

# *The Economic Benefits of Natural Goods and Services*

A Report for the Piedmont Environmental Council



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## Executive Summary

Virginia receives a myriad of economic benefits from its natural resources in the form of market products, non-market services, and added value. Using a value transfer approach, this study leverages the results of pre-existing studies to quantify the estimated annual contribution of nine such natural services – water quality, water supply, pollination, recreation, forest products, farm products, disturbance prevention, habitat, and carbon sequestration – to be approximately \$21.8 billion. State and federal public lands in Virginia provide \$5.1 billion of this total, and the more than 700,000 acres of private lands under conservation easement provide approximately \$520 million of the total.

Over one hundred articles and policy papers were reviewed to produce per-acre value estimates for the nine different commonly studied natural benefits. These were then scaled to the desired policy levels through manipulation of the US Geological Survey’s 2002 National Land Cover Dataset.

**Table 1. Summary of Findings, Total Service Values by Policy Level<sup>1</sup>**

	All Virginia Land Cover	Public Lands in Virginia	Virginia Lands Under Easements
<b>Water Quality</b>	\$5,200,000,000	\$810,000,000	\$140,000,000
<b>Water Supply</b>	\$980,000,000	\$170,000,000	\$24,000,000
<b>Pollination</b>	\$27,000,000	\$460,000	\$650,000
<b>Recreation</b>	\$8,000,000,000	\$3,200,000,000	\$130,000,000
<b>Forest Products</b>	\$1,800,000,000	\$250,000,000	\$42,000,000
<b>Farm Products</b>	\$2,300,000,000	\$43,000,000	\$94,000,000
<b>Disturbance Prevention</b>	\$1,900,000,000	\$410,000,000	\$55,000,000
<b>Habitat</b>	\$450,000,000	\$91,000,000	\$14,000,000
<b>Carbon Sequestration</b>	\$1,100,000,000	\$170,000,000	\$26,000,000
<b>Total</b>	<b>\$21,800,000,000</b>	<b>\$5,100,000,000</b>	<b>\$520,000,000</b>

<sup>1</sup> Totals may not add due to rounding

With outdoor recreationists spending over \$8 billion dollars within the state annually, recreation was estimated to be the single largest natural benefit to the Virginia economy. The state's numerous forests and wetlands provide approximately \$5.2 billion in annual savings



from runoff prevention, filtration, and cost avoidance. Farms and forests produce over \$4 billion worth of products annually, excluding secondary processing within the state. The coastal barrier islands and beaches help coastal municipalities and property owners avoid \$1.9 billion in costs stemming from with maritime erosion and storm damage. Coastal wetlands provide habitat and nurseries, used by the Chesapeake's crabbers and fishermen, which are valued at \$450 million. Similarly, Virginia's farmers, vintners, and fruit growers receive \$27 million in pollination services from native insects and birds. Forests, wetlands and lakes store and help supply, moderate and clean the state's drinking water supply, valued at \$980 million. Finally, the state's forests, and, to a much lesser degree, grasslands and croplands, sequester 42.9 million tons of CO<sub>2</sub> equivalent, which carries a \$1.1 billion value based on a price of \$25 per ton. The per-acre estimates used to produce the policy level values are given in Table 2.

**Table 2. Natural Benefits Per-Acre by Land Cover Type**

	<b>Acreage in VA</b>	<b>Value Per Acre</b>
<b>Beaches (Sand and Clay)</b>	2,746	\$507,768
<b>Emergent Herbaceous Wetlands</b>	190,164	\$4,827
<b>Woody Wetlands</b>	706,409	\$4,815
<b>Open water</b>	492,275	\$1,805
<b>Evergreen Forest</b>	2,147,214	\$765
<b>Mixed Forest</b>	3,630,432	\$729
<b>Deciduous Forest</b>	10,904,427	\$698
<b>Pasture/Hay</b>	4,837,562	\$207
<b>Row Crops</b>	37,032	\$88
<b>Urban/Recreational Grasses</b>	1,284,127	\$58
<b>Transitional</b>	317,973	\$46
<b>Quarries/Strip Mines/Gravel</b>	42,991	\$0
<b>Low Intensity Residential</b>	570,750	\$0
<b>High Intensity Residential</b>	32,546	\$0
<b>Commercial/Industrial/Transportation</b>	270,425	\$0

On a per acre basis, the most valuable land cover type was sand and clay as it encompasses the Commonwealth's relatively limited beaches. As these both defend against ocean erosion and host a tourism industry that draws over a billion dollars in annual revenue, they are the most valuable land cover type. However, merely by virtue of comprising 42.8 percent of the state's land area, deciduous forests provide the most benefit overall. As has been widely determined in environmental economic literature, wetlands are extremely valuable on a per acre basis as well due to the water supply, water filtration, habitat, and storm surge protection that they provide. All intensely developed, impermeable surface land cover types were estimated to provide zero natural benefits. Although urban green spaces exist and are extremely valuable, significantly more so than similar sites in rural areas, their benefit is not accounted for in the developed land cover classes.<sup>2</sup> Instead the forest and grass cover types capture the benefits of parks, playing fields, and green ways.



These estimates for natural benefits include both market values for goods such as forest and farm products as well as non-market benefits such as water filtration, that save municipalities money or generate wealth but which are not evaluated in traditional accounting schemes. This report has given preference to studies that rely on cost of replacement, defensive

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<sup>2</sup> Trust for Public Land. *The Economic Benefits of the Parks and Recreation System in Macklenberg County North Carolina*, 2010. Trust for Public Land. *How Much Value does the City of Wilmington Receive from its Park and Recreation System*. 2009.

expenditure, voluntary market, or hedonic analytical methods over those that use contingent valuation and group valuation methods. The former group of methods assesses ecosystem service values in terms of how much it would cost to replace them, savings they make for a municipal government, or value they add to a home while the latter essentially ask respondents what they would be willing to pay to protect a resource. While contingent valuation is accepted academic practice, the goal of this project has been to quantify palpable economic impacts of natural resources and not willingness to pay, which favors the first set of methods.

Virginia's voters, businesses, trade groups, and two most recent Governors have commented on the value of the state's natural resources in different terms. Economic value may not necessarily be the first concern among outdoors appreciators, but it is significant. This report represents the first attempt to quantify the annual contribution of these assets to Virginia's economy in the hopes that policy makers and business owners may better account for them in the planning for the next phase of economic prosperity within the Old Dominion.

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## *Natural Benefits and the Virginia Economy*

Virginia has experienced impressive economic growth in recent years. Despite two major recessions, the Commonwealth's economy has grown by 100 percent since 1997, which represents a rate of growth three times greater than that of the U.S. over the same period or roughly comparable to that of fast growing Asian economies, such as South Korea. With a GDP larger than that of Austria or Saudi Arabia, Virginia notionally represents the world's 23<sup>rd</sup> largest economy.<sup>3</sup> Such impressive growth reflects the Commonwealth's fundamentally strong business environment. CNBC recently named the state the best place to do business in the U.S. for the third time in five years (in 2010 and 2008 it ranked second to Texas). In describing the state's strong performance the study cited its strategic location, friendly regulatory climate, diverse economy, and improved education system.<sup>4</sup>

This impressive growth has precipitated significant development and urban expansion, especially in the northern reaches of the state. While population has increased by 29 percent since 1990, vehicle registrations have grown by 50 percent over the same period, reflecting the increasing share of the population living in suburban communities.<sup>5</sup> In further evidence of this trend, since 1987, 1.28 million acres of Virginia's rural lands have been developed, including 426,000 acres of prime farmland.<sup>6</sup> Looking ahead, forest cover in the northern piedmont is projected to decline by 31 percent from current levels by 2040 while forest cover in the central piedmont and northern mountain regions is projected to decline by 13 percent and 8 percent respectively.<sup>7</sup> Although these deforestation and development trends are far from exceptional in comparison to other states, for example North Carolina has seen significantly higher rates of both farmland and forest conversion, these trends present planners and resource managers with the challenge of pursuing economic growth and natural resource preservation, in concert.

The value of Virginia's natural capital has been implicitly recognized by numerous entities in recent years. In 2006, citing the increasing costs of land throughout the commonwealth and the benefits of runoff mitigation, Governor Tim Kaine set a goal of conserving 400,000 acres

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<sup>3</sup> World Bank, 2010; Bureau of Economic Analysis, 2011.

<sup>4</sup> Fortune Magazine, 2007; CNBC, 2011.

<sup>5</sup> Virginia Department of Transportation, 2011.

<sup>6</sup> Farmland Information Center, 2011;

[http://www.farmlandinfo.org/agricultural\\_statistics/index.cfm?function=statistics\\_view&stateID=VA](http://www.farmlandinfo.org/agricultural_statistics/index.cfm?function=statistics_view&stateID=VA)

<sup>7</sup> US Forest Service, Southern Forestry Assessment, 2002. Data Center: Area Change Dataset.

<http://www.srs.fs.usda.gov/sustain/data/index.htm>

of land during his term. With Virginia's transferable land preservation tax credit as a powerful incentive, this goal was met by January 2010. His successor, Governor Bob McDonnell, set a new 400,000 acre conservation goal upon taking office. In short, political leaders from both parties perceived a need to preserve Virginia's natural qualities and open spaces for health, quality of life, and cultural heritage reasons.



The aforementioned CNBC study similarly recognized the importance of clean water, clean air, and natural places but also went so far as to evaluate the state's performance in providing these services to its workers. Out of the ten criteria CNBC used to rank states on their business attractiveness, Virginia's lowest score was in quality of life, ranking 26<sup>th</sup> in the nation.<sup>8</sup> In addition to health care, this aspect looks at air quality, water quality, and access to attractions, such as parks. Business owners and policy makers increasingly consider the livability of sites when making decisions about where to open a new office or how to plan developments. The National Association of Realtors surveyed new home buyers to determine preferences for selecting new homes. They found that an increasing number of buyers actively seek mixed use communities with a number of shops, businesses and amenities within walking distance. Those that would trade a short commute for a larger home increasingly prefer larger, secluded lots.<sup>9</sup>

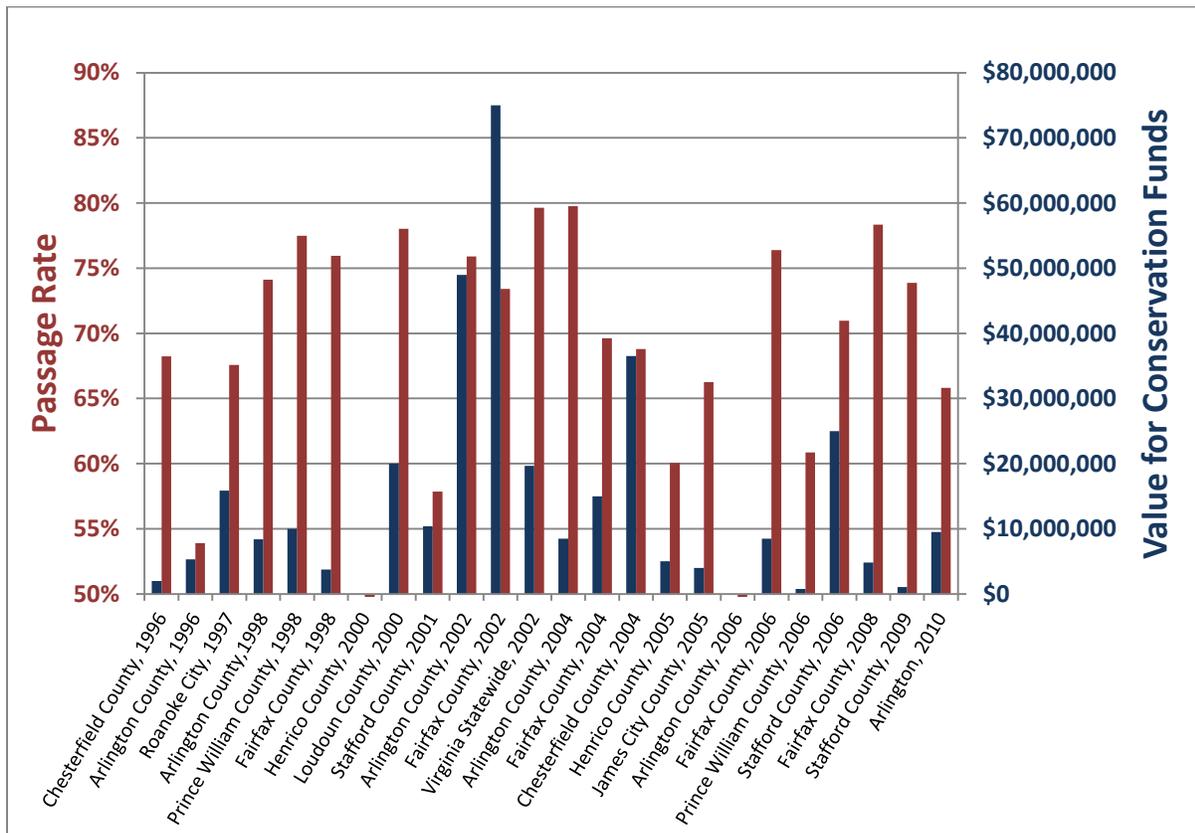
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<sup>8</sup> CNBC, 2011. <http://www.cnbc.com/id/43227250>

<sup>9</sup> National Association of Realtors. 2011 Community Preference Study: What Are Americans Looking For When Deciding Where to Live?

These trends represent continued departure from the suburban development paradigm and advocate for more open space conservation and dense urban development.

Virginia voters have confirmed these NAR findings in numerous referendums on funding for land conservation. Since 1996, there have been 26 referendums for conservation funding and other public goods, mostly at the county level, of which 24 have passed. On average, these measures have received 68 percent of the vote and have appropriated a total of \$338 million for conserving public open space, or \$15 million on average (see Figure 1). In further testament to growing popular concern over suburban sprawl, all of these initiatives occurred in the fast growing suburban communities surrounding Washington and Richmond. The only exceptions being a City of Roanoke initiative in 1997 and a statewide bond issue in 2002.



**Figure 1: Support for and Value of Virginia Conservation Bond Referendums<sup>10</sup>**

<sup>10</sup> Trust for Public Land, Land Vote Database.

Unlike legislative appropriations, general obligation bonds such as those voted on in these referendums usually entail a property or sales tax increase to repay the debt. As such, each bond amounts to a self-imposed tax by Virginia voters that has been levied in both strong and weak economic times. In addition to such instances of indirect or implicit recognition of land's myriad value, thousands of academic and policy studies have quantified the market, non-market, and non-use values of natural resources throughout the world. Through the use of these various resources, the estimation of a state's natural resource service value becomes possible.



*Photo by Kaye Kohler*

## *Articulating Virginia's Natural Benefits*

Natural benefits include the economic value of the goods and services provided by ecosystems and abiotic sources. These goods include drinking water, timber, mineral deposits, crops and livestock, and have readily quantifiable market values. Natural services are often not priced explicitly and can only be quantified through non-market valuation techniques. Some examples include water purification from forests and wetlands, erosion and disturbance prevention from barrier islands, pollination from native insects, habitat provision for marine resources, carbon sequestration, and property value enhancement. This study quantified the economic contribution of nine goods and services within Virginia, its public lands, and lands under easement.

### **1. Water Quality**



Forests, pastures and wetlands absorb excess nutrient runoff as well as toxins from transportation corridors, agricultural enterprises, and industrial sources. High concentrations of nitrogen and phosphorus in the Chesapeake Bay have been detrimental to marine resources stocks and drinking water supplies. Wetland restoration and reforestation activities in the

watershed have been instrumental in reducing nutrient loading in the bay.<sup>11</sup> Forests filter the flow higher in the watershed, thereby saving municipalities from making major capital expenditures in chemical or mechanical treatment. A study by the American Water Works Association and The Trust for Public Land found forest cover to be negatively correlated with water treatment costs.<sup>12</sup> Furthermore, forest cover mitigates runoff during periods of heavy rain and therefore limits sedimentation of waterways and helps to retain ground water. Different natural land cover types provide a filtration, reduce runoff, and ensure a relatively consistent flow of water for their surrounding municipalities.

#### Case Study – Hardware River Fencing Project

The Hardware River fencing project protected approximately one mile of degraded frontage on the Hardware River in Albemarle County. The Virginia Department of Conservation and Recreation Natural Heritage Program has identified the James spiny mussel (*Pleurobema collina*), a federal and state endangered species, in the Hardware River. The Thomas Jefferson Soil and Water Conservation District had identified the property as one of the more degraded stretches of the river in the watershed. While approximately 12 acres of riverfront pastureland were taken out of production for the fencing project, the farmer was actually able to open up more than 12 acres of additional land for grazing through the installation of new fencing and a new watering system. A conservation easement is expected to be recorded with the Virginia Outdoors Foundation to protect the entire 120 acre property prior to the end of 2011.

## **2. Water Supply**

Forests and wetlands slow runoff, minimize evaporation, and allow for high rates of ground water restoration. This process moderates flow during periods of drought and flood to provide a relatively consistent supply of water for consumption, electricity generation, industrial uses, and recreation compared to what would exist in their absence. The value of this service has been estimated between \$0.26 and \$50.87/acre foot, depending on the watershed.<sup>13</sup> Lakes and reservoirs regulate water supply more directly through storage and relief. Sedell estimated the consumptive value of water to be approximately \$52/ acre foot (in 2011 dollars). As such, the four million acre feet retained in Virginian reservoirs hold a use value of approximately \$210 million.<sup>14</sup>

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<sup>11</sup> Morgan et al., 2001; Bradburn et al., 2010.

<sup>12</sup> TPL & AWWA, 2004

<sup>13</sup> Krieger, 2001.

<sup>14</sup> Sedell, 2000; Virginia Natural Resources, 2011.

### **Case Study: Goose Creek**

Goose Creek is a state designated Scenic River whose watershed in Loudoun and Fauquier counties is a rich and varied landscape of rolling countryside with farms, forests and historic sites. Its soils are well suited to agriculture, and the area has a network of fresh springs. The water and streams have made this some of the most productive farming country in the United States. Goose Creek also provides drinking water to the City of Fairfax and the rapidly growing suburbs of eastern Loudoun County.

Water quality surveys performed in the early 1990's showed it to be one of the cleanest waterways on the Atlantic seaboard. Additionally, the forested riparian areas and farm fence hedgerows of the watershed provide natural habitat and essential corridors for wildlife. This diverse watershed is an invaluable natural resource at high risk. The state of Virginia has identified the North Fork of Goose Creek as a high-priority area for non-point-source pollution and Lower Goose Creek as an impaired waterway. As of 2011, 88,000 acres – over 35 percent of this watershed, are permanently protected from development and further degradation with conservation easements.

### **3. Pollination**

Numerous Virginia crops rely on insect pollination for propagation. Much of this is provided by domesticated honeybees that farmers purchase commercially and therefore have a readily quantifiable market price. Native insects and birds from forests, wetlands and pasture provide the remaining pollination services at no cost. A study of rain forest fragments near a Costa Rican coffee plantation found that they provided \$60,000 per year in pollination services. This figure exceeds the potential return from all alternative land uses for the sites. An assessment of the economic value of all pollination services in the United States placed the value between \$1.6 and \$5.7 billion annually based on forecasted price increases resulting from the loss of such services.<sup>15</sup> This assessment relied on a study by Losey and Vaughan that estimated the proportion of pollination services provided by native insects for fifty one fruits, nuts, field crops, and vegetables to quantify the share of crop value attributable to feral insects and bird.<sup>16</sup>



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<sup>15</sup> Ricketts, et al. 2004; Southwick and Southwick, 1992.

<sup>16</sup> Losey and Vaughan, 2006.

## 4. Recreation

Virginia's mountains, rivers, forests, beaches, lakes and parks are a substantial economic draw for the Commonwealth. Forty-five percent of all overnight trips to Virginia include some component of outdoor recreation. The Virginia Tourism Corporation estimates that these visitors spend approximately \$8 billion per year within the state annually. The two largest draws included state and national parks, which attract 48 percent of outdoor recreationists, and beaches,



which attract 34 percent. Skyline Drive and the Blue Ridge Parkway are tremendous recreational assets for the state and region. Approximately 31 percent of groups reported taking a scenic drive during their stay, frequently while en route to another outdoor attraction. A 1997 North Carolina State University Study found that the Blue Ridge

Parkway generated \$510 million for the surrounding communities in direct expenditures and indirect benefit.<sup>17</sup> Many economic studies equate the value of natural resources, such as Shenandoah National Park, the Blue Ridge Parkway, or Virginia Beach, with the expressed willingness to pay for either the site or an improvement in site quality.<sup>18</sup> In order to retain the study's preference for market valuations, this study quantified their recreational value in terms of their contribution to the state's recreational economy.

### **Case Study: Shenandoah National Park**

Visitors from across the country and around the world visit Shenandoah National Park every year for its singular recreational opportunities and breathtaking vistas. The sheer distance that these far flung travelers transit to visit the park underlies its unique appeal.

A survey of park visitors conducted by the Piedmont Environmental Council during the 2011 summer found that the average group traveled over 1000 miles to reach the park. Furthermore, these travelers generate billions of dollars in economic activity at area hotels, restaurants, touring groups, and other amenities.

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<sup>17</sup> North Carolina State University, 2007; Virginia Tourism Corporation, FY2007-2009 Profile of Leisure Travel in Virginia; Virginia Tourism Corporation, FY 2007-2009 Outdoor Activities Travel Profile. <http://www.vatc.org/research/visitation.asp>

<sup>18</sup> Rosenberg and Loomis, 2000; Shrestha and Loomis, 2001; Bell, 1997. Numerous other.

## 5. Forest Products

Virginia has 16 million acres of forestland, which comprise 62 percent of its total land area. Most of this land belongs to non-industrial, private land owners such as timber investment management organizations, individuals and families, and real estate investment trusts. Virginia's annual forest production amounts to 500 million cubic feet, of which saw logs comprise 45 percent, pulpwood 40 percent, and veneer logs, mulch, and other post industrial products comprising the remainder. While the oak-hickory forest type comprises 64 percent of all Virginia forest land, hardwoods make up slightly less than half of all forest products. Loblolly and shortleaf pine, accounting for only 18 percent of Virginia forest cover, have yielded an average of 52 percent of the state forest sector's total output over the last ten years.<sup>19</sup> As such, evergreen forests have a best estimate per-acre consumptive value four times that of hardwood forests.

### **Case Study: Dragon Run**

Dragon Run, and its surrounding forest, is one of Virginia's most productive habitats. The area provides habitat to over 90 species of birds and 55 species of fish. As such, it represents an ecological treasure to the state. At present, over 20,000 acres of the watershed have been placed under conservation easement. However, a partnership between the Nature Conservancy and several private timber owners has succeeded in preserving part of the land for timber uses. Forest parcels outside of the wetland buffer zone have been retained for sustainable timber harvesting.

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<sup>19</sup> Weldon Cooper and Raphann, 2008; Virginia Department of Forestry, Statewide Value and Volume Data, 2009.

## 6. Farm Products



Farm products include the field crops, hay, fruits, vegetables and livestock produced for use or consumption. Like forest products, they have a readily quantifiable market value based on their sale price. In 2007, Virginia had 30,500 farms harvesting 3.2 million acres of cropland or pasture with a total annual product of \$2.3 billion.<sup>20</sup> Easements on agricultural lands help preserve these industries and their jobs for future generations by ensuring that they are not developed for other purposes.

## 7. Disturbance Prevention

A series of destructive Atlantic hurricane seasons from 2004-2009 have made the value of maritime buffer zones evident. Beaches and coastal wetlands protect coastal properties and infrastructure by absorbing storm surges, mitigating flooding and minimizing erosion. Scientists estimate that, over the past 50 years, Delaware's beaches, which are largely similar to Virginia's, have suffered over \$290 million in damage as a result of erosion.<sup>21</sup> Regression analysis of

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<sup>20</sup> U.S. Department of Agriculture, Virginia Agricultural Census 2007.

<sup>21</sup> Parsons & Powell, 2001.

shorefront property values and ocean frontage shows prices to be correlated with wider beaches, after controlling for all other factors influencing price. This indicates that the housing market values beach width as a hedge against future disturbance.<sup>22</sup>

## 8. Habitat

There is no all-encompassing market valuation technique for quantifying the economic benefit of wildlife habitat. This is largely because those benefits are not fully understood. Pharmaceutical science has derived numerous disease-curing medications from compounds only found in biologically diverse ecosystems like coral reefs and tropical rainforests.<sup>23</sup> Mangroves and coastal wetlands provide breeding habitat for marketable fish, crustaceans and mollusks. Migratory bird species that feed on pest insects require unbroken patches of forest cover in order to navigate on their long journeys. Forests provide game for hunters and predators, necessary to retain an ecosystem's crucial functions. Due to the lack of a consistent market valuation approach, wildlife habitat is frequently the subject of contingent valuation (CV) studies that ask respondents for their willingness to pay to preserve a particular parcel or ecosystem. While CV has achieved greater acceptance and has been deemed an appropriate method of evaluation by the U.S. Circuit Court of Appeals, it is difficult to discern the economic benefit to a community or region from such an assessment.<sup>24</sup> Therefore, this study only estimated the contribution of habitat types to marketable resources. Specifically, this study estimated the contribution of all wetlands to Virginia's marine resource harvest.



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<sup>22</sup> Pompe & Rinehard, 1995.

<sup>23</sup> "This Reef May Save Your Life", Huffington Post, May 2011; Lynne et al., 1981; Batie and Wilson, 1978.

<sup>24</sup> Ingraham and Foster, 2008

## 9. Carbon Sequestration

Virginia's forests, pasture, and crop lands act as a "carbon sink" by consuming more carbon dioxide than they emit. Rising levels of atmospheric CO<sub>2</sub> have been correlated with higher air temperatures, decreased spring runoff, increased risk of drought, increased frequency of severe weather events, and rising sea levels.<sup>25</sup> Despite the lack of comprehensive cap and trade legislation, numerous pressures exist to compel emissions reductions or offsets. The US Environmental Protection Agency is presently taking steps to mandate reduced CO<sub>2</sub> emissions from stationary sources.<sup>26</sup> Ten northeastern and Mid Atlantic states have formed the Regional Greenhouse Gas Initiative (RGGI) to reduce emissions by ten percent by 2018.<sup>27</sup> The European Union Emission's Trading Scheme (EUTS) has regulated GHG from stationary energy and industrial sources since 2005 with a 21 percent reduction goal by 2020.<sup>28</sup> A growing chorus of regulatory, policy, and corporate entities view the reduction of atmospheric concentrations of CO<sub>2</sub> as a valuable service. Irrespective of the incentive, a number of factors compel the resource manager to view the carbon sequestration capability of Virginia's grasslands, croplands, and especially forest lands as strategic capital assets.



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<sup>25</sup> UN Inter-Governmental Panel on Climate Change 2007: Fourth Assessment Report, Working Group II, Impacts, Adaptation and Vulnerability.

<sup>26</sup> US EPA, 2010. <http://www.epa.gov/airquality/ghgsettlement.html>

<sup>27</sup> <http://www.rggi.org/>

<sup>28</sup> [http://ec.europa.eu/clima/policies/ets/index\\_en.htm](http://ec.europa.eu/clima/policies/ets/index_en.htm)

## ***Methods for Analysis***

Aside from taking the value of those natural goods that are bought and exchanged in the market place, there are many accepted methods for estimating the economic benefit of natural services. Service values for water quality, pollination, disturbance prevention, habitat, and carbon sequestration were all estimated via sources employing one or more of the following common methods.

### **1. Travel Cost Method**

This involves surveying visitors to a natural or heritage site to determine the costs they expended visiting the site. Tourists are asked for their home location and standardized assumptions are made to estimate their trip expenditures. After controlling for the substitution effect and a number of demographic variables, an estimate of willingness to pay can be derived by regressing travel costs on the number of trips taken and integrating the resulting function.

### **2. Cost Avoidance & Defensive Expenditure Methods**

These methods estimate an ecosystem service by quantifying what it would cost to replace a natural function with a mechanical process. Common examples of this are replacing forest and wetland water filtration services with water treatment plants or replacing the erosion mitigation properties of beaches with dredging or ocean walls.

### **3. Hedonic Price Method**

This method quantifies an ecosystem service by evaluating the impact of a natural resource on property values. The process involves collecting a robust home sale data set, holding all other household amenities equal, and seeing how sale prices change in relation to distance from natural sites such as coastline, nature preserves, or parks. As a general trend, close proximity to natural sites almost always results in increased home values.

### **4. Contingent Valuation**

This is a process by which a group of people are asked by some manner what their willingness is to pay to protect a certain natural resource. The respondents do not actually transfer funds and the process is an entirely hypothetical exercise. In all likelihood the respondents will never have visited the site in question. However, surveying in this manner

allows for the quantification of non-use values such as the value the people place on knowing a resource exists or having the option to eventually see it. No other method answers these questions.

## **5. Group Valuation**

This method is very similar to contingent valuation but involves surveying a group of people instead of individuals. The group then determines its collective willingness to pay to preserve a resource through an elicitation process.

## **6. Meta-Analysis**

A meta-analysis occurs after several dozen or hundred studies of a resource, land cover type, or methodological type have been conducted. The researcher then takes those studies and performs regression analysis of their results and any number of different characteristics to discern trends in the analysis. This study relied on several meta-analyses to assess the range of values that have been assigned to wetlands and forests in different publications. Meta analyses for ecosystem services usually focus on how the different evaluation methodologies, such as those outlined above, impact overall value estimates. Notably, travel cost and contingent valuation studies produce significantly lower estimates for wetlands than cost of replacement studies.<sup>29</sup>

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<sup>29</sup> Brander et al., 2006.

## Results

This study's best estimate for benefit provided by these nine goods and service types totaled \$21.8 billion for all lands in the Commonwealth of Virginia, \$5.1 billion for public lands, and \$520 million for lands under easement. Additional low and high estimates were generated by varying market prices, non-market valuations, production trends, and visitation rates. For all land cover these estimates ranged from \$18.1 billion to \$27.4 billion, for public lands they ranged from \$4.4 to \$6.3 billion, and for lands under easement they ranged from \$410 to \$690 million. These results are summarized in Table 3.

**Table 3. Economic Benefit of Natural Services**<sup>30</sup>

	Low Estimate	Best Estimate	High Estimate
All Virginia Land Cover	\$18,100,000,000	\$21,800,000,000	\$27,400,000,000
Public Lands in Virginia	\$4,400,000,000	\$5,100,000,000	\$6,300,000,000
Virginia Lands Under Easements	\$410,000,000	\$520,000,000	\$690,000,000

This best estimate amounts to an average benefit of \$854 per acre. Recent value transfer studies for New Jersey and Delaware, states with roughly similar land cover types and developmental patterns, have produced somewhat higher average values of \$7500 and \$3500 per acre.<sup>31</sup> This discrepancy is largely attributable to the inclusion of a wider range of services such as cultural/ spiritual value, nutrient cycling, soil formation and a more generous accounting for habitat. The aforementioned studies also made greater use of non-use values than this effort. Although meta-analyses have shown that contingent valuations produce statistically similar results to other valuations of the same resource, their inclusion does widen the number of benefits that can be included. For example, habitat and water quality improvements are often only estimated via contingent valuation. Valuing habitat by the same method as Costanza et al. gives a statewide total of \$14.1 billion, which increases the average per-acre value to \$1300.<sup>32</sup>

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<sup>30</sup> Estimates are rounded to three significant figures.

<sup>31</sup> Costanza, et al. 2006; Kaufman et al., 2011.

<sup>32</sup> Costanza et al., 2006.

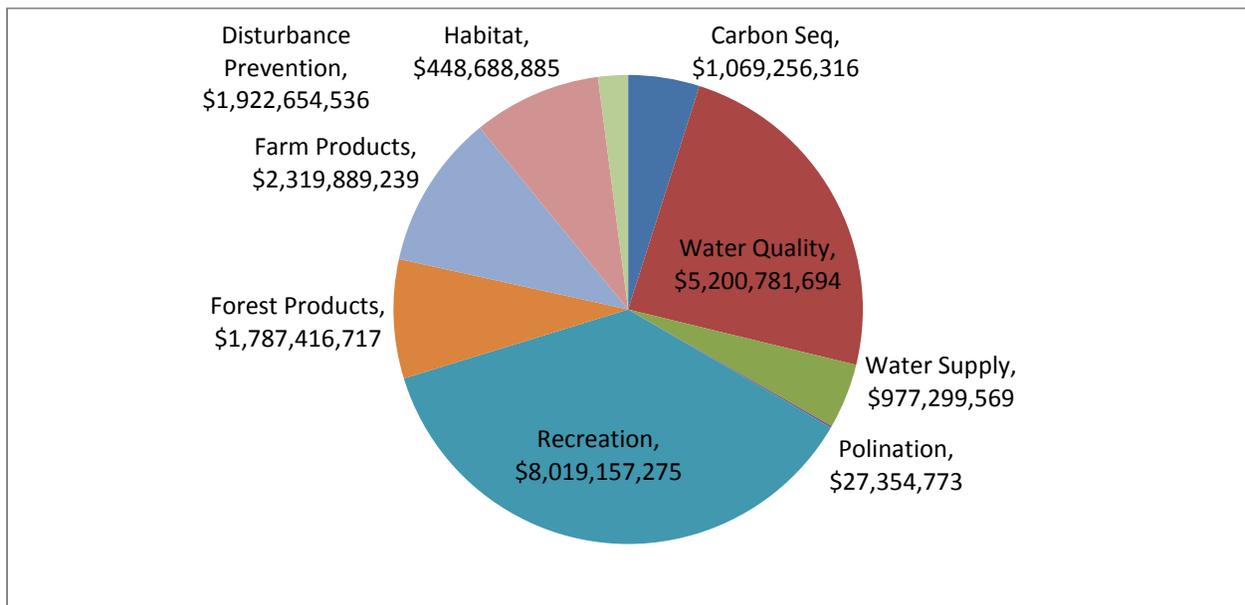
**Table 4. Total Best Estimate Service Values by Land Cover Type**

	<b>All Virginia Land Cover</b>	<b>Public Lands in Virginia</b>	<b>Virginia Lands Under Easements</b>
<b>Open water</b>	\$973,352,795	\$141,504,730	\$11,209,197
<b>Low Intensity Residential</b>	\$0	\$0	\$0
<b>High Intensity Residential</b>	\$0	\$0	\$0
<b>Commercial/ Industrial/ Transportation</b>	\$0	\$0	\$0
<b>Beaches/Sand</b>	\$1,394,398,682	\$668,622,025	\$1,467,127
<b>Quarries/Strip Mines/Gravel</b>	\$0	\$0	\$0
<b>Transitional</b>	\$14,562,219	\$14,459,931	\$1,245
<b>Deciduous Forest</b>	\$7,605,929,040	\$2,386,298,884	\$151,081,129
<b>Evergreen Forest</b>	\$1,642,991,653	\$317,576,625	\$28,778,403
<b>Mixed Forest</b>	\$2,646,262,581	\$540,568,979	\$66,121,362
<b>Pasture/Hay</b>	\$2,613,215,378	\$72,035,738	\$121,853,602
<b>Row Crops</b>	\$531,885,093	\$8,957,991	\$12,655,061
<b>Urban/Recreational Grasses</b>	\$3,274,410	\$3,263,340	\$21
<b>Woody Wetlands</b>	\$3,401,331,059	\$745,728,968	\$73,393,644
<b>Emergent Herbaceous Wetlands</b>	\$917,941,320	\$219,760,516	\$53,413,012
<b>Total</b>	<b>\$21,745,144,231</b>	<b>\$5,118,777,728</b>	<b>\$519,973,803</b>

Deciduous forests provide an aggregate of \$7.6 billion dollars in total annual benefit, making them the most valuable land cover type. This is mostly due to the abundance of deciduous forests in Virginia. Wetlands provide six times more economic benefit than any forest type on a per acre basis due to valuable disturbance prevention, filtration, and nutrient regulation services. Beaches provide over seven hundred times as much economic benefit, but this reflects the huge economic draw of Virginia’s relatively limited amount of sandy shoreline. Pasture and row crops provide valuable commodities, but their non-market benefits are comparatively low. Urban recreational grasses and transitional landscapes provide minor carbon sequestration benefits by remaining undeveloped. All urban or industrial land cover types by contrast provide no benefits.

Of all the services studied, outdoor recreation had the largest impact on the state’s economy. Overnight visits, which entail at least one outdoor recreational activity, generate over

\$8 billion in immediate economic activity. Various land cover types provide \$5.2 billion in annual benefit from filtration services that enhance water quality through avoided capital expenditure, sedimentation mitigation, and nutrient cycling. Pollination services provided the smallest benefit at \$27 million, although other studies have estimated much higher figures. Costanza et al. estimated the total value of pollination services in New Jersey to be \$245 million annually.<sup>33</sup> One notable reason for this difference was that this study excluded the contribution of domesticated bees from its quantification of total benefit.



**Figure 2: Total Annual Economic Benefits by Service Type**

Goods and services priced in commodity and service markets, such as recreation, forest products, farm products, and water supply, represented 56 percent of the total natural benefits to the state. Non-market benefits that were assessed via cost of replacement, hedonic price, market impact studies, cost of avoidance, and other methods represented the remaining 44 percent of Virginia’s natural benefits. Owing to the exclusion of several important non-market services, such as property value enhancement, cost of community services, air quality improvement, and quality of life, this is almost certainly an underestimate of the total value of natural services provided by Virginia’s land cover types. This study also excludes from consideration all

<sup>33</sup> Costanza et al., 2006

secondary economic impacts, or ripple effects, from these various services and industry. The value of forest products, for example, represents only the sale price of the sawlogs, cordwood, or pulp and not the value of any additional wood products produced in Virginia, such as paper or furniture.

## 1. Water Quality

Natural systems enhance water quality in numerous ways. They remove excess nutrients from agriculture and industrial sources, minimize sedimentation, and neutralize toxic chemicals.<sup>34</sup> Multiple studies have sought to quantify the value of these services for numerous wetlands and have derived widely varying estimates. Meta-analyses of wetland services evaluations have found estimates varying from \$0.06 per acre to over \$22,000 per acre.<sup>35</sup> However, wetlands tend to receive lower values from travel cost and contingent valuation studies as their recreation and aesthetic value is usually significantly less than their service value. Fisherman and boaters in the lower Chesapeake Bay directly benefit from the water filtration services of the Great Dismal Swamp, but they are unlikely to visit the site for recreational purposes. In evidence of this trend, Woodward and Wui found that all travel cost studies of wetlands averaged \$198 per acre, while cost of replacement studies produced an average value of \$1555 per acre.<sup>36</sup> An analysis of wetland services in the Mississippi Floodplain eco-region by Jenkins et al., which includes Virginia, estimated the value of nitrogen and phosphate retention by wetlands at \$505 per acre.<sup>37</sup> These two values represent the lower and higher bounds of the estimates while the average of these two figures represents the best estimate for wetland water filtration services -- all have been adjusted for inflation.

The values for forests are comprised of filtration, runoff mitigation, and avoided costs. In a study of the costs of water purification in different municipalities, the Trust for Public Land and American Water Works Association found forest cover to be correlated with low treatment costs. Using the OLS regression of treatment costs on forest cover provided in that paper, this study estimated that Virginia's forests provided a total of \$217 million in annual filtration

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<sup>34</sup> Jenkins et al., 2010. Pick a single citation format

<sup>35</sup> Brander et al., 2005; Woodward & Wui, 2001.

<sup>36</sup> Woodward & Wui, 2001

<sup>37</sup> Jenkins et al., 2010.

savings, which represents about \$15/acre.<sup>38</sup> Forests also mitigate sedimentation and preempt the construction of artificial retaining ponds to capture runoff. Using the benefit estimates provided in an American Forests study on the Baltimore-Washington corridor, this study estimated that Virginia’s forests save its tax payers approximately \$5.3 billion in expenditures related to runoff containment which represents benefits of \$320/acre.<sup>39</sup> The value for pasture was derived from Costanza et al. (1997).

**Table 5. Values of Water Filtration Services per Acre/Year**

Land Cover Type	Low	Best	High
Deciduous Forest	\$233.41	\$238.44	\$245.53
Evergreen Forest	\$233.41	\$238.44	\$245.53
Mixed Forest	\$233.41	\$238.44	\$245.53
Pasture/Hay	\$46.33	\$61.77	\$77.21
Woody Wetlands	\$580.16	\$1,278.75	\$1,977.34
Emergent Herbaceous Wetlands	\$580.16	\$1,278.75	\$1,977.34

## 2. Water Supply

Wetlands, open water and forests store water in various physiological capacities. Open water sources, such as lakes and reservoirs, simply contain water for off stream uses. The prices seen in Table 6 reflect the estimated volume of Virginia’s reservoirs, multiplied by the estimated value of that water, and then divided by the number of open water acres in the GIS model. Forests and wetlands retain runoff and facilitate the recharge of the water table. The values for wetlands are derived from a meta-analysis of wetland service valuation papers which gave an average value of \$485/ acre. The values for forests are derived by taking the amount of water provided by forested aquifers in the Virginia and applying the average consumptive use value of \$52/acre foot.<sup>40</sup>

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<sup>38</sup> TPL & AWWA, 2004

<sup>39</sup> Virginia Department of Natural Resources, 2011; American Forests, 1999.

<sup>40</sup> Sedell, 2001; Brander et al., 2006; Virginia Department of Natural Resources, 2011.

**Table 6: Value of Water Supply Services per Acre**

Land Cover Type	Low	Mid	High
Open water	\$319.21	\$425.62	\$532.02
Deciduous Forest	\$9.96	\$19.91	\$29.87
Evergreen Forest	\$9.96	\$19.91	\$29.87
Mixed Forest	\$9.96	\$19.91	\$29.87
Woody Wetlands	\$40.49	\$485.83	\$931.17
Emergent Herbaceous Wetlands	\$40.49	\$485.83	\$931.17

### 3. Native Pollination Services

Unlike for most other natural services, pollination has not been widely evaluated. This study relied on three articles to inform its assessment methodology. Southwick and Southwick (1992) estimated that the total value of pollination services in the U.S. ranged from \$1.6 to \$5.7 billion dollars annually. Ricketts et al. (2004) estimated that two forest patches near a Costa Rican coffee plantation yielded \$60,000 in annual services. With these two studies having established the premise of pollination value, the total value of natural pollination services in Virginia was estimated by using the findings of Losey and Vaughan (2006). They estimated the proportion of pollination services provided by native bees for dozens of crops, and the Virginia Census of Agriculture (2007), which details total acreage devoted to specific crops, yield and value.<sup>41</sup> This study assumed that the value of natural pollination services was equal to the total value of that crop times the proportion of reproduction facilitated by native pollinators, which produced an estimate of \$27 million in total annual pollination benefit. This study did not make this judgment via a per-acre estimate but instead estimated the total benefit to the state's agricultural product. As such, the economic upside is not attributed to forest, wetland, or pasture land cover types that provide the service but to the crop land that receives it.

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<sup>41</sup> US Department of Agriculture, 2007.

**Table 7: Pollination Services Provided by Native Bees**

Crop	VA Acres under Cultivation 2002	VA Average Value (M\$ 2003)	Dependence on Insect Pollination	Proportion of Pollinators that are Native Bees	Annual value attributable to native bees (M\$ 2011)
<b>Fruits and Nuts</b>					
Apples	19331	\$66.03	100%	10%	\$7.74
Apricot	10	\$0.02	70%	20%	\$0.00
Blueberry - Cultivated	256	\$0.64	100%	10%	\$0.08
Cherry - Sweet	47	\$0.15	90%	10%	\$0.02
Cherry - Tart	27	\$0.03	90%	10%	\$0.00
Grape	3616	\$9.46	10%	90%	\$1.00
Kiwifruit	1	\$0.00	90%	10%	\$0.00
Peach	2029	\$5.37	60%	20%	\$0.75
Pear	171	\$0.56	70%	10%	\$0.05
Plum/prune	71	\$0.09	70%	10%	\$0.01
Raspberry	78	\$0.35	80%	10%	\$0.03
Strawberry	330	\$6.67	20%	90%	\$1.41
<b>Vegetables</b>					
Asparagus	88	\$0.33	100%	10%	\$0.04
Broccoli	551	\$2.29	100%	10%	\$0.27
Cantaloupe	715	\$3.40	80%	10%	\$0.32
Carrot	8	\$0.05	100%	10%	\$0.01
Cauliflower	1	\$0.01	100%	10%	\$0.00
Cucumber	861	\$2.15	90%	10%	\$0.23
Honeydew	5	\$0.03	80%	10%	\$0.00
Pumpkin	2075	\$1.69	90%	90%	\$1.60
Squash	408	\$1.44	90%	90%	\$1.37
Watermelon	972	\$2.16	70%	10%	\$0.18
<b>Field Crops</b>					
Alfalfa - Hay	89,213	\$31.79	100%	5%	\$1.86
Cotton	92,809	\$25.70	20%	20%	\$1.20
Peanuts	57,373	\$37.20	10%	80%	\$3.49
Soybeans	467,210	\$97.41	10%	50%	\$5.71
Sunflower	137	\$0.02	100%	10%	\$0.00

#### 4. Outdoor Recreation

Between 2007 and 2009 the Virginia Tourism Corporation (VTC) conducted a survey of leisure travelers to the state to determine demographics, expenditures, attractions and activities. They came up with an estimate for total annual expenditures related to overnight trips of \$18 billion annually, 45 percent of which was expended by groups who engaged in at least one outdoor recreation component. Therefore, this study estimated the total annual, in-state expenditures related to outdoor recreation to be \$8.4 billion. Actual recreational expenditures likely surpass this figure because VTC only analyzed trips with at least one overnight stay. They ignore the millions of day trips that occur each year and the economic activity they entail. As such, these figures should be considered conservative.

The average group traveling for outdoor recreational purposes spends 55 percent more than the average leisure travelers. Their travel parties tend to be somewhat larger and their stays longer than average. VTC also determined the proportion of outdoor recreational trips planned around visiting specific sites and resources. The most popular of these were state and national parks, beaches and scenic drives. Other attractions included wildlife, rivers, lakes, mountains, gardens, caverns and the Chesapeake Bay. Per acre values for recreational activity were estimated by cross-referencing the land cover types for each attraction with the corresponding economic activity.<sup>42</sup> The results are detailed below in Table 8.

**Table 8: Value of Outdoor Recreation Benefits per Acre**

Land Cover Type	Low	Mid	High
Open water	\$1,324	\$1,379	\$1,434
Beaches/Sand	\$455,870	\$474,864	\$493,859
Deciduous Forest	\$190	\$203	\$171
Evergreen Forest	\$153	\$159	\$166
Mixed Forest	\$153	\$198	\$166
Pasture/Hay	\$113	\$118	\$122
Woody Wetlands	\$362	\$377	\$392
Emergent Herbaceous Wetlands	\$362	\$377	\$392

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<sup>42</sup> Virginia Tourism Corporation, Outdoor Activities Participant Profile, 2009.

Because of the large number of expenditures related explicitly to parks, public lands received a “premium” that captured this value equal to \$649 per acre, which is not included in Table 8, but is included in the overall estimates. This has the effect of making the state’s publicly owned forest land significantly more valuable than its privately owned forests. The state’s renowned, but geographically limited, collection of beaches draws by far the largest benefit. The boating, fishing and aqua sport constituencies give open water its high recreational value. Several contingent valuation studies have demonstrated that people are generally willing to pay for an improvement in water quality so that they might glean more enjoyment from the recreational pursuits.<sup>43</sup> The results of these contingent valuation studies are not included in these per-acre totals, and their exclusion speaks to the conservative nature of these per-acre estimates.

## 5. Forest Products

In 2008, the Weldon Cooper Center found that Virginia forests produced \$1.8 billion in annual output. Core processing, extended processing, and distribution added another \$13 billion to the state’s economy, but this study only included the actual saw log or cord wood value of the



*Photo by Ryan Wick*

harvested stand in its estimate. Processing facilities invariably work on wood imported from other areas, and a sophisticated assessment of substitution effect was beyond the scope of this analysis. Nevertheless, the exclusion of this data speaks to the conservative nature of these estimates. The Virginia Department of Forestry’s product inventory found that 52 percent of all products are derived from pine species, while 48 percent are derived from hardwoods, based on value.<sup>44</sup> The economic benefit of one acre of pine is therefore about four times greater than that of hardwood, as there is 400 percent more deciduous forest in the state than evergreen. The value for mixed forests simply represents the average of the two other types. Low and high estimates were taken by varying the best estimate by ten percent lower or higher, which is comparable variance to that seen in forest industry output as a result of the recent recession.

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<sup>43</sup> Bockstael et al., 1985; Collins et al., 2005; Eisen-Hecht & Kramer, 2002.

<sup>44</sup> Virginia Department of Forestry, 2009.

**Table 9: Value of Forest Product Benefits per Acre/Year**

Land Cover Type	Low	Best	High
Deciduous Forest	\$60.39	\$67.10	\$73.81
Evergreen Forest	\$212.14	\$235.71	\$259.28
Mixed Forest	\$136.26	\$151.40	\$166.54

The assessment of forest product benefits assumed that all timberlands in the state were available for harvesting. Obviously, this is not the case, but data constraints prevent a more nuanced analysis. Future efforts that can obtain comprehensive GIS data on timberland size and ownership may be able to enhance these findings.

## 6. Disturbance Prevention

Studies on erosion mitigation and storm buffering services provided by beaches and wetlands are broadly categorized as disturbance prevention. Two studies on property values and capital investments near the coasts of Delaware and South Carolina, both with similar coastlines to Virginia, found that beaches provided \$24,800 and \$40,300 per acre in enhanced or preserved property value.<sup>45</sup> The benefit estimate for the sand land cover class is equal to the average of these two figures, adjusted for inflation. The figure for wetlands reflects the average of three different studies.<sup>46</sup> The high and low values, for both beaches and wetlands, reflect the upper and lower bounds of the values provided by the literature.

**Table 10: Value of Disturbance Prevention Benefits per Acre/Year**

Land Cover Type	Low	Best	High
Bare Rock/Sand/Clay	\$24,872	\$32,593	\$40,315
Woody Wetlands	\$564	\$2,045	\$5,134
Emergent Herbaceous Wetlands	\$564	\$2,045	\$5,134

## 7. Farm Products

According to the 2007 Census of Agriculture, Virginia produces approximately \$2.1 billion annually in fruits, vegetables, hay, meat products, aquaculture and livestock. The benefit

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<sup>45</sup> Pompe & Rinehart, 1995; Parsons and Powell, 2001.

<sup>46</sup> Costanza et al., 1997; Farber & Costanza, 1987; Farber, 1987.

per acre was determined by correlating the different farm or agricultural activities with their corresponding land cover types. Almost all fruits and vegetables were correlated with the row crop type while hay, meat products, and livestock were correlated with pasture. The yield from the state’s limited aquaculture industry was assigned to the open water cover type in reflection of its high water needs.

**Table 11: Value of Farm Produce Benefits per Acre**

Land Cover Type	Low	Best	High
Open water	\$155.10	\$172.33	\$189.56
Pasture/Hay	\$317.15	\$352.39	\$387.63
Row Crops	\$383.22	\$412.99	\$445.08

## 8. Habitat

A number of ecosystem services that could be categorized as habitat benefits have been quantified under other service types in this report. Pollination and recreation, for the purpose of viewing or hunting wildlife, reflect the benefits of vibrant habitat. Also reflective of the economic value of biodiversity is the amount of money that people are willing to spend to preserve it. Numerous contingent valuation studies have shown that most



people place a value on the protection of wilderness and wildlife refuges, even if they never expect to visit them in their lifetimes. Most value transfer studies include such data in their assessment of habitat services, which yield much higher values. If this study had taken a similar approach, the per-acre values for forest habitat would have easily exceeded \$800, even by purposefully excluding high-value outliers. Instead, this study restricted its definition of habitat benefits to those services that produced a readily quantifiable market impact and that have not been captured by other services, such as pollination. The role of wetlands in the nurturing and cultivation of marine resources is the only benefit included in this estimate of habitat services.

Three studies of this service formed the inputs of this value transfer model.<sup>47</sup> The best estimate represents the mean of the three, while the high and low represent the bounds of their findings.

**Table 12: Value of Habitat Benefits per Acre**

Land Cover Type	Low	Best	High
Woody Wetlands	\$311.67	\$500.45	\$1,302.27
Emergent Herbaceous Wetlands	\$311.67	\$500.45	\$1,302.27

Batie and Wilson’s \$1300 estimate reflected economic benefits to oyster crops of Virginia wetlands specifically. As this was the highest value and only representative of the benefit to one marine resource industry, it is likely that the value of wetland service is in fact much higher.

## 9. Carbon Sequestration

The vast majority of carbon sequestration services in Virginia are provided by forests. The U.S. Forest Service estimates that a hectare of oak-hickory forest, the predominant type in Virginia, sequesters 164 metric tons of carbon over an 80 year cycle, while the predominant evergreen forest type, loblolly pine, sequesters 141. In terms of average CO<sub>2</sub> equivalent, Virginia’s deciduous and evergreen forests sequester 2.69 and 2.16 tons per acre, respectively. Mixed forests were assumed to sequester 2.42 tons per acre as they are comprised of approximately half deciduous and half coniferous species, on average. Overall, Virginia forests sequester a total of 42.8 million tons of CO<sub>2</sub> equivalent annually. Greenhouse Gas Inventory data was used to estimate the sequestration rates of grass coverage and transitional parcels. However, their contribution to total sequestration amounts to one third of one percent of that provided by forests. Low, best and high estimates were determined via three historical price points on the European Union Emissions Trading Scheme between 2005 and 2008: \$22.20, \$24.90, and \$27.70 per ton of CO<sub>2</sub> equivalent. These were then factored by average, per-acre sequestration rates to give the values seen in Table 4.<sup>48</sup>

<sup>47</sup> Johnston et al, 2002; Costanza et al., 1997; Batie & Wilson, 1978.

<sup>48</sup> US Forest Service, Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States, 2006; US Greenhouse Gas Inventory, 2011.

**Table 13: Value of Carbon Sequestration Services per Acre/Year**

	Low	Best	High
Transitional	\$0.31	\$0.35	\$0.38
Deciduous Forest	\$59.67	\$67.03	\$74.40
Evergreen Forest	\$47.91	\$53.82	\$59.74
Mixed Forest	\$53.79	\$60.43	\$67.07
Pasture/Hay	\$0.31	\$0.35	\$0.38
Row Crops	\$1.07	\$1.21	\$1.34
Urban/Recreational Grasses	\$0.31	\$0.35	\$0.38

### *Highlighting Other Natural Benefits*

Not all of Virginia’s natural benefits are readily quantifiable in terms of a land cover type. Even those benefits that can be quantified tend to vary between parcels of the same cover type due to a number of variables. The value transfer approach presumes that an average service value extrapolated from academic literature or policy data sources can represent the various levels of service provided by different parcels of a single land cover type. In reality, they range between urban and rural patches, old growth and early initiation forests, freshwater and saltwater wetlands, prairie and managed pasture, and any number of other distinctions. Simply by virtue of scarcity, urban green spaces are dramatically more valuable than parcels of the same vegetation type. For example, the Trust for Public Land estimated that Wilmington Delaware’s 444 acres of parks provided \$110,000 in annual private savings, direct benefit, and public savings.<sup>49</sup> The results of this study should not be viewed as the last word on the economic benefits of Virginia’s natural land cover. In fact, it does not include several important aspects that are discussed below.

#### **1. Cost of Community Services**

Different land uses produce different levels of tax revenue and demand differing levels of service. Although residential housing developments pay the highest taxes of any land owner in a

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<sup>49</sup> Trust for Public Land, 2009.

given municipality, they also demand the most in services, such as education and emergency management personnel. Agriculture/open space and commercial/industrial land uses, by contrast, pay lower marginal tax levels but demand less in services. The result is that lands zoned for these non-residential uses pay more into municipal coffers than they receive. Kotchen and Schultke’s meta-analysis of 125 costs of community service studies found this trend to be extremely consistent irrespective of demographics, specific agricultural enterprise, or type of industry.<sup>50</sup> The ratios of average tax liabilities to service received for three different land-use types in six Virginia counties are provided in Table 13. They illustrate that residential homes demand more in municipal expenditures than they provide in revenues, while the opposite is true for commercial, industrial, working and open space parcels.

**Table 14: Revenue to Expenditure Ratio<sup>51</sup>**

<b>County</b>	<b>Residential</b>	<b>Commercial &amp; Industrial</b>	<b>Working &amp; Open Land</b>
Augusta	1 : 1.22	1 : 0.20	1 : 0.80
Bedford	1 : 1.07	1 : 0.40	1 : 0.25
Clarke	1 : 1.26	1 : 0.21	1 : 0.15
Culpeper	1 : 1.22	1 : 0.41	1 : 0.32
Frederick	1 : 1.19	1 : 0.23	1 : 0.33
Northampton	1 : 1.13	1 : 0.97	1 : 0.23

Conserving land in working farms, working forests, public preserves or private easements saves the local governments money. Residential developments have a place in all growth plans, but they can also leave a town or county scrambling for additional funds to build new schools and roads if pursued in a haphazard manner.

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<sup>50</sup> Kotchen and Schultke, 2008.

<sup>51</sup> American Farmland Trust, 2008.

## 2. Quality of Place

While agriculture and industry have taken turns as the driver of Virginia's economy, the expanding service sector has incited the most recent surge in growth. Where natural resources only served a utilitarian role as inputs into economic processes, they now serve to attract the workers and business that make up the new economy. Business owners now consider the environmental quality of a new office or start up's location of paramount importance. Parks, open-spaces, air quality, water quality, and readily available cultural activities all help to attract



this human capital.<sup>52</sup> Furthermore, research by the National Association of Realtors shows that American home buyers increasingly prefer mixed use communities over low-density residential developments. Smaller homes and greater access to parks, restaurants, shops and businesses appear more attractive than larger homes and yards. Land conservation, in conjunction with an active planning office, can help foster such communities.<sup>53</sup>

## 3. Virginia's Equine Industry

The Commonwealth's large tracts of open pasture have helped to sustain many of the region's traditional horse-related businesses. Horse shows and races attract tourists from abroad to some of the state's less developed regions, and horse owners spend millions on this traditional

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<sup>52</sup> Trust for Public Land, 2009.

<sup>53</sup> National Association of Realtors, 2011

Virginia industry. A recent Weldon Cooper study found that the equine industry contributes over \$1.2 billion to the state's economy every year.

Virginian horse owners alone contribute approximately \$400 million to this total and support over 12,000 jobs. The



industry has a presence throughout the state, but its impact is particularly acute in the northern counties of Loudon and Fauquier, which support approximately 800 horse-related jobs.<sup>54</sup> As development has progressed in these fast-growth areas, the value of their fields and pastures has increased due to the confluence of resource scarcity and increased investment in the form of equine activities.

#### 4. Property Values

A large number of studies have correlated proximity to protected areas and waterfront with enhanced property values.<sup>55</sup> Holding all other facets of alternative houses equal, home buyers are almost universally willing to pay a premium for enhanced access to a park, beach, lake, waterfront or forest preserve. While a full hedonic price analysis was beyond the resources of this project, and such studies do not lend themselves well to a value transfer approach, open space has some positive effect on property values in Virginia. Although this study cannot produce a reliable estimate of the net impact of such services, the abundance of academic literature reporting the same finding indicates that they provide some level of this service. Costanza et al.'s value transfer analysis for New Jersey land cover type included a hedonic analysis component. They found that homes sold within three hundred feet of a beach zone in four different markets enjoyed a \$81,000 to \$194,000 premium over homes located farther away.

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<sup>54</sup> Weldon Cooper Center for Public Policy. Economic Impact of Virginia's Equine Industry, 2011.

<sup>55</sup> Trust for Public Land, Economic Benefits of the Parks and Recreation System Maklenburg County, 2010; Costanza et al., Value of New Jersey's Ecosystem Services and Natural Capital, 2006; Green Space Alliance et al., The Economic Value of Protected Space in South Eastern Pennsylvania, 2010; Netusil et al., Estimating Demand for Tree Canopy, 2010; Trust for Public Land, Value of Willmington Delaware's Park System, 2009.

**Table 15: Results of Costanza et al. (2006) New Jersey Hedonic Analysis**

Natural Resource	Number of Markets Analyzed	Distance to Realize Premium	Premium on Home Sale Price
Beaches	Four	300 Feet from the beach	\$81,000 to \$194,000
Beaches	Two	300 to 2000 feet from the beach	\$16,000 to \$44,000
Environmentally Sensitive Zones	Two	Within the zone	\$8600 to \$34,500
Water Zones	One	Within 100 feet of the water body	\$33,000
Small Parks (<50 acres)	Four	100 feet from the park	\$17,000 to \$178,000
Medium Parks (50-2000 acres)	Two	100 feet from the park	\$9,000 to \$66,000
Large Parks (>2000 acres)	Three	100 feet from the park	\$33,000 to \$40,000

Additional housing markets in close proximity to parks showed a negative premium compared to similar units distant from the park. The study’s authors hypothesize that larger parks may entail greater distance to shops and job opportunities, which lower sale prices. However, beaches, water zones and natural areas were all correlated with higher home values than sites further removed from the resource in question.

## 5. Health Benefits

Open space, conserved lands, and parks provide readily available, low-cost recreational opportunities to their communities. In the face of nationwide increases in obesity and physical inactivity related conditions, their services become more needed. The Center for Disease Control and Prevention estimated that \$147 billion in additional annual health care costs can be attributed to obesity-related conditions.<sup>56</sup> However, research indicates that people who live within walking distance of parks are more likely to exercise at recommended levels than those without such access. The Trust for Public Land’s study of Charlotte North Carolina found that the city’s park system provided \$81 million in avoided health care costs to its citizens. The GreenSpace Alliance and Delaware Valley Regional Planning Commission estimated that protected open

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<sup>56</sup> Center for Disease Control, 2008.

space in southeastern Pennsylvania saves area residents \$795 million in annual health care costs. An assessment of the natural economic benefits of the Chesapeake Bay Watershed in Delaware estimated that the area's open space provided a \$188 million in annual health benefits.<sup>57</sup> All three of these studies focus



*Photo by  
Jeffrey Michael*

on areas within the Mid Atlantic region with similar demographics, populations, and land cover types. Therefore, it is reasonable to presume that Virginia's cities and towns receive comparable benefits.

## **Conclusion**

This study leveraged the results of pre-existing academic and policy studies to quantify the economic benefits of natural resources and land cover types in Virginia; on its public lands and on lands under easement. This analysis estimates the state's economic benefit from natural services to be \$21.8 billion annually. This is comparable to the \$35 billion in defense contracts that Virginia received in 2010.<sup>58</sup> Of the benefits from natural services, \$5.1 billion is provided by public lands and \$520 million from private lands under easement.

Because the value transfer method inevitably introduces error, low and high estimates of the economic benefit of natural goods and services were generated by adjusting for variations in the literature, economic activity, and methodologies. This produced a range of total benefits between a low of \$18.1 billion and a high of \$27.4 billion for the nine goods and services analyzed in this effort. These estimates could change dramatically if markets for nitrate runoff or greenhouse gas emissions became formalized. These estimates also exclude benefits that cannot be reduced to per-acre values such as enhanced property values, cost savings for local governments, quality of life considerations, and health benefits. As such, best estimate of \$21.8

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<sup>57</sup> Trust for Public Land, *Economic Benefits of the Parks and Recreation System Maklenburg County*, 2010; Green Space Alliance et al., *The Economic Value of Protected Space in South Eastern Pennsylvania*, 2010.

<sup>58</sup> Washington Post. "Virginia Stands to Feel the Most Pain from Defense Cuts." August 10, 2010. <http://www.washingtonpost.com/wp-dyn/content/article/2010/08/09/AR2010080906083.html>

billion probably underestimates the overall contribution of natural goods and services to Virginia's economy.

Virginia has enjoyed over a decade of sustained economic prosperity by any measure. Fortune 500 companies, small businesses, startups, skilled workers and young talent have flocked to the state in recent years to reap the benefits of this growth. In-state GDP has dramatically outperformed the national average and has matched the pace of many fast growing East Asian economies over the last 15 years. The key to Virginia's success has been the diversity of its economic interests, which range from knowledge-based service industries, to higher education, to manufacturing, to agriculture, to defense contracting, to forestry, to mining, and to tourism. As with any well performing business, it is important to take stock of the company's value-generating assets, which includes Virginia's natural resources.

This report offers a baseline estimate of the contribution of those assets to the commonwealth's economic success and wellbeing. The elected stewards of these public goods have long recognized their cultural heritage and aesthetic value, as have the voters through a series of conservation referendums. Successive governors from opposing political parties have now called for identical conservation targets. While still fundamentally an act of preservation and not a financial investment, land conservation entails the preservation of natural services and the protection of traditional industries. It maintains the diversity of the economy, enhances the quality of life of the state's residence, and provides cost-saving services. While it will never be possible to fully articulate the worth of open space in monetary terms, it is simultaneously important to not discount its realizable value.



*Photo by David Anhold*

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