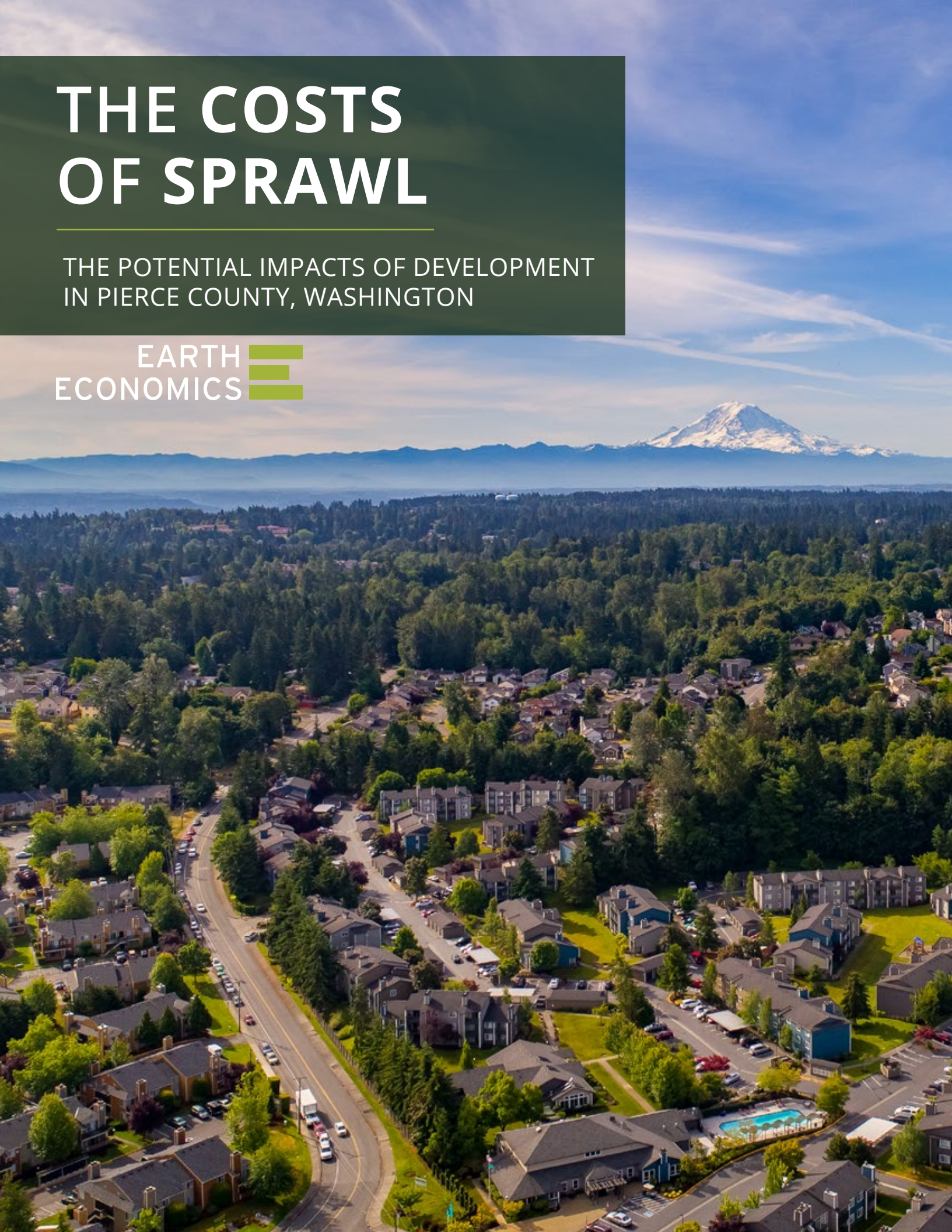
THE COSTS OF SPRAWL

THE POTENTIAL IMPACTS OF DEVELOPMENT IN PIERCE COUNTY, WASHINGTON

EARTH ECONOMICS



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EXECUTIVE SUMMARY

Pierce County is one of the fastest growing counties in Washington State and the majority of this growth is occurring in unincorporated areas. In fact, from 2000 to 2015, unincorporated Pierce County experienced higher levels of population growth compared to incorporated municipal areas. As pressure to develop Pierce County's natural lands and open spaces increases, in particular agricultural lands and forested areas, there is a need to understand the trade-offs of developing rural and unincorporated areas to accommodate population growth.

This report finds that development in Pierce County has the potential to significantly impact the value of ecosystem services, the public benefits derived from nature such as clean air, purified water, raw materials like timber, and agricultural products. The report also finds that development can drastically increase county costs in the form of service extensions (e.g., public safety costs, utility costs), and impact the potential revenue from working farms and forests. Modeling these impacts through two development scenarios, our analysis shows that on average, developing in unincorporated Pierce County results in significantly higher impacts in each of the categories analyzed when compared to the alternative development scenario in incorporated Pierce County. While the impacts in this case are hypothetical, they represent the very real costs of sprawl, costs that should be considered when making holistic decisions about development and the future of Pierce County's natural landscapes.

AUTHORS

Matt Van Deren, Corrine Armistead, Nina Kerr, Jared Soares

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The authors are responsible for the content of this report.

The Puyallup Watershed Initiative is a new model for community-centered change. Our mission is to improve social and environmental conditions throughout the region, which comprises more than 1,000 square miles from Mt. Rainier to Commencement Bay. The PWI brings together people not typically at the same table to address our region's persistent challenges and most promising opportunities. We believe everyone has something to contribute to our shared home.

Puyallup Watershed Initiative Agriculture

Puyallup Watershed Initiative

Puyallup Watershed Initiative Forests

Earth Economics is a leader in ecological economics and has provided innovative analysis and recommendations to governments, tribes, organizations, private firms, and communities around the world.

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EARTH ECONOMICS

PIERCE COUNTY
NATURAL FEATURES

Pierce County is situated between Puget Sound and the Cascade Mountains in Western Washington. The County's diverse geography spans from the State's tallest peak, Mount Rainier, to more than 1,100 miles of Puget Sound shoreline.[1] In between, a dynamic mesh of forests, rivers, and grasslands comprises Northwest ecosystems that have long been home to communities, human and non-human alike.

The County contains large portions of two Western Washington watersheds, the Puyallup and Nisqually. Over 90% of the Puyallup Watershed is within Pierce County, draining from the slopes of Mount Rainier through the Foss Waterway into Commencement Bay and the Puget Sound. The Puyallup River is the largest river in the watershed, originating from the Puyallup and Tahoma glaciers of Mount Rainier and flowing 46 miles westward to Puget Sound. The Puyallup River and its tributaries, the White and Carbon Rivers, together drain 60% of Mount Rainier.[2] In total, the watershed encompasses an area of approximately 670,000 acres with over 728 miles of streams.

MAP 1 NATURAL FEATURES AND WATERSHEDS, PIERCE COUNTY

Sources: ESRI, USGS

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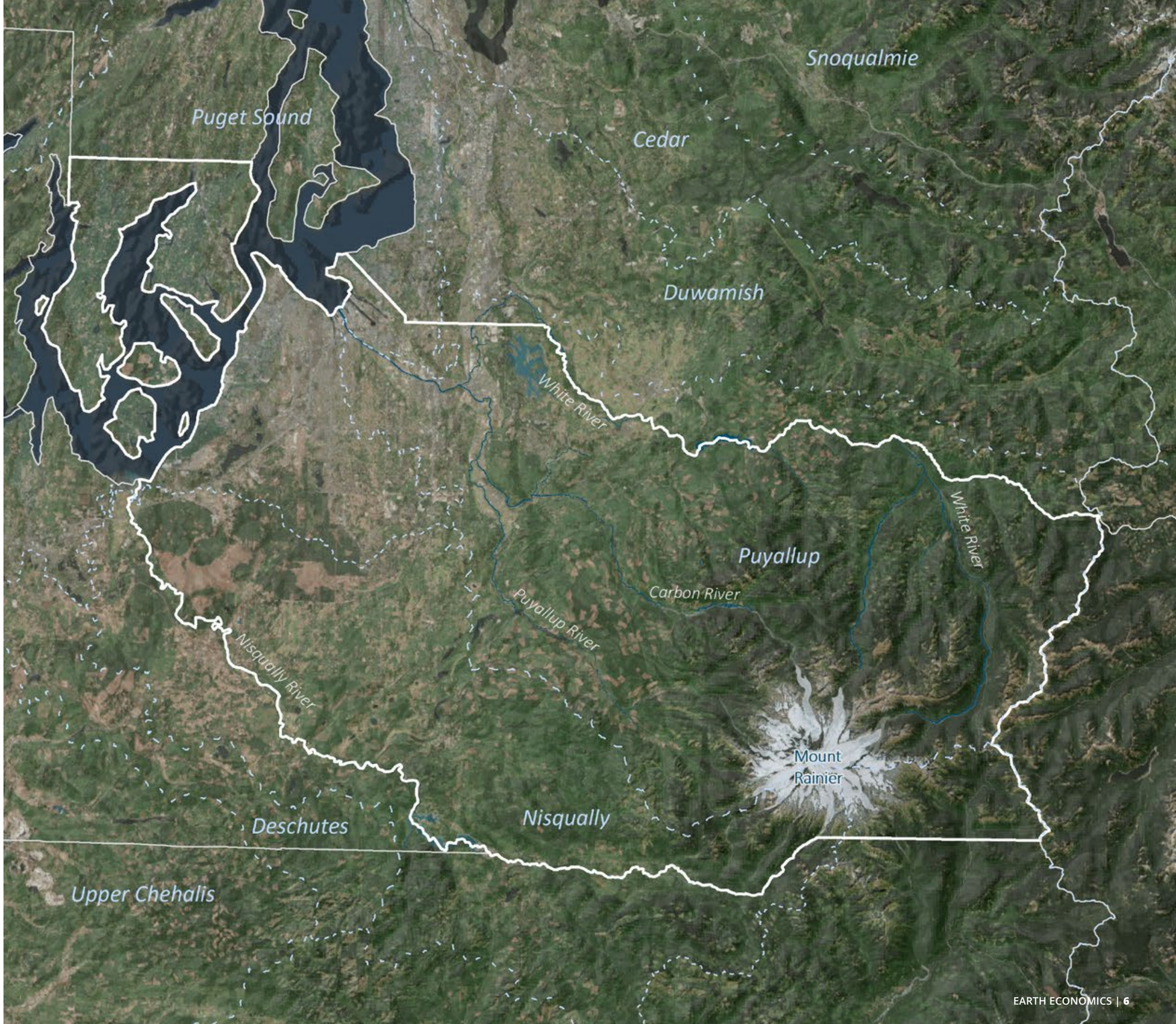
40 MILES



PIERCE COUNTY
PLACES & LAND USE

Positioned between Washington's capital city, Olympia, and largest metropolitan area, Seattle, Pierce County serves as a hub for commerce and a home for over 800,000 of the State's residents. The County encompasses 24 cities and towns, including the city of Tacoma, and Joint Base Lewis-McChord, Washington's third largest city and one of the largest military bases in the country respectively. Additionally, this region has long been home to Salish Sea tribes, including the Puyallup, Nisqually, and Steilacoom Tribes.

MAP 2 PLACES AND LAND USE, PIERCE COUNTY

Sources: ESRI, USGS, WA Dept. of Ecology, USFS, US Census

- WASHINGTON URBAN GROWTH AREAS
- RESERVATIONS
- CULTIVATED LANDS
- JOINT BASE LEWIS-MCCHORD
- STATE PARKS
- MOUNT RAINIER NATIONAL PARK
- NATIONAL FORESTS

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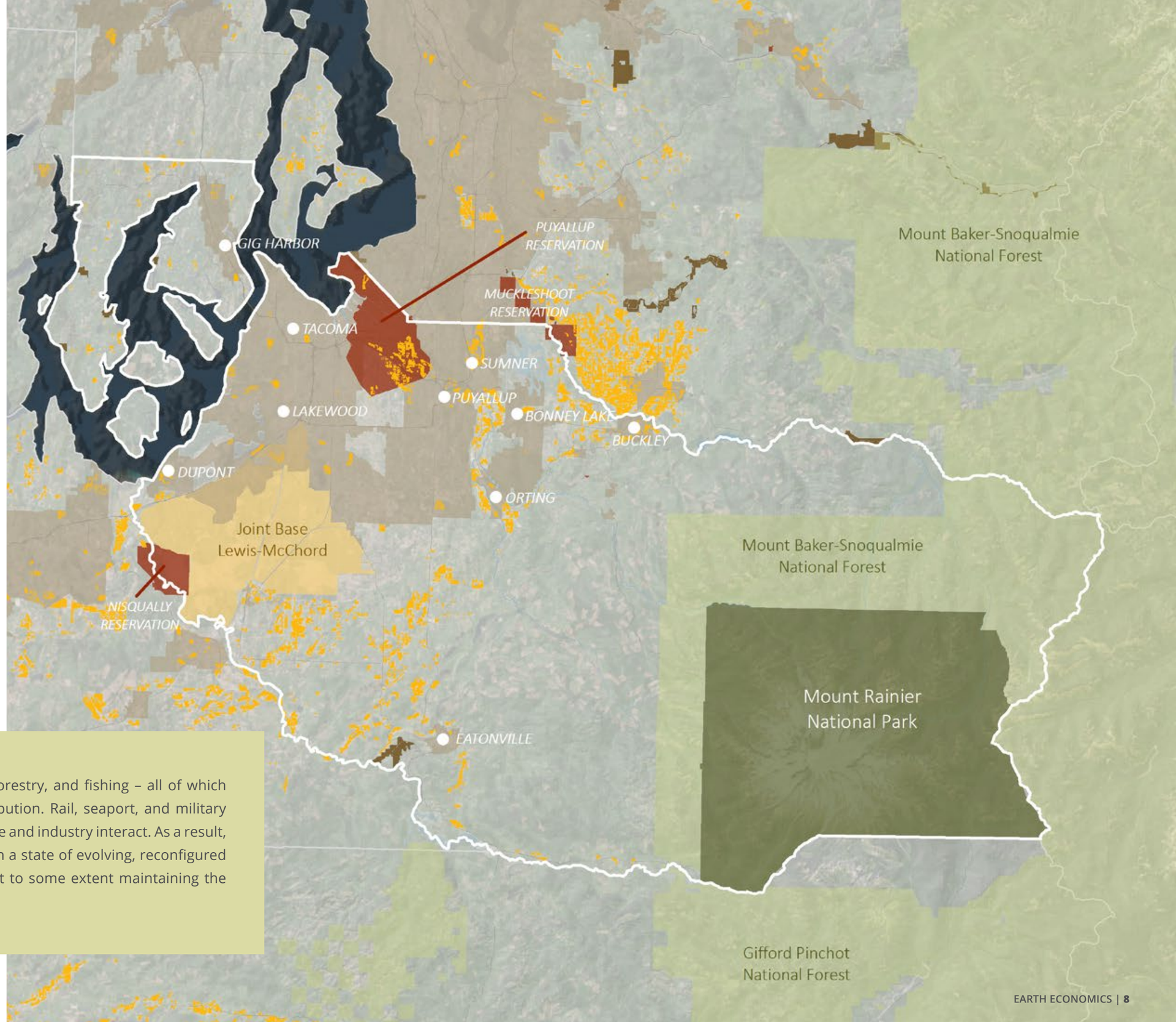


Pierce County has a long history of agriculture, forestry, and fishing – all of which reflect on current land use and population distribution. Rail, seaport, and military operations have also shaped how and where people and industry interact. As a result, our natural and built landscapes are perpetually in a state of evolving, reconfigured by the changing dynamics of human influence yet to some extent maintaining the patterns and infrastructures of Earth's processes.

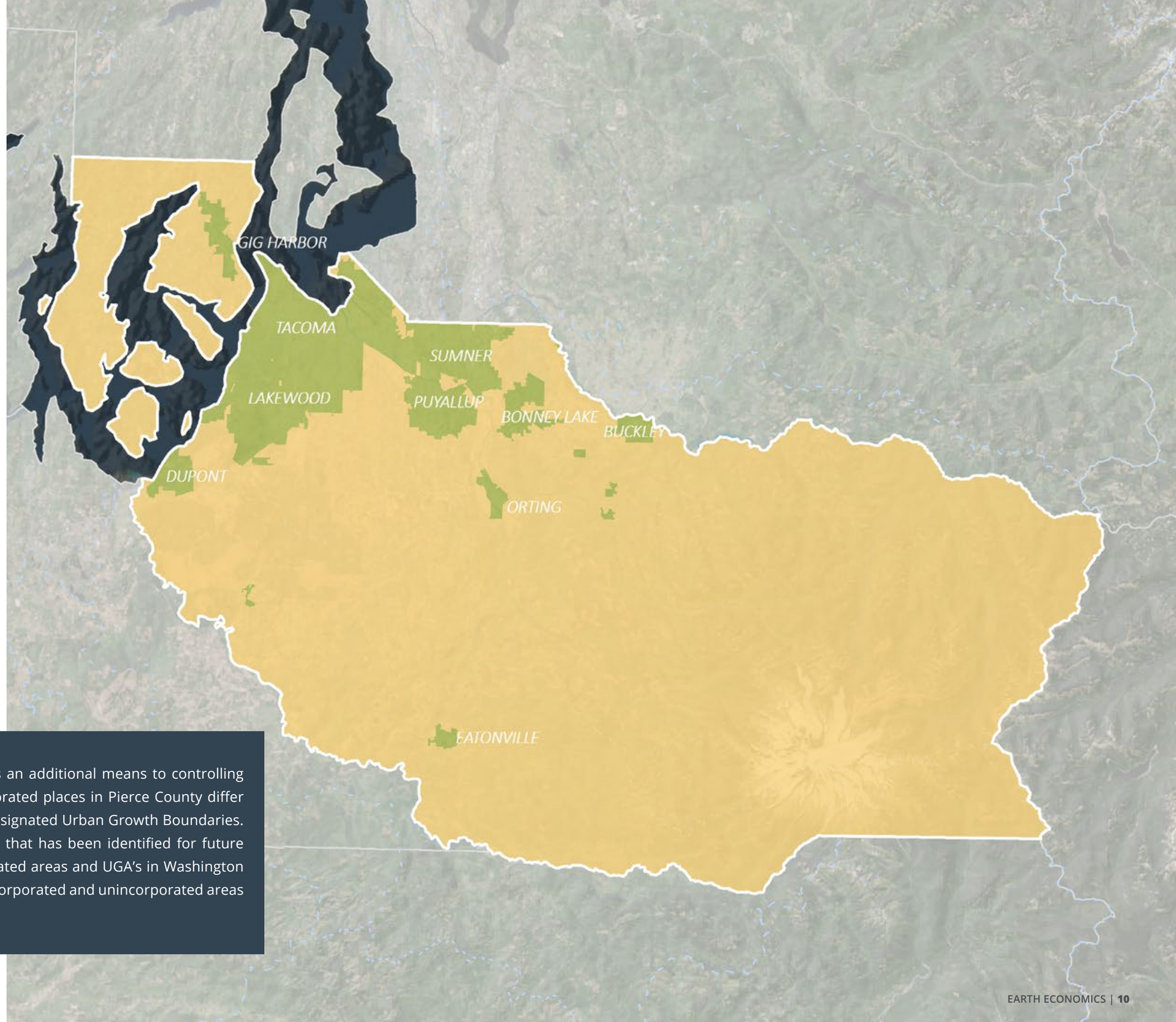
PIERCE COUNTY
URBAN GROWTH AREAS

For jurisdictional and land use planning purposes counties are further divided into designated incorporated and unincorporated areas. The U.S. Census Bureau defines an incorporated place as a geographic area with legally defined municipal boundaries under the laws of the state in which it is located. In Washington State, the process of incorporation involves petition by local voters, county review, and ultimately elections to appoint city leadership.[3] To incorporate, an area must have a minimum 1,500 inhabitants, 3,000 if the area is within five miles of a 15,000-plus population city.[4]

Incorporated areas have the benefit of increased control over development and future land use decisions. Pierce County is home to 24 unique incorporated areas, including Tacoma, Lakewood, and Puyallup. Altogether, incorporated areas cover 16% of the county's land while unincorporated Pierce County comprises 84% of the county by area. By population, over two-thirds of Pierce County residents live within the boundaries of incorporated areas, though trends show increased development on unincorporated land.

MAP 3 URBAN GROWTH AREAS, PIERCE COUNTY

Sources: ESRI, USGS, Pierce County



Washington also designates Urban Growth Areas as an additional means to controlling development and future land use decisions. Incorporated places in Pierce County differ from Urban Growth Areas (UGAs) in Washington's designated Urban Growth Boundaries. An Urban Growth Area (UGA) is effectively the area that has been identified for future expansion of a particular city. Even though incorporated areas and UGA's in Washington State have similar boundaries, UGA's include both incorporated and unincorporated areas identified for potential expansion.

INTRODUCTION

Washington State is no stranger to population growth. In fact, states in the Pacific Northwest are consistently among the fastest growing states in the nation.[5] But for Washington, this growth is centralized in specific counties experiencing historic levels of population growth. U.S. Census data from 2016 reveals that not only is Pierce County the fastest growing county in Washington, it is also one of the fastest growing counties in the nation, with the annual number of new residents moving from another U.S. county more than doubling between 2015 and 2016.[6]

With the inpour of new residents from other counties, and from out of state, there has been an increase in pressure to develop properties throughout Pierce County, particularly in unincorporated areas, which are growing faster than municipal areas.[7] Developing in unincorporated Pierce County often entails the conversion of agricultural lands, forest lands, natural areas, and open spaces. These lands provide a suite of benefits and services, including ecosystem services, that benefit local communities. While building places for Pierce County's newest residents is an important part of our region's economic growth, decisions on where to develop must be weighed against the losses of converting previously undeveloped lands.

In 2017, Earth Economics consulted with the Puyallup Watershed Initiative to prepare an exploratory report to better understand the potential tradeoffs that can occur when developing properties in incorporated and unincorporated Pierce County. These tradeoffs include the potential loss of ecosystem services, additional costs to the county to extend services to new residential properties, and impacts on working farms and forests. The results of these explorations are presented below and later synthesized in two development scenarios. The results and scenario modeling are intended to inform development decisions that integrate environmental, social, and economic considerations.

While building places for Pierce County's newest residents is an important part of our region's economic growth, **decisions on where to develop** must be weighed against the losses of converting previously undeveloped lands.

POTENTIAL COSTS OF URBAN SPRAWL

ECOSYSTEM SERVICES | SERVICE EXTENSIONS | WORKING LANDS | WORKING FORESTS

Urban sprawl, or the expansion of cities into previously less developed areas, is a reality in many parts of the country, particularly the rapid growing Pacific Northwest. In the absence of land use codes typically present in incorporated areas, rural areas can undergo widespread development to fill the demand for new housing created by a growing population. The following analysis considers four costs associated with urban sprawl, specifically the conversion of natural ecosystems and working lands in Pierce County.

The first cost is presented as a loss of the ongoing benefits communities derive from surrounding natural ecosystems. Understanding the current value of ecosystem services derived from Pierce County lands helps to frame what stands to be lost in future land use changes. The next category discussed is the direct cost born by Pierce County in the form of service provision. Extending and maintaining services is more expensive for the County in less densely populated areas. As a result, the per-household cost of county provided services is an important inclusion in development decisions. Finally, the potential revenue lost through reduction in working lands is considered. This cost is assessed based on the current average per-acre revenue generated from agriculture and forestry products. Together, these four categories begin to shed light on the costs associated with urban sprawl.

ECOSYSTEM SERVICE COSTS

Ecosystem services are the goods and services that humans receive from nature, including breathable air, drinkable water, nourishing food, and climate stabilization. While the services provided by nature are as diverse as ecosystems themselves, the bottom line is that humans benefit from these services and value them.

When developing previously natural or undeveloped lands, these services are lost. This is particularly true when developing properties in rural area where ecosystems are more likely to be in a natural, high functioning state when compared to those in and near urban areas. For example, when a previously forested area is developed into a new residential area, trees, shrubland, and grassland may be cleared to make space for new homes, their yards, and new roads. Trees, shrubland, and grassland all play a critical role in sequestering carbon, filtering air, and improving water quality, services that will be negatively impacted or lost when replaced with man-made structures.

The goods and services provided by ecosystems are similar to the goods and services provided in a traditional market in that they can be valued as a dollar figure. The process of valuing the goods and services provided by an ecosystem is called ecosystem services valuation (ESV) and it's a critical first step in understanding the value of services provided in the county, and the value of services that may be lost if natural lands are converted to developed areas.

ECOSYSTEM SERVICES VALUATION METHODOLOGY

Building on decades of research that values ecosystem services, the valuation of services provided by ecosystems in Pierce County involves four major steps:

STEP 1 Identification and Quantification of Land Cover Classes

STEP 2 Identification and Valuation of Ecosystem Services

STEP 3 Annual Value of Ecosystem Services

STEP 4 Ecosystem Service Results

TABLE 1 SPATIAL ATTRIBUTES

This table describes how each spatial attribute was derived and the datasets involved in calculating the boundaries of each spatial attribute.

ATTRIBUTE	SOURCE
Riparian	U.S. Fish and Wildlife Service, 2016 National Wetlands Inventory
Urban	Washington State Office of the Chief Information Officer (OCIO) and The Department of Ecology 2015 Urban Growth Area Boundaries

TABLE 2 LAND COVER ACREAGES FOR INCORPORATED AND UNINCORPORATED PIERCE COUNTY

This table presents the results of our Pierce County land cover analysis, an aggregation of publicly available land cover and land use data.

FOREST TYPE	ATTRIBUTE		INCORPORATED PIERCE COUNTY (ACRES)	UNINCORPORATED PIERCE COUNTY (ACRES)
	RIPARIAN	URBAN		
CULTIVATED				
PASTURE/HAY			5,041	20,974
CULTIVATED CROPS			7,713	14,636
FORESTS				
DECIDUOUS FORESTS			31	18,451
	R		9	2,762
		U	5,067	2,178
	R	U	804	136
EVERGREEN FORESTS			106	368,761
	R		112	88,781
		U	30,479	6,461
	R	U	7,300	410
MIXED FORESTS			99	59,047
	R		34	9,441
		U	10,347	4,904
	R	U	1,326	332
GRASSLAND				
GRASSLAND			14	57,338
	R		658	5,569
		U	4,555	1,945
SHRUBLANDS				
SHRUBLAND			12,571	125,599
WATER				
LAKE/POND			2,268	9,160
RIVER			3,064	28,856
WETLANDS & ESTUARY				
ESTUARY			2,268	9,160
WETLANDS (FRESHWATER)			3,064	28,856
		TOTAL ACRES	98,932	863,365

PIERCE COUNTY
LAND COVER

The rich diversity of Pierce County's ecosystems forms the basis of this valuation of ecosystem services. Spanning from Mount Rainier's glaciers to the shellfish habitat of the Puget Sound, the County's natural features form the basis of our thriving communities and economies. Over half of Pierce County is forested, covering a mixture of Federal, State, and Private land and providing a range of ecosystem services to surrounding residents.

Though the coastal, forest, and high-elevation ecosystems are intricate and unique, to value the flow of ecosystem services using the benefit transfer method (discussed below) we rely on simplified models of this complex landscape. After identifying available data sources and land cover types, we simplify into aggregate ecosystem classes for which valuation data is present. For this analysis, the ecosystems included to represent the current landscape of Pierce County are presented below and in the map to the right.

MAP 4 LAND COVER, PIERCE COUNTY

Sources: NLCD, US Census, USGS

- PASTURE/HAY
- CULTIVATED CROPS
- DECIDUOUS FOREST
- EVERGREEN FOREST
- MIXED FOREST
- GRASSLAND
- SHRUBLAND
- FRESHWATER
- WETLANDS
- DEVELOPED

N

40 MILES

2011 National Land Cover Database GIS data published by the Multi-Resolution Land Characteristics Consortium was used as the base for this assessment.[8] Additional datasets were overlaid to refine land cover categories, including Washington State Department of Agriculture's (WSDA) annual crop data, and the U.S. Fish and Wildlife Service's National Wetlands Inventory.[9, 10] The aggregation and simplification of base land cover, crops, and wetlands data generated the land cover classes for this valuation. Water identified in the National Wetlands Inventory and Washington's urban growth boundaries were used to define riparian and urban proximity attributes, respectively.[11, 12]

IDENTIFICATION AND QUANTIFICATION OF LAND COVER CLASSES

As the first step in conducting an ESV, Geographic Information Systems (GIS) data was used to calculate the extent of land cover types (e.g. wetland, forest, estuary) within incorporated and unincorporated Pierce County. In this analysis, we also considered two spatial attributes—proximity to urban areas, and proximity to waterways— to reflect unique values derived from ecosystems in these locations. Acreages of base land cover categories and attributes are presented in the table on page 14, with additional information on land cover classification following.

IDENTIFICATION AND VALUATION OF ECOSYSTEM SERVICES

For each land cover type, the ecosystem services provided by that land cover were identified. For example, forests comprise a large portion of unincorporated Pierce County, and each acre of forest provides a suite of ecosystem services unique to that land cover (e.g., water quality, carbon sequestration, habitat).[i]

Earth Economics then valued these services using the benefit transfer method (BTM). BTM is broadly defined as "the use of existing data or information in settings other than for what it was originally collected." BTM begins by identifying peer reviewed studies that value ecosystem services in locations similar to Pierce County using a variety of well-accepted valuation methods.[ii] Each value estimate in these studies is then transformed into a dollars-per-acre-per-year format to ensure "apples to apples" comparisons, as these estimates are "transferred" to the study site. In this sense, BTM is similar to a home appraisal, in which the features and pricing of similar nearby homes are used to estimate the value of other similar homes. While the BTM process is imperfect, it is able to quickly and efficiently generate reasonable values for policy and project analysis.

Table 3 reports the ecosystem services that could be valued for each land cover type in incorporated and unincorporated Pierce County. Where valuation estimates for particular ecosystem service-land cover combinations were not available, the cell has been left blank. This is not meant to suggest that such ecosystem services contribute no value at all, only that rigorous research on those contributions provided by specific land cover types were not available at the time this research was conducted.

[i] See Appendix A for a comprehensive list of possible ecosystem services.
[ii] See Appendix B for a comprehensive list of valuation methods.

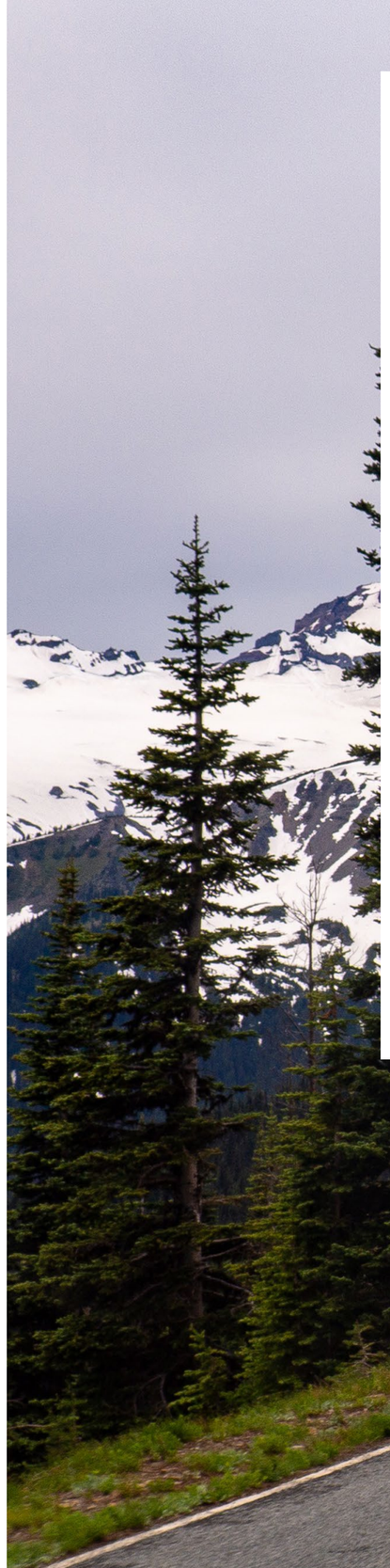
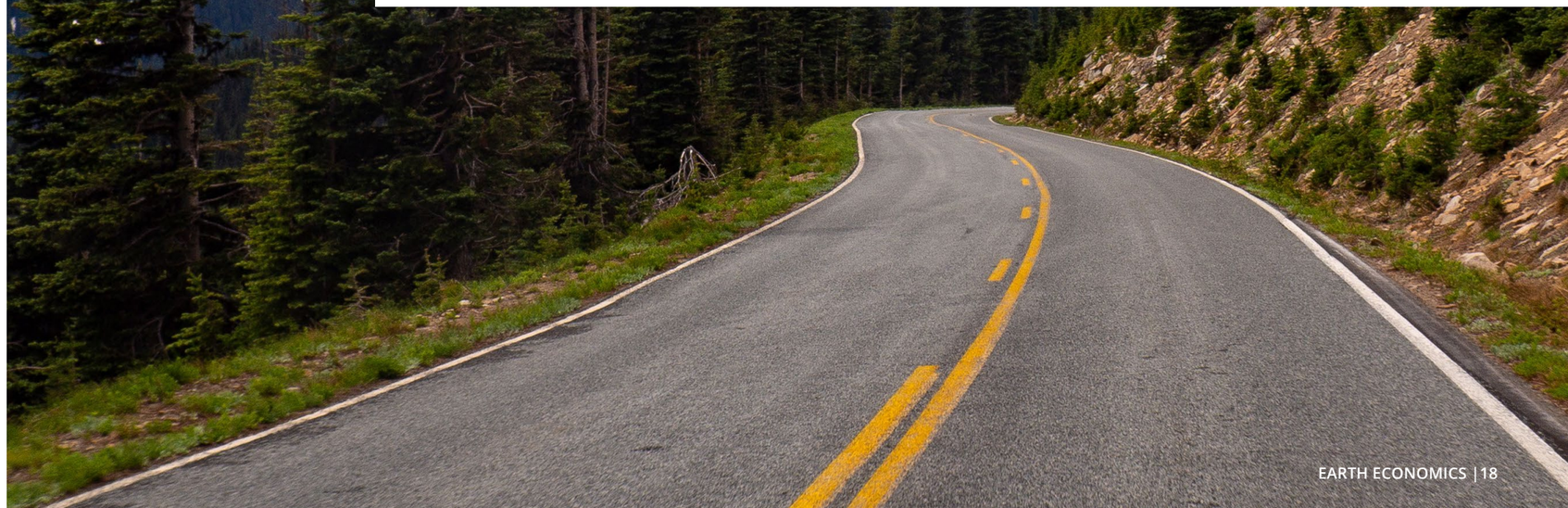


TABLE 3 ECOSYSTEM SERVICES BY ATTRIBUTE

The table below reports which ecosystem services could be valued for each land cover type. Where valuation estimates for particular ecosystem service–land cover combinations were not available, the cell has been left blank. This is not meant to suggest that such ecosystem services contribute no value at all—only that rigorous research on those contributions provided by specific land cover types were not available at the time research was conducted.

FOREST TYPE	ATTRIBUTE		ECOSYSTEM SERVICE									
	RIPARIAN	URBAN	AIR QUALITY	CARBON SEQUESTRATION	DISASTER RISK REDUCTION	ENERGY & RAW MATERIALS	HABITAT	SOIL FORMATION	SOIL RETENTION	WATER CAPTURE, CONVEYANCE & SUPPLY	WATER STORAGE	WATER QUALITY
CULTIVATED												
PASTURE/HAY			x	x			x	x	x			
CULTIVATED CROPS				x				x				
FORESTS												
DECIDUOUS FORESTS			x	x			x		x	x		x
	R		x	x			x		x	x		x
		U	x	x			x		x	x		x
	R	U	x	x			x		x	x		x
EVERGREEN FORESTS			x	x		x	x		x	x		x
	R		x	x		x	x		x	x		x
		U	x	x		x	x		x	x		x
	R	U	x	x			x		x	x		x
MIXED FORESTS			x	x			x		x	x		x
	R		x	x			x		x	x		x
		U	x	x			x		x	x		x
	R	U	x	x			x		x	x		x
GRASSLANDS												
GRASSLAND				x								x
	R			x								x
		U		x								x
SHRUBLANDS												
SHRUBLAND					x	x						x
WATER												
LAKE/POND										x	x	x
RIVER										x	x	x
WETLANDS & ESTUARY												
ESTUARY				x								x
WETLANDS (FRESHWATER)	R			x								x

[3] See Appendix A for a comprehensive list of possible ecosystem services.
[4] See Appendix B for a comprehensive list of valuation methods.



ANNUAL VALUE OF ECOSYSTEM SERVICES

Bringing together the land cover analysis and identification of ecosystem service values for individual ecosystem types, we calculate the total annual contribution of ecosystem services within Pierce County. The sum of ecosystem services values provided by one acre of each land cover type was multiplied by the total number of acres of that land cover type present within the County. Aggregating this across all ecosystem types (e.g. forests, pastures, and rivers) results in a total annual ecosystem services value for incorporated and unincorporated Pierce County.

To illustrate the collective benefits of ecosystem services that are provided by diverse landscapes, the image below shows a few of the ecosystem services provided by lands in Pierce County. The value for each of these services, and others, provided by the entire county, are reflected in the section below.

ECOSYSTEM SERVICES ARE COMPRISED OF 21 SERVICES

PROVISIONING SERVICES
Ornamental Resources, Water Storage, Food, Medicinal Resources

REGULATING SERVICES
Climate Stability, Navigation, Water Supply, Water Quality, Air Quality, Soil Formation, Soil Quality, Soil Retention, Genetic Transfer, Biological Control, Disaster Risk Reduction

SUPPORTING SERVICES
Habitat & Nursery

INFORMATION SERVICES
Aesthetic Information, Recreation & Tourism, Cultural Value, Science & Education

ECOSYSTEM SERVICE RESULTS

For this analysis, ten ecosystem services were valued across nine land cover types present in Pierce County (Table 3). Impervious material, including roads and parking lots, were not valued as a part of this study. Our analysis shows that incorporated and unincorporated Pierce County provides between $114 million and $411 million, and $745 million and $2.5 billion worth of ecosystem services each year, respectively (Table 4) (Table 5). **This brings the total value of ecosystem services provided by the natural and open spaces in the county between $860 million and $2.9 billion every year.**

The range in estimated value of ecosystem services provided by the wild and natural areas in Pierce County is largely the result of variation that exists within the primary valuation studies used in this analysis. While methodologically sound, these studies have various approaches to valuing ecosystem services, each with the potential for bias. Moreover, the ecosystems valued in each study likely have varying degrees of health and productivity. To account for potential bias that exists within the primary valuation studies used in our analysis, and to account for the varying degrees of ecosystem health and productivity in Pierce County, Earth Economics presents the estimates as a range. However, whether considering the high or low end of the range of values provided by the ecosystems in Pierce County, both figures illustrate the significant benefits provided to the public by Pierce County's natural areas an open space.

As expected, unincorporated Pierce County is the larger source of ecosystem services in the county, both because it comprises a larger portion of the county, and because it contains less developed and urban lands. Understanding the value of benefits provided by lands subject to development is a critical first step in making development decisions. The impact of developments on the value of ecosystem services is explored in the development scenarios below. These estimates can also be used to measure the loss of ecosystem service value associated with the conversion of specific land cover types for future developments.

FIGURE 1 DEVELOPMENT DENSITY AND ANNUAL SERVICE COST, PIERCE COUNTY (2018)

SERVICE EXTENSION COSTS

Shifting patterns in urban and suburban development affect the cost of providing public services to residents. This analysis looks specifically at the cost of extending services provided by Pierce County, although other public entities would likely experience increased demand for services, as well. Different patterns of development (e.g., urban, rural) and dwelling types (e.g., single-family, multifamily), lead to varying costs for the provision of public services. For instance, the per-household cost to install electricity in an urban, multifamily building is far less than for single family, rural or suburban homes. To estimate these cost differences, this analysis draws on two primary components: total annual Pierce County expenditures on service provision, and an estimated proportional household cost of county services per housing density.

In 2016, Pierce County reported spending more than $335 million on services, forming the baseline expenditures for this analysis.[iii] To derive per-household service costs for different development densities, this analysis draws from a report of development patterns in Halifax, Nova Scotia, using their proportional differences in public service provision by housing density (dwelling type) to estimate similar expenditures in Pierce County (See Table 6). This methodology was recently used by Earth Economics for Thurston Regional Planning Council to create the Thurston County Climate Resilience Plan—an effort recognized with an American Planning Association award—which includes the incorporation of ecosystem services into benefit-cost analyses of mitigation measures.

Following this approach generates different per-household service costs for incorporated and unincorporated portions of the County, based on Pierce County expenditures and current household counts. This baseline can then be used to illustrate impacts of different development scenarios, discussed below. This estimate captures one component of service cost, the County-incurred expenses of expanding public services to new households in Pierce County.

Taking a larger view, it is important to note that there are costs to Washington State and other entities not captured here. In addition, this analysis represents a snapshot based on current county services provided and does not consider future costs of new infrastructure or services (such as extension of public transportation to increasingly rural destinations). This analysis further does not account for costs to individual residents, including ease of accessing government- and NGO-provided services, opportunities to engage and create community, and accessible employment options. While further work is needed to quantify the economic and social cost of different development strategies, understanding the impact to county expenditures is an important step to inclusion of public costs in development decisions.

[iii] Service spending includes county expenditures relating to utilities, public safety, transportation, and culture and recreation. It does not include fixed costs for programs of services unlikely to expand with increased development in unincorporated Pierce County.

WORKING LANDS COSTS

Agricultural lands are a central part of Pierce County's social and cultural identity. Supported by an extensive network of fertile lands, both large- and small-scale farming operations are a critical source of agricultural products, as well as a key economic driver, providing income for farmers and their families throughout the region. The 2012 Census of Agriculture, conducted by the United States Department of Agriculture National Agricultural Statistics Service found that the average acre of agricultural land in Pierce County supports the production of $1,838 worth of agricultural products, with the average farm size just over 30 acres. The majority of this market value (74%) was tied to the sale of livestock, with the remaining (26%) coming from crop sales.[13]

Because 2012 is the most recent data for which agricultural census data exists, we inflated the 2012 value in step with national inflation rates provided by the World Bank, resulting in an estimated market value of $2,010 per acre in 2018 dollars.[14] While this value represents the potential loss in market value associated with the conversion of agricultural land that would otherwise produce agricultural products, it is likely an underestimate of the true loss associated with converting agricultural lands as analyzing market value alone fails to capture the downstream impacts of reduced economic activity within a region. This value does not include the reduction in county, state, and federal taxes, and lost economic activity in industries supported by agricultural operations.

WORKING FOREST COSTS

Pierce County's expansive forests have long been used for the commercial growth and harvest of timber, an industry which has supported the region for decades. But population growth has led to a conversion of working forests, with an estimated loss of more than 18,000 acres of working forest throughout the region since 2004.[15] When working forests are lost, so are the ecosystem services that forests provide (see Loss of Ecosystem Services), but the conversion of forest land also includes the loss of economic benefits of sustainable timber harvesting.

The economic value of harvesting timber varies widely across harvesting operations and depends heavily on harvesting methods, labor and transportation costs, tree species, growth rate, and harvest rate. However, the Washington State Department of Revenue estimates an average "stumpage value" per 1000 board feet for a variety of tree species in western Washington. Stumpage is defined as the price a private firm is willing to pay a forest land owner for the right to harvest timber on their property.[16] The table below presents the average stumpage fee per 1000 board feet of the most harvested species in Pierce County in 2017, and the total stumpage per acre, assuming an average of 2700 board feet per acre.[17, 18] The results show that on average, an acre of working forest lost to development correlates with roughly $1,190 of lost timber harvest value, when using a weighted average.

TABLE 4 PRICE PER ACRE OF BOARD FEET - WESTERN WASHINGTON (2018)

SPECIES	% of 2017 PIERCE COUNTY HARVEST	AVERAGE STUMPAGE (1,000 BOARD FEET)	TOTAL STUMPAGE PER ACRE
DOUGLAS FIR	43%	$519	$1,427
WESTERN HEMLOCK	29%	$344	$946
OTHER CONIFER	16%	$344	$946
OTHER HARDWOOD	9%	$312	$858
CEDARS AND RED ALDER	3%	$840	$2,310

DEVELOPMENT **SCENARIOS**

The impacts of urban sprawl and increased development in Pierce County described above can be difficult to understand outside the context of a specific development plan. What ecosystems or land uses will new homes be replacing? Which housing types can be expected in different areas? And, how do these variations translate into economic impacts?

Based on current land use and housing densities throughout Pierce County, Earth Economics developed two scenarios to house 100 new residents. Scenario 1 assumes new houses will be built in unincorporated Pierce County while Scenario 2 assumes housing will be added in incorporated areas. Unincorporated areas of the county both are larger than incorporated areas and have fewer zoning restrictions. The density of housing in these rural and suburban unincorporated areas is thus much lower than in Pierce County cities (incorporated areas).

Using the present distribution in housing density, we calculated the amount of land required to house 100 people in unincorporated (Scenario 1) vs. incorporated Pierce County (Scenario 2). To understand the types of land that would be impacted, we assume that various land covers will be converted to new development based on the current distribution described in the "Ecosystem Service Costs" section of this report.

Creating new housing in unincorporated vs. incorporated Pierce County translates to differing levels of impact – specifically the loss of ecosystem services, increased County costs of public services, and foregone economic benefits of agriculture and sustainable forestry. This example of scenario analysis provides context for the costs of development decisions included in this report. Exploring costs of these and other scenarios is a valuable method for assessment of future land use or development decisions. Broken-down comparisons of the impacts are described in the following sections.

SCENARIOS

SCENARIO 1 UNINCORPORATED PIERCE COUNTY
100 PEOPLE, RURAL/SUBURBAN HOUSING DENSITY, 124 ACRES

SCENARIO 2 INCORPORATED PIERCE COUNTY
100 PEOPLE, URBAN/SUBURBAN HOUSING DENSITY, 25 ACRES

PEOPLE

1 PERSON = 10 PEOPLE

SCENARIO 1 100 PEOPLE
SCENARIO 2 100 PEOPLE

HOUSEHOLDS

1 HOUSE = 10 HOUSEHOLDS

SCENARIO 1 39 HOUSEHOLDS
SCENARIO 2 39 HOUSEHOLDS

HOUSING TYPE

SCENARIO 1 RURAL/SUBURBAN
PRIMARILY SINGLE-FAMILY HOMES

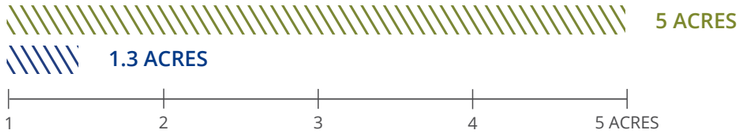
SCENARIO 2 URBAN
PRIMARILY APARTMENTS

ACRES

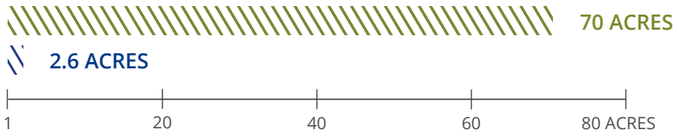
SCENARIO 1
124 TOTAL ACRES

SCENARIO 2
25 TOTAL ACRES

WORKING LANDS



WORKING FORESTS



SCENARIO **IMPACTS**

IMPACTS ON ECOSYSTEM SERVICES

A development's impact on the value of ecosystem services provided by the land it is built upon is driven primarily by the size of the development and the types of land cover converted in the construction process. While it is certainly possible to be strategic when determining what land is utilized in development (i.e., choosing to develop properties with degraded or less valuable ecosystem services), our analysis assumes that the developments under each scenario would convert lands that correlate with the proportional distribution of land cover found in unincorporated or incorporated Pierce County in their entirety (see figures below for breakdown of land cover type, within Pierce County). For example, 13% of the land in unincorporated Pierce County is shrubland, meaning that 13% of the land developed in Scenario 1: Unincorporated is assumed to be shrubland.

The results show that under Scenario 1: Unincorporated, the development of 124 acres of land to house 100 people would result in the loss of over $210,000 worth of ecosystem services every year. Much of this loss comes from the conversion of evergreen forests. Urban evergreen forests are a critical source of ecosystem services, including air and water purifying services which are particularly important given the forest's proximity to urban areas. These lands can moderate urban temperatures, filter air pollutants, sequester carbon, and purify stormwater, thereby reducing energy and healthcare costs for residents and reducing the impact of urban areas on their surrounding ecosystems.[19] In contrast, the developments under Scenario 2: Incorporated, which would also provide housing for 100 people, would only require 25 acres of land and would result in an annual loss of less than $36,000 worth of ecosystem services. In other words, by choosing to develop properties in Pierce County, the public can expect save over $175,000 worth of ecosystem services every year. For a detailed breakdown of the loss of ecosystem service value by land cover type please see Appendix E.

FIGURE 2 LAND COVER, INCORPORATED PIERCE COUNTY

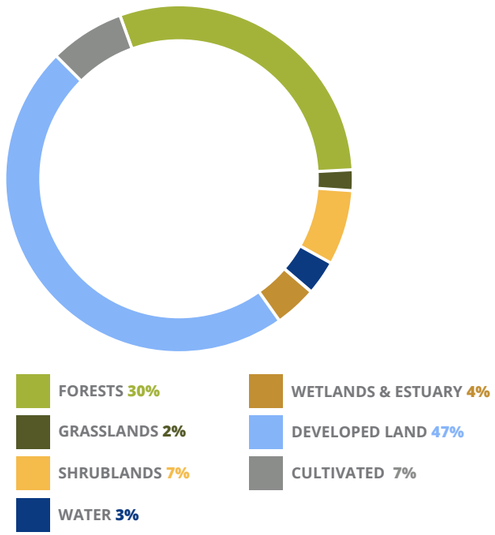
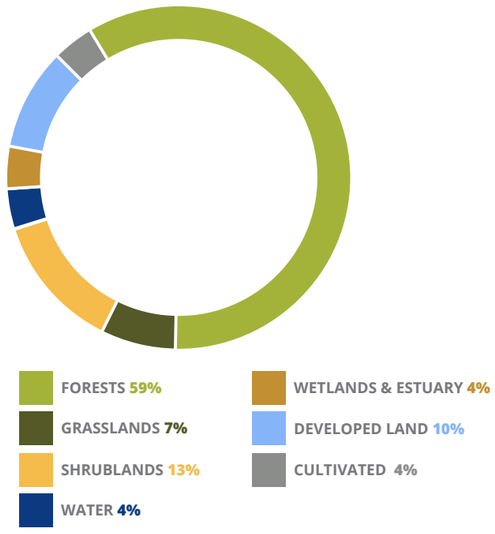


FIGURE 3 LAND COVER, UNINCORPORATED PIERCE COUNTY



IMPACTS ON WORKING LANDS

In addition to the loss of ecosystem services through the conversion of natural lands to developed space, the conversion of agricultural lands also results in the loss of economic activity associated with the production and sale of agricultural products. The potential loss of value in both development scenarios was calculated using the average market value of agricultural goods produced per acre of cultivated land within Pierce County (see "Working Lands Costs" section). In Scenario 1: Unincorporated, the various developments would require 124 acres of land, nearly 5 acres of which would be cultivated lands, equating to a loss of roughly $9,300 every year. In Scenario 2: Incorporated, the developments would only require 25 acres of land, of which less than 2 acres are cultivated lands. Under this scenario the conversion of cultivated lands would only result in a loss of roughly $3,400 per year. In other words, choosing to develop properties in incorporated Pierce County would produce an additional $5,900 worth of agricultural goods each year.

IMPACTS ON WORKING FORESTS

The conversion of forest lands also results in a potential economic loss. The loss of potential timber revenue from sustainable forestry associated with each development scenario was calculated using the weighted stumpage per acre fees calculated for the most common tree species (see section "Working Forests Costs"). In Scenario 1: Unincorporated, the developments needed to house 100 people would require 124 acres of land with roughly 70 acres of that land comprised of evergreen and mixed forest lands. The conversion of these forested areas equates to a loss of roughly $82,900 every 30 years, the average length of time for evergreen and mixed forests to regrow. In Scenario 2: Incorporated, the developments would only require 25 acres of land, just over 2 acres of which are evergreen and mixed forest lands. Under this scenario the conversion of forest land only equated to a loss of roughly $7,900 every 30 years.

IMPACTS ON EXTENDING SERVICES

Based on the per-household cost of services identified in Table 6 and the current density patterns across Pierce County incorporated and unincorporated areas, the cost of County-provided services is evaluated for the development alternatives. In each presented scenario, 100 people would be housed. On average, there are 2.6 people per household in Pierce County.[20] Using this average household size, both scenarios would require the addition of 39 new housing units. The difference in location, unincorporated vs. incorporated, determines the presumed housing density and cost of providing services to those households.

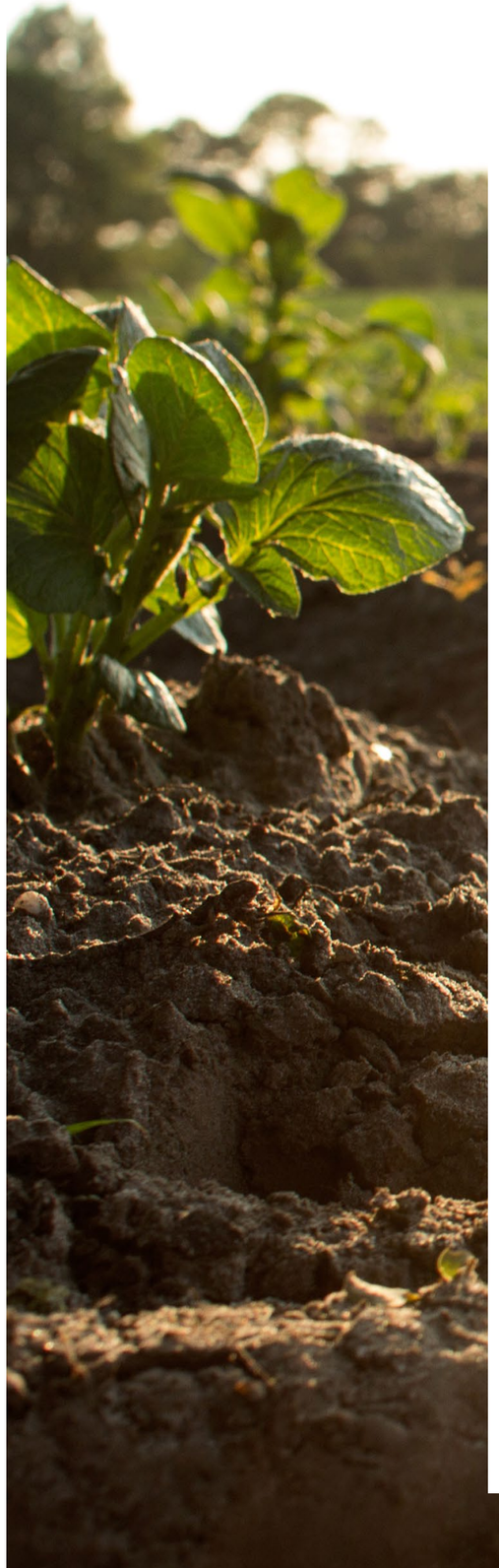
Under Scenario 1, 100 people would be housed in unincorporated Pierce County. Following the current distribution of housing density, new residents would be split between rural and rural/suburban housing densities with an annual county service provision cost ranging from $1,560 to $2,090 per household (See Table 6). For 39 new housing units, Scenario 1 would cost the County an additional $70,000 annually. Alternatively, Scenario 2 would also create 39 new housing units, but half would be constructed at urban densities, with the remaining split between suburban and rural/suburban densities. New housing units under Scenario 2 would cost the County $39,200 every year, which is 56% of the Scenario 1 cost.

IMPACT SUMMARY

While the impacts observed in these hypothetical scenarios are indeed hypothetical, they illustrate the very real tradeoffs that can occur when developing natural areas in incorporated and unincorporated Pierce County. Totaling these impacts also illustrates how significant the costs of sprawl can be, especially when considering the multitude of properties being developed, as opposed to the single development scenarios examined in our report. To account for the impacts on working forests, which are calculated on a 30-year cycle to account for forest growth rates, our overall impact summery also considers a 30-year timeframe.[iv] These results are presented in the summary provided to the right

Across all categories, the developments in Scenario 2: Incorporated prove more advantageous. These Scenario 2 developments would still have an impact on ecosystem services, agricultural productivity, potential timber harvest revenue, and resulted in higher costs of county expenditures. However, these impacts would cost $2.3 million over 30 years, or $6.4 million less than the developments in Scenario 1: Unincorporated.

[iv] For this analysis, costs were assumed to be constant across the 30-year timeline. in reality, the cost of providing services, stumpage fees, and the value of ecosystem services would likely rise.



POTENTIAL ECONOMIC LOSS

TOTAL COST OF SPRAWL - 30 YEAR TIMELINE ($2018)

SCENARIO 1 UNINCORPORATED PIERCE COUNTY
100 PEOPLE, RURAL/SUBURBAN HOUSING DENSITY, 124 ACRES

SCENARIO 2 INCORPORATED PIERCE COUNTY
100 PEOPLE, URBAN/SUBURBAN HOUSING DENSITY, 25 ACRES

LOSS OF ECOSYSTEM SERVICE VALUE

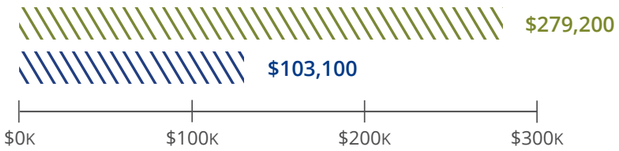
MARGINAL DIFFERENCE: $5,805,200

LOSS FROM EXTENDING SERVICES

MARGINAL DIFFERENCE: $925,800

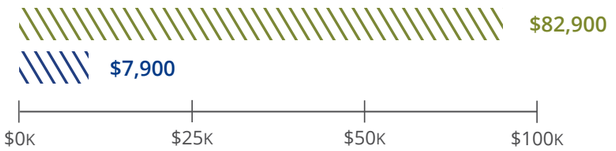
LOSS OF AGRICULTURAL VALUE

MARGINAL DIFFERENCE: $176,100



LOSS OF TIMBER HARVEST VALUE

MARGINAL DIFFERENCE: $75,000



CONCLUSION AND **NEXT STEPS**

This report explores some of the key impacts of the conversion of Pierce County's natural landscapes and open spaces. Namely, we examine how development impacts the value of ecosystem services, the productivity of working farms and forests, and the cost of extending county services to new areas. While development is necessary component of Pierce County's economic growth, developers and policymakers alike need to understand the trade-offs of developing rural and unincorporated areas, as opposed to incorporated or urban areas, to make the most effective decisions for Pierce County's residents.

Modeling the impacts analyzed in this report in two development scenarios, each designed to house 100 residents, we found that developing properties in incorporated Pierce County would result in a loss of $1.8 million over 30 years. Alternatively, developing properties in unincorporated Pierce County would result in a loss of $8.8 million over 30 years, or $7 million worth of additional losses. While these estimates are based on hypothetical scenarios, they represent the real costs of sprawl, which are important considerations for the future of Pierce County's natural landscapes.

In addition to the costs of sprawl analyzed in this report, Earth Economics also presents the following recommendations for additional research and considerations that will further support strategic decision-making on development.

1 RELATIONSHIP BETWEEN HOUSING SUPPLY AND AFFORDABILITY

An increase in housing supply can provide homes for new residents, but also reduce prices for existing residents by increasing the number of homes on the market, an effect that can be particularly important for low-income residents. This dynamic impacts development decisions, tied to issues of affordability, equity, and environmental justice. Additionally, the location of affordable housing has impact on its ability to be a sustainable, long-term housing option. Reduced accessibility to jobs and public services has the potential to negate the positive benefits of lower housing prices. Further study of these effects would help inform the impact of development decisions on residents.

2 IMPACTS MITIGATED THROUGH LOW IMPACT DEVELOPMENT

As noted throughout the report, the impacts of a particular development can be mitigated by developing specific properties, or developing in a particular way. For example, a development that converts several acres of grassland, or a previously degraded area, will have a smaller impact on the value of ecosystem services provided by that area than if that development converted forest land, or a highly functioning ecosystem. The development may also incorporate solar energy, pervious pavement, or other green infrastructure, thereby reducing its overall impact. Additional research is needed to understand how specific building techniques can mitigate the impact of converting natural lands.

3 TOTAL ECONOMIC BENEFITS OF WORKING FARMS AND FORESTS

The economic benefits of working farms and forests examined in the report focused on the market value for agricultural products and stumpage fees paid to forest land owners to harvest timber from their property. However, our analysis was unable to capture the ripple effects of the economic activity generated by working farms and forests in Pierce County. For example, a farming family in the county will produce agricultural products that can be valued based on local markets. But in order to produce those goods, that family will likely have to buy seeds, fertilizer, and farming equipment, hire workers to help farm the land, and pay income taxes on products sold. This means that the market value of the goods produced does not capture the broader economic activity support by that families farming activities. Having a more holistic understanding of the total economic benefits supported by farming and forestry activities will improve decision-making for converting productive lands.

APPENDIX

APPENDIX A
ECOSYSTEM SERVICES, BY DEFINITION

FIGURE 4 ECOSYSTEM SERVICES, BY DEFINITION

PROVISIONING	
Food	Can include crops, fish, game, and/or produce
Medicinal Resources	Can include traditional medicines, pharmaceuticals, and/or assay organisms
Ornamental Resources	Resources for clothing, jewerly, handicrafts, worship, and decoration
Energy and Raw Materials	Can include fuel, fiber, fertilizer, minerals, and/or energy
Water Storage	Amount of surface or ground water held and its capacity to reliably supply water
REGULATING	
Air Quality	Ability to create and maintain clean, breatable air
Biological Control	Pest and/or disease control
Climate Stability	Ability to support a stable climate at global or local levels
Disaster Risk Reduction	Ability to prevent and mitigate natural disasters, including flood, fire, drought, etc.
Genetic Transfer	Includes pollination and/or seed dispersal
Soil Formation	Soil creation for agricultural and/or ecosystem(s) integrity
Soil Quality	Soil quality improvement due to decomposition and pollutant removal
Soil Retention	Ability to retain arable land, slope stability, and coastal integrity
Water Quality	Water quality improvement due to decomposition and pollutant removal
Water Supply	Ability to provide natural irrigation, drainage, supply, flow, and use of water
Navigation	Ability to maintain neccersary water depth for recreational and commercial vessels
SUPPORTING	
Habitat and Nursery	Ability to maintain genetic and biological diversity, and to promote species growth
INFORMATION	
Aesthetic Information	Enjoyment and appreciation of nature through the senses (sight, sound, etc.)
Cultural Value	Use of nature in art, symbols, architecture, and religious/spiritual purposes
Recreation and Tourism	Can include hiking, boating, travel, camping, and more
Science and Education	Use of natural systems for education and scientific research

ZUCCHINI PLANT

APPENDIX B VALUATION METHODS

The valuation of most ecosystem services is well-understood and straightforward. However, for ecosystem services that are difficult to value, the benefits are often better described qualitatively. The primary studies from which values are drawn employ a range of valuation techniques depending on the specific circumstances, including:

MARKET PRICING The current market value of goods produced within an ecosystem. *e.g., food, timber*

REPLACEMENT COST The cost of replacing services provided by functional natural systems with man-made infrastructure. *e.g., installation of a levee to replace natural floodplain protection*

AVOIDED COST Ecosystem services can help communities avoid harm that would have incurred in the absence of those services. *e.g. flooding reduction by wetlands and riparian buffers*

PRODUCTION APPROACHES Ecosystem services which enhance output. *e.g. rain-fed irrigation can increase crop productivity*

TRAVEL COST Demand for some ecosystem services may require travel, the cost of which reflects the implicit value of those services. *e.g., recreation and tourism*

HEDONIC PRICING Property values vary by proximity to some ecosystem services. *e.g. homes with water views often sell for higher prices than similar homes without such views*

CONTINGENT VALUATION Estimates of value based on surveys of the values assigned to certain activities. *e.g., willingness-to-pay to protect water quality*

APPENDIX C STUDY LIMITATIONS

Valuation exercises have limitations, yet these limitations should not detract from the core finding that ecosystems produce significant economic value for society. Like any economic analysis, the benefit transfer method (BTM) has strengths and weaknesses. Some arguments against benefit transfer include:

- Every ecosystem is unique; per-acre values derived from another location may be of limited relevance to the ecosystems under analysis.
- Even within a single ecosystem, the value per acre depends on the size of the ecosystem; in most cases, as the size decreases, the per-acre value is expected to increase, and vice versa. (In technical terms, the marginal cost per acre is generally expected to increase as the quantity supplied decreases; a single average value is not the same as a range of marginal values).
- Gathering all the information needed to estimate the specific value for every ecosystem within the study area is not currently feasible. Therefore, the full value of all of the shrubland, grassland, et cetera in a large geographic area cannot yet be ascertained. In technical terms, far too few data points are available to construct a realistic demand curve or estimate a demand function.
- The prior studies upon which calculations are based encompass a wide variety of time periods, geographic areas, investigators, and analytic methods. Many of them provide a range of estimated values rather than single-point estimates. The present study preserves this variance; no studies were removed from the database because their estimated values were deemed too high or too low. In addition, only limited sensitivity analyses were performed. This approach is similar to determining an asking price for a piece of land based on the prices of comparable parcels ("comps"): Even though the property being sold is unique, realtors and lenders feel justified in following this procedure to the extent of publicizing a single asking price rather than a price range.
- The objection to the absence of even an imaginary exchange transaction was made in response to the study by Costanza et al. (1997) of the value of all of the world's ecosystems. Even this is not necessary if one recognizes the different purpose of valuation at this scale – a purpose that is more analogous to national income accounting than to estimating exchange values.[21]

This report displays study results in a way that allows one to appreciate the range of values and their distribution. It is clear from inspection of the tables that the final estimates are not precise. However, they are much better estimates than the alternative of assuming that ecosystem services have zero value, or, alternatively, of assuming they have infinite value. Pragmatically, in estimating the value of ecosystem services, it would be better to be approximately right than precisely wrong.

APPENDIX D
ECOSYSTEM SERVICE VALUE CALCULATIONS

TABLE 5 UNINCORPORATED PIERCE COUNTY, ROUNDED

FOREST TYPE	ATTRIBUTE		ACRES	USD/ACRE/YEAR		USD/YEAR	
	RIPARIAN	URBAN		LOW	HIGH	LOW	HIGH
CULTIVATED							
PASTURE/HAY			20,974	$310	$2,100	$60,501,940	$44,045,400
CULTIVATED CROPS			14,636	$50	$50	$731,800	$731,800
FORESTS							
DECIDUOUS FORESTS			18,451	$830	$2,690	$15,314,330	$49,633,190
	R		2,762	$900	$6,400	$2,485,800	$17,676,800
		U	2,178	$1,330	$3,170	$2,896,740	$6,904,260
	R	U	136	$1,330	$6,400	$180,880	$870,400
EVERGREEN FORESTS			368,761	$950	$2,810	$350,322,950	$1,036,218,410
	R		88,781	$1,020	$6,530	$90,322,950	$579,739,930
		U	6,461	$1,450	$6,530	$9,368,450	$42,190,330
	R	U	410	$1,450	$6,530	$594,500	$2,677,300
MIXED FORESTS			59,047	$820	$2,690	$48,418,540	$158,836,430
	R		9,441	$900	$6,400	$8,496,900	$60,422,400
		U	4,904	$1,690	$3,760	$9,287,760	$18,439,040
	R	U	332	$1,690	$7,000	$561,080	$2,324,000
GRASSLAND							
GRASSLAND			57,338	$10	$20	$573,380	$1,146,760
	R		5,569	$460	$480	$2,561,740	$2,673,120
		U	1,945	$10	$20	$19,450	$38,900
SHRUBLANDS							
SHRUBLAND			125,599	$70	$90	$8,791,930	$11,303,910
WATER							
LAKE/POND			9,160	$850	$1,310	$7,786,000	$11,999,600
RIVER			28,856	$3,660	$4,280	$105,612,960	$123,503,680
WETLANDS & ESTUARY							
ESTUARY			4,132	$200	$6,690	$826,400	$27,643,080
WETLANDS (FRESHWATER)			33,492	$7,001	$8,900	$73,682,400	$298,078,800
DEVELOPED LAND							
DEVELOPED LAND			91,769	-	-	-	-
		TOTALS	**955,134**	**-**	**-**	**$744,572,550**	**$2,497,097,540**

TABLE 6 INCORPORATED PIERCE COUNTY, ROUNDED

FOREST TYPE	ATTRIBUTE		ACRES	USD/ACRE/YEAR		USD/YEAR	
	RIPARIAN	URBAN		LOW	HIGH	LOW	HIGH
CULTIVATED							
PASTURE/HAY			5,041	$310	$2,100	$1,558,100	$10,575,970
CULTIVATED CROPS			7,713	$50	$50	$385,650	$385,650
FORESTS							
DECIDUOUS FORESTS			31	$830	$2,690	$25,730	$83,390
	R		9	$900	$6,400	$8,100	$57,600
		U	5,067	$1,330	$3,170	$6,739,110	$16,062,390
	R	U	804	$1,330	$6,400	$1,069,320	$5,145,600
EVERGREEN FORESTS			106	$950	$2,810	$100,700	$297,860
	R		112	$1,020	$6,530	$114,240	$731,360
		U	30,479	$1,450	$6,530	$44,194,5500	$199,027,970
	R	U	7,300	$1,450	$6,530	$10,585,000	$47,669,000
MIXED FORESTS			99	$820	$2,690	$81,180	$266,310
	R		34	$900	$6,400	$30,600	$217,600
		U	10,347	$1,690	$3,760	$17,486,430	$38,904,720
	R	U	1,326	$1,690	$7,000	$2,240,940	$9,282,000
GRASSLAND							
GRASSLAND			14	$10	$20	$140	$280
	R		658	$460	$480	$302,680	$315,840
		U	4,555	$10	$20	$45,550	$91,100
SHRUBLANDS							
SHRUBLAND			12,571	$70	$90	$879,970	$1,131,390
WATER							
LAKE/POND			2,268	$850	$1,310	$1,927,800	$2,971,080
RIVER			3,064	$3,064	$4,280	$11,214,240	$13,113,920
WETLANDS & ESTUARY							
ESTUARY			333	$333	$6,690	$66,600	$2,227,770
WETLANDS (FRESHWATER)			7,001	$7,001	$8,900	$15,402,200	$62,308,900
DEVELOPED LAND							
DEVELOPED LAND			87,346	-	-	-	-
		TOTALS	**186,278**	**-**	**-**	**$114,458,830**	**$410,867,600**

APPENDIX E
LOSS OF ECOSYSTEM SERVICES CALCULATIONS

TABLE 7 LOSS OF ANNUAL ECOSYSTEM SERVICE VALUE - SCENARIO 1: UNINCORPORATED ($2018)

FOREST TYPE	ATTRIBUTE		ACRES	% OF LAND COVER	ACRES IN SCENARIO 2	AVG. ECOSYSTEM SERVICES VALUE PER ACRE	VALUE OF ECOSYSTEM SERVICES LOST IN SCENARIO 2
	RIPARIAN	URBAN					
CULTIVATED							
PASTURE/HAY			20,974	2%	2.72	$1,204	$3,277
CULTIVATED CROPS			14,636	2%	1.90	$47	$90
FORESTS							
DECIDUOUS FORESTS			18,451	2%	2.40	$1,760	$4,216
	R		2,762	0%	0.36	$3,653	$1,310
		U	2,178	0%	0.28	$2,249	$636
	R	U	136	0%	0.02	$3,868	$68
EVERGREEN FORESTS			368,761	39%	47.87	$1,881	$90,044
	R		88,781	9%	11.53	$3,773	$43,491
		U	6,461	1%	0.84	$3,988	$3,345
	R	U	410	0%	0.05	$3,988	$212
MIXED FORESTS			59,047	6%	7.67	$1,755	$13,456
	R		9,441	1%	1.23	$3,648	$4,471
		U	4,904	1%	0.64	$2,724	$1,734
	R	U	332	0%	0.04	$4,343	$187
GRASSLAND							
GRASSLAND			57,338	6%	7.44	$14	$107
	R		5,569	1%	0.72	$471	$341
		U	1,945	0%	0.25	$14	$4
SHRUBLANDS							
SHRUBLAND			125,599	13%	16.31	$80	$1,311
WATER							
LAKE/POND			9,160	1%	1.19	$1,082	$1,287
RIVER			28,856	3%	3.75	$3,969	$14,869
WETLANDS & ESTUARY							
ESTUARY			4,132	0%	0.54	$3,443	$1,847
WETLANDS (FRESHWATER)			33,492	4%	4.35	$5,547	$24,119
DEVELOPED LAND							
DEVELOPED LAND			91,769	10%	11.91	-	-
		TOTALS	**955,134**	**100%**	**124.00**	**-**	**$210,422**

TABLE 8 LOSS OF ANNUAL ECOSYSTEM SERVICE VALUE - SCENARIO 2: INCORPORATED ($2018)

FOREST TYPE	ATTRIBUTE		ACRES	% OF LAND COVER	ACRES IN SCENARIO 1	AVG. ECOSYSTEM SERVICES VALUE PER ACRE	VALUE OF ECOSYSTEM SERVICES LOST IN SCENARIO 1
	RIPARIAN	URBAN					
CULTIVATED							
PASTURE/HAY			5,041	3%	0.68	$1,204	$814
CULTIVATED CROPS			7,713	4%	1.04	$47	$49
FORESTS							
DECIDUOUS FORESTS			31	0%	0.00	$1,760	$7
	R		9	0%	0.00	$3,653	$4
		U	5,067	3%	0.68	$2,249	$1,529
	R	U	804	0%	0.11	$3,868	$417
EVERGREEN FORESTS			106	0%	0.01	$1,881	$27
	R		112	0%	0.02	$3,773	$57
		U	30,479	16%	4.09	$3,988	$16,315
	R	U	7,300	4%	0.98	$3,988	$3,908
MIXED FORESTS			99	0%	0.01	$1,755	$23
	R		34	0%	0.00	$3,648	$17
		U	10,347	6%	1.39	$2,724	$3,783
	R	U	1,326	1%	0.18	$4,343	$773
GRASSLAND							
GRASSLAND			14	0%	0.00	$14	$0
	R		658	0%	0.30	$471	$42
		U	4,555	2%	0.41	$14	$9
SHRUBLANDS							
SHRUBLAND			12,571	7%	1.69	$80	$136
WATER							
LAKE/POND			2,268	1%	0.30	$1,082	$329
RIVER			3,064	2%	0.41	$3,969	$1,632
WETLANDS & ESTUARY							
ESTUARY			333	0%	0.04	$3,443	$154
WETLANDS (FRESHWATER)			7,001	4%	0.94	$5,547	$5,212
DEVELOPED LAND							
DEVELOPED LAND			87,346	47%	11.72	-	-
		TOTALS	**186,278**	**100%**	**25.00**	**-**	**$35,237**

APPENDIX F
ECOSYSTEM SERVICE VALUATION REFERENCES

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