

CFAES

ECONOMIC VALUATION OF NATURAL AREAS IN OHIO

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EXECUTIVE SUMMARY

This report estimates the “value” of outdoor recreation in Ohio, the amount of money Ohioans and others spend on outdoor recreational trips in Ohio, and the contribution of this outdoor recreation to Ohio’s economy. In addition, we calculate the value of ecosystem service flows on Ohio’s natural land and map those values by county. Highlights of these analyses include:

- We estimate that there are 171 million outdoor recreational trips in Ohio, and that these trips are worth \$3.6 billion per year to the people who take them. We also estimate that in the course of taking these trips, outdoor recreationalists spend \$5.9 billion per year in Ohio’s economy, which amounts to about \$34 per trip.
- The contribution of this expenditure to Ohio’s overall economic activity is estimated to be \$8.1 billion per year, which amounts to 1.3% of Ohio’s economy. The outdoor recreational sector is estimated to employ 132,790 workers in Ohio, or 1.9% of Ohio’s workforce.
- Across the ecosystem services we consider—agriculture, timber production, carbon storage, and forest recreation—we estimate that the annual value of ecosystem services on Ohio’s natural land is \$287 per acre of natural land per year, for a total value of \$5.8 billion per year.
- Forests provide the largest ecosystem service values, with the greatest value provided by carbon sequestration services. On average, carbon sequestration provides \$404 per acre of forestland in value each year.
- Forests on public land generate \$273 million per year in recreational benefits, or \$309 per acre of public forestland per year in value. In comparison, the Ohio Department of Natural Resources spends around \$244 per acre of public land per year to manage public lands, suggesting that the benefits of recreation on public forests alone outweigh the expenditure by government agencies to manage those lands.



Acknowledgments: The authors appreciate the help of Ryan Brune who produced estimates of the consumer surplus of recreational trips to state wildlife areas used in the study. The authors also appreciate comments from Kevin Egan, Chair of the Department of Economics at the University of Toledo, and Randy Rosenberger, Professor of Environmental Economics at Oregon State University. All errors, of course, are ours as authors alone.

INTRODUCTION

Interest in nature-based recreation in the United States is growing rapidly amongst people engaging in these activities, encouraging growth in institutions that promote outdoor recreation and environmental conservation. However, there has been some debate about how much growth has occurred and where it is occurring (Pergams and Zaradic, 2008; White et al., 2016). Research has measured the positive impact on community well-being that recreation in natural areas brings through the important physical, mental, and social values people derive from various recreational activities. Businesses and communities are also directly affected by efforts to maintain natural spaces, habitat, and biodiversity. For example, the U.S. Bureau of Economic Analysis estimates that outdoor recreation provides \$412 billion, or 2% of the Gross Domestic Product of the U.S. (ORSA 2018), and the Outdoor Industry Association (2017a) estimates that outdoor recreation in Ohio annually generates \$24.3 billion in consumer spending, supports 215,000 direct jobs, \$7 billion in wages, and \$1.5 billion in state and local tax revenue.

Though the economic impacts of nature-based recreation are substantial, natural areas provide other benefits to people beyond those they derive from recreation. Ecosystem services are outputs from ecosystems that provide important services to humans (MEA, 2005). These services could include well-known outputs like food and forest products that are directly consumed by humans. Ecosystem services, however, also include a host of other services that benefit humans, including carbon storage in trees (which mitigates climate change), water flow and quality regulation from forests and wetlands, and other services such as pollination, education and cultural heritage.

The tangible economic benefits of nature-based recreation illustrate how businesses and communities benefit from maintaining natural spaces, habitat, and biodiversity. The estimates presented in this study provide information that can help policy makers evaluate the economic gains associated with policies intended to protect and improve the natural environment. For instance, the state spends \$70-\$75 million per year, or \$253 per acre, managing state lands. It is useful to assess whether the public benefits outweigh these costs, and to determine where the acquisition of new lands is likely to be the most beneficial.

Overview of Methods and Results

To conduct this assessment, we first develop estimates of outdoor recreation occurring within the state. While Ohio is not widely known for its nature-based tourism, by our definition, there are over 170 million outdoor recreational trips in Ohio. We then estimate the value of that recreation to the individuals engaged in it. We estimate that over those 170 million trips, people recreating in Ohio receive \$3.5 billion per year in value, with national and state park day use and fishing accounting for the largest share of value. We then calculate how much people spend when they take trips in Ohio. By our estimate, this amounts to \$5.4 billion in annual spending on a range of goods and services associated with taking trips in Ohio. Finally, we assess how much this outdoor recreation contributes to Ohio's economy, following the approach in Highfill and Smith-Nelson (2018). We calculate that outdoor recreation generated \$8.1 billion, or 1.2%, of Ohio's Gross State Product of \$651 billion in 2017, and it supported 133,000 jobs, or 1.9% of Ohio's total workforce.

This report also presents estimates of the value of several ecosystem services provided by Ohio's agricultural and forest land. Ecosystem services include outputs like carbon storage in trees, which

mitigates the impacts of climate change, water flow and quality regulation from wetlands, pollination, food, freshwater, education and cultural heritage, as shown in Figure 1. Ecosystem services provide significant value to society globally, estimated globally to exceed \$125 trillion annually (e.g., Costanza et al., 1997; 2014).

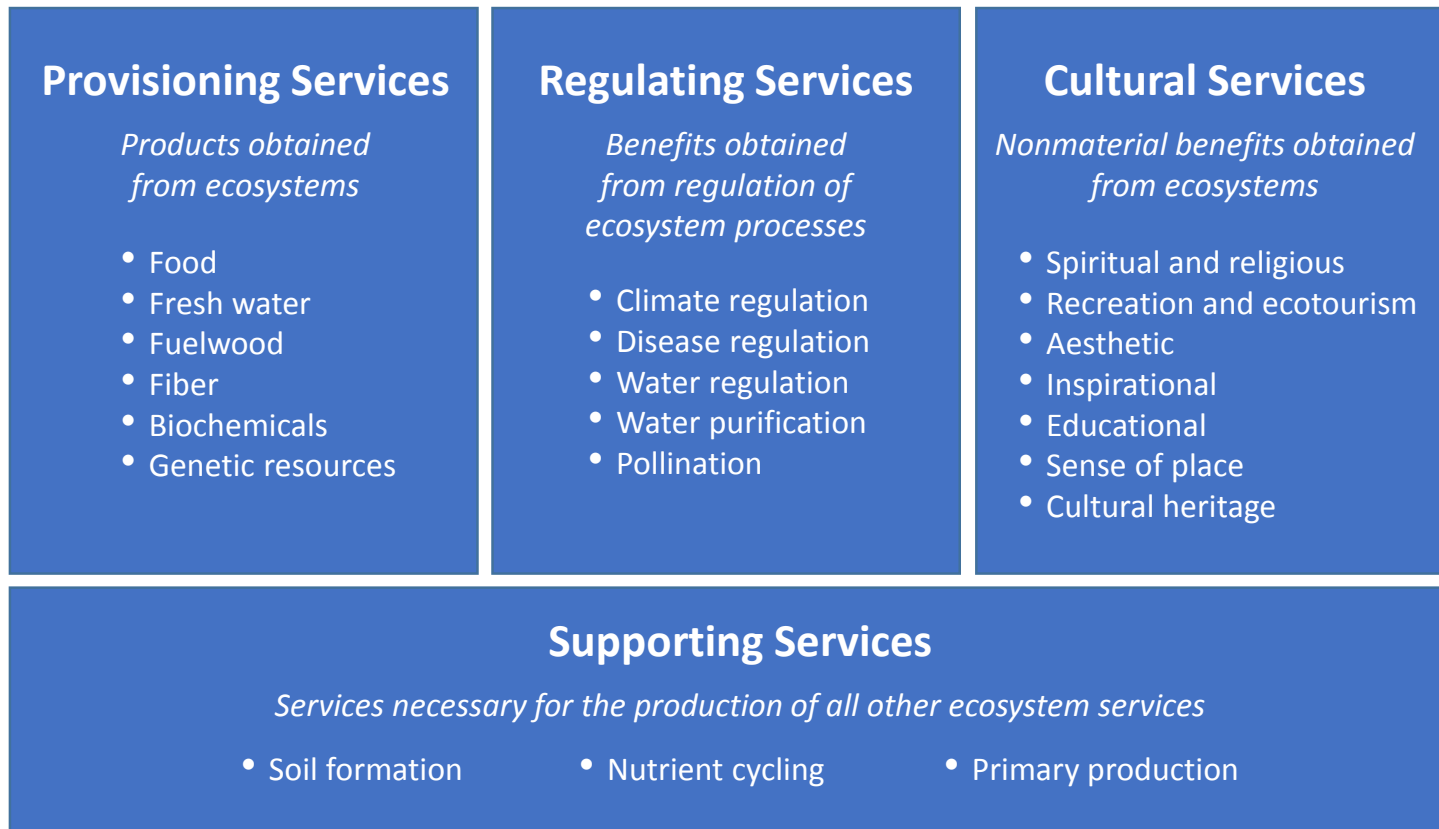


Figure 1: Ecosystem Services overview from MEA (2005).

The emergence of multiple, disparate studies allowed us to quantify the value of a number of ecosystem services in Ohio. This report provides a set of estimates made over several observable ecosystem services for the state that can be valued with current information, including food production, timber production, recreational value, and carbon sequestration. Based on the definitions of ecosystem services provided by the Millennium Ecosystem Assessment (MEA, 2005), we value services in three key categories, provisioning, regulating and cultural. We estimate that ecosystem services values from agricultural and forest lands are \$5.8 billion annually.

The remainder of this report is organized as follows. The first section describes what the various economic values presented in this report are and how they relate to each other. In the second section, we provide a profile of outdoor recreation in Ohio, illustrating our estimates of the total amount of recreation that occurs in the state, as well as the value received by individuals who recreate and their expenditure. The third section presents estimates of the contribution of this outdoor recreation to the state’s economy and employment. The final section presents maps of ecosystem service values across the state.

DEFINING THE VALUE OF OUTDOOR RECREATION AND ECOSYSTEM SERVICES

This report presents a number of different economic values that result from the protection and maintenance of land-based and aquatic ecosystems on public and private land in the state of Ohio. It is useful to define the terms that will be used and to describe how the monetary flows involved relate to each other.

Starting with outdoor recreation, e.g., hiking, biking, camping, fishing, or hunting, there are several important values at play. Consider a trip you are planning to take with family to go on a hike in a state park. You could instead mow the lawn, do other chores around the house, read a book, go to a concert, or engage in any number of other activities. To go hiking, or to participate in any outdoor recreational activity, you give up spending time doing something else. This means that the time you spend hiking

is valuable time, which can be valued by considering the tradeoff between the other activities you could be doing and the hiking. Economists have developed techniques to value outdoor recreation trips by estimating their price in terms of the cost of the other activities the individual gave up (See for example Freeman, Herriges, and Kling). The price of a recreational trip is the direct cost of accessing a recreational site (the costs of driving there) including the value of the activities the person gave up taking the outdoor recreational trip. With prices and the number of trips people take to visit a given site, economists can estimate demand for the site, which represents citizen's "willingness to pay" or "worth" for the recreational site.

The economic value of a site, called **consumer surplus**, is then derived from the demand. This is academic jargon for the economic value of an outdoor recreational trip. It's a measure of what you were willing to give up (your willingness to pay) going on the outdoor recreational trip, including your driving costs and the costs of your time to take the trip. Consumer surplus is a direct estimate of the economic value individuals gain when they take recreational trips. It is the most widely used measure for evaluating the economic costs and benefits of policies aimed at improving outdoor recreational opportunities.

A different measure that is often reported in economic studies is consumer **expenditure**. This is money an individual spends when they take an outdoor recreational trip. Expenditures will include direct costs of a trip, including money spent on gasoline, airfare, hotels, food, bait, and other one-time expenses associated with taking a trip. Expenditures typically do not include expenses for equipment, such as fishing poles or boats or shotguns, which have longer life spans than the trips themselves. These are important things for outdoor recreationists to have, but studies estimating consumer expenditure on trips do not include these types of expenses. Accordingly, we do not include these expenses when estimating consumer expenditure, but we do include them below when we calculate the full contribution of outdoor recreation to Ohio's economy.



Consumer expenditures are useful information that tell us something about how much was spent in the local economy as people took outdoor recreational trips. It's a measure of the flow of money spent on things that are important for trips, and it can be used to help local communities know how much local convenience stores, restaurants, and other establishments benefit from locating near places that offer outdoor recreational opportunities (e.g., near parks or lakes). It is thus a partial measure of the benefits that members of the local community who support the outdoor recreational industry get.



We refer to expenditure as a partial measure of the dollars supporting outdoor recreation because expenditure is typically limited to an estimate of the money outdoor recreational participants spent on their trip. As noted above, additional equipment is often needed for recreation, such as boats, or boots, or camping equipment, and these expenditures are not included in most outdoor recreational expenditure calculations. This means that expenditure provides just some of the information useful to evaluate how much money outdoor recreation provides to the local economy.

There is another problem, besides being incomplete, with using consumer expenditure directly to measure the dollars supporting the outdoor recreational industry. Consider the local convenience store that sells you ten gallons of gas, a couple bags of potato chips, and coffee on your hike at the state park. If you paid \$2.80/gallon for the gasoline, the owner of the store probably paid \$2.65 for gas, leaving \$0.15/gallon to pay employees, insurance, maintenance, and other costs. The benefit to the convenience store owner is not the \$28 you paid them for gasoline, but something less than the \$1.50 that was left after they paid for the gasoline they sold you plus all the other expenses associated with selling you that gas (hiring employees, paying insurance etc.). This is the value-added, or income, generated locally when you purchased your gas. It's the actual benefit the local store got when you bought the gas.

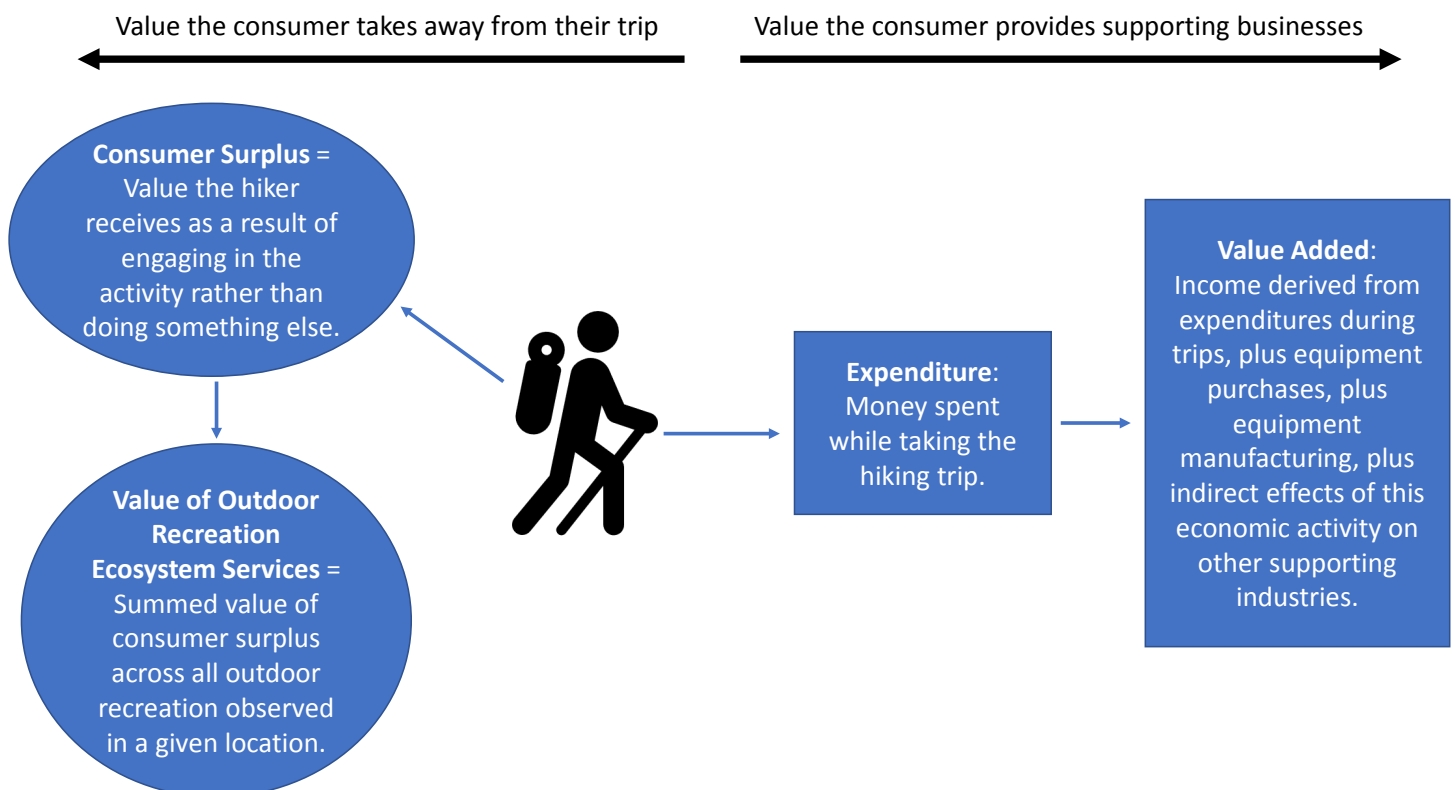
When determining the benefits of outdoor recreation to the local economy, we want to use the measure of **value-added** to estimate value. It is the income businesses receive as a result of the recreational activity. Importantly, value-added can be summed up across all businesses and industries involved without double counting. For instance, consider the gas purchase described above. When the convenience store owner paid \$2.65 for the gas, they paid a distributor to deliver it from the refinery. The distributor paid the refinery, which in turn paid a pipeline company to deliver the oil from a production field, and so on. At each stage in the production and distribution of gasoline, the value-added can be calculated and summed to determine how the purchase of gasoline during an outdoor recreation trip affects the economy. Since we are interested in determining the value-added for Ohio only, we use Ohio data to determine which components of these processes and sectors occurred in Ohio, and attribute only the value-added occurring in Ohio to the Ohio outdoor recreational sector.

The gasoline example is a useful one, but it's a one-time purchase made in the course of a trip. How do we handle purchases of equipment that lasts over multiple trips and multiple years? For this analysis, we have included estimates of the value-added contributed to Ohio's economy by annual purchases of outdoor recreation-related equipment in our analysis. These estimates of equipment purchases are confined to Ohio residents. Ohio is a heavy manufacturing state, and some sectors participate in manufacturing outdoor recreational equipment. We also include estimates of this production, even if the equipment will ultimately be used by people who live outside of Ohio.

The final set of values reported in this study are the values of the **ecosystem services** that we have considered. The value of any ecosystem service is the price, or willingness to pay, for the flow of the service. For goods that are bought and sold in markets, valuing the flow of the service is relatively easy because we can observe prices in the underlying markets. So in the case of agricultural land, which produces crops or animals, the value of the land is the annual net return on the land, which can be observed in markets. Similarly for timber the value of the land is the annual flow of timber revenues, measured with stumpage prices (the price for standing trees before they are cut). For carbon storage in standing trees, the value of the ecosystem service is based on a concept called the social cost of carbon, or price for carbon. Because carbon stored in trees is carbon that is not in the atmosphere, forests provide important services for society because they mitigate climate change. And finally, for the recreational benefits, the value is based on the consumer surplus benefits obtained by those recreating. We do not include the flow of money through the economy resulting from expenditures made while on trips, or when purchasing equipment, when valuing ecosystem services associated with recreation.

The relationship between the economic concepts discussed above — consumer surplus, expenditure, value-added, and the value of ecosystem services — is illustrated in Figure 2. Consumer surplus and ecosystem service values for outdoor recreation are components of value that the consumer receives. The expenditures and value-added are value that derive from the consumers spending patterns on outdoor recreational trips. They are all important to consider when evaluating policies to maintain or enhance ecosystem services that generate demand for recreational trips.

Figure 2: Relationship between concepts used to assess economic values and economic contributions of outdoor recreation.



OUTDOOR RECREATION PROFILE OF OHIO

Outdoor recreation in this study is defined as “all recreational activities undertaken outdoors that occur in nature-based environments.” Such recreation offers an escape from busy, structured lives, it contributes to the bonding of families and communities, and it instills pride in our natural areas (White et al., 2016). Nature-based recreation offers improved physical and mental well-being, it provides us with opportunities to build skills, it provokes our interest in the natural world, and, as suggested in emerging research, it provides an economic stimulus to local and national markets (ORSA, 2018; Outdoor Industry Association, 2017; White, et al., 2016; United States Fish and Wildlife Service, 2011; Costanza et. al., 1997, 2014; Balmford et. al., 2002). Not only does outdoor recreation play an important role in lives of families already involved, but it is growing to reach new populations. Nationally, according to the U.S. Forest Service, outdoor recreation activities grew 7.1% in the first ten years of the 21st century, while specific activities have grown faster: Birding (36%), Rock Climbing (12%), Backpacking (26%), Water Skiing (20%), and Kayaking (86%) (White et al, 2016).

Ohio boasts many outdoor recreational activities, from visiting Lake Erie beaches, to winter sports, to rock climbing, to hiking or biking in Cuyahoga Valley National Park. Compiling visitation data from a range of data sources, we estimate that Ohioans take 170.7 million outdoor recreational trips to Ohio’s natural areas annually, including state, federal, locally managed lands (see appendix A). Table 1 summarizes our estimates of the number, economic value measured in consumer surplus, and annual expenditure for outdoor recreational trips taken in Ohio by type of trip. For the most part, the estimates focus on recreation conducted on public land and public waterways, but also include fishing and hunting on private land because much of the game taken on those lands is managed by the state.

Table 1: Number of trips, economic value (consumer surplus), and annual trip expenditure for outdoor recreational trips taken in Ohio.

Activity	Trips	Economic Value (Consumer Surplus)	Trip Expenditure
	# year (%)	\$/yr (%)	\$/yr (%)
Local park visits	60,738,674 (35.6)	\$364,432,044 (10.2)	\$364,432,044 (6.2)
Bicycling	34,251,788 (20.1)	\$357,931,181 (10)	\$106,180,542 (1.8)
State/National park day use	34,276,195 (20.1)	\$841,480,583 (23.5)	\$1,372,761,603 (23.4)
Fishing	20,396,446 (11.9)	\$822,809,907 (23)	\$2,714,704,973 (46.2)
Hunting	8,967,000 (5.3)	\$741,750,240 (20.7)	\$803,552,868 (13.7)
Hiking/camping	2,434,952 (1.4)	\$64,587,968 (1.8)	\$204,632,065 (3.5)
Boating (all)	9,619,778 (5.6)	\$383,044,255 (10.7)	\$302,442,393 (5.2)
Off Highway vehicle use	52,319 (0)	\$519,523 (0)	\$2,615,927 (0)
Total	170,737,152	\$3,576,555,701	\$5,871,322,415
Value per Ohioan ¹	14.8	\$309.10	\$507.40

¹Value per Ohioan is the total amount divided by the population in Ohio. It is important to recognize that many of the trips were taken by people outside of Ohio so this is an over-estimate of trips and economic value on average.

The consumer surplus of these trips amounts to \$3.6 billion per year. Trip expenditures, which is the amount people taking trips spend when they are on their trips, are estimated to be \$5.9 billion per year. On average, Ohioans receive \$20.94 per trip in consumer surplus when they take outdoor recreational trips and they spend \$34.38 per trip in the local economy when they are taking their trip.

While visits to local parks, bicycling, and visits to state and national parks represent the bulk of the trips Ohioans take each year, large economic value accrues to anglers and hunters. Fishing and state park visitation are the largest contributor to Ohio's economy among the recreational sectors. It is important to note that the value of the state parks is understated here because we have attributed any angling and hunting that occurs in state parks or through state park visits to the fishing and hunting components.

There are few comparable data sources that can be used to corroborate the estimates in Table 1. A recent survey conducted by Ohio University (OU) for the Ohio Department of Natural Resources, provides some information (Ruhil et al., 2018). Unfortunately, the non-random sample frame of the ODNR/OU survey respondents does not allow us to recover statewide estimates of outdoor recreational activities — participation in the survey was voluntary and unrestricted and no information was collected to allow us to adjust for non-representativeness in the set of respondents.

CONTRIBUTION OF OUTDOOR RECREATION TO OHIO'S ECONOMY

In 2018 the United States Bureau of Economic Analysis (BEA) provided the first national estimates of the value-added to our national economy of outdoor recreation through the Outdoor Recreation Satellite Account (ORSA, 2018). The BEA is the official government agency tasked with calculating Gross Domestic Product in the US, which is the sum of all Gross State Products across the US. Their study attempted to measure the contribution of outdoor recreation to Gross Domestic Product (ORSA, 2018 and Highfill, and Smith-Nelson, 2018). They concluded that outdoor recreation is responsible for adding \$412 billion to the nation's GDP, or 2.2% of the American economy, and employs 4.55 million Americans (BEA, 2019). For comparison purposes, the automobile industry accounts for about 3% of GDP and 7 million jobs (American Automobile Council).



This section reports on our estimates of the contribution of outdoor recreation to Ohio's economy. As we built our Ohio estimates of the contribution of outdoor recreation, we consulted the ORSA tables, and followed their methods, with a couple of exceptions. The first exception is that we defined outdoor recreation more narrowly. The BEA chose to define outdoor recreation as, "all recreational activities undertaken for pleasure that occur outdoors," meaning it included amusement parks, outdoor concerts, and outdoor festivals (Highfill and Smith-Nelson, 2018). We chose to use a more limited definition of outdoor recreation, consistent with activities described in Table 1 above.

Similarly, we include value derived from core and supporting outdoor recreation activities, where core activities are those activities associated with taking the recreational trip itself, including the fuel, equipment, food, etc. Supporting components involve travel and tourism components, construction and maintenance of recreation sites. Because Ohio has a strong manufacturing base, we also included sectors that manufacture equipment that is specifically used by the outdoor recreational sector. This means that we have included additional value added in the manufacturing sector that is associated with purchases by people not taking trips in Ohio from companies that are located partially or entirely in Ohio. The full detail of the sectors included directly in our accounts are provided in Appendix B.

The second difference is that we use IMPLAN to determine the value-added for sectors that support outdoor recreational trips, such as wholesale and transportation sectors that arrange for delivery of goods from manufacturers to retailers, or metal fabrication industries that provide inputs to the manufacturers that produced outdoor recreational equipment. We only count the value added associated with the direct expenditure of money on outdoor recreational components. We do not count the induced effects associated with the expenditures that compensated employees make on goods and services they buy.

We find that outdoor recreation contributes \$8.1 billion in value added to Ohio's economy annually, or 1.25% of Ohio's economy (Table 2). Outdoor recreation adds the greatest value to the retail sector, \$2.3 billion, or 6.41%, which includes the purchasing of gear, clothes, and gasoline. Further, outdoor recreation has the second largest impact on the arts, entertainment, recreation, accommodation, and food services sector providing 7.8% of the value-added in this sector in Ohio. Outdoor recreation adds \$1.4 billion to the Transportation and Warehousing sector, due mainly to scenic and sightseeing activities in the state. We calculate that outdoor recreation accounts for employment of about 132,790 people in Ohio, or 1.89% (Table 3). This suggests that 1 in 50 employees in Ohio are employed either directly or indirectly in the outdoor recreation sector.

Table 2: Summary Table of Value Added by Outdoor Recreation to Ohio's Gross State Product (2017). Based on data developed for this report and analysis with IMPLAN.

	Value-Added by Outdoor Recreation	Ohio Value-Added by Sector (Gross State Product)	Percentage VA by OR to Ohio GSP
All Industries	\$8,133,751,411	\$651,542,302,612	1.25%
Private Industries	\$8,026,437,904	\$578,735,301,622	1.39%
Agriculture, forestry, fishing, and hunting	\$4,156,546	\$3,361,691,854	0.12%
Mining	\$39,101,524	\$9,741,770,313	0.40%
Utilities	\$110,833,732	\$11,146,384,480	0.99%
Construction	\$54,865,066	\$28,117,123,627	0.20%
Manufacturing	\$385,892,077	\$104,479,334,402	0.37%
Wholesale trade	\$147,045,013	\$38,940,394,043	0.38%
Retail trade	\$2,326,201,528	\$36,290,195,359	6.41%
Transportation and warehousing	\$1,437,754,116	\$21,359,074,937	6.73%
Information	\$101,240,160	\$16,152,525,279	0.63%
Finance, insurance, real estate, rental, and leasing	\$798,329,608	\$126,682,985,866	0.63%
Professional and business services	\$781,027,059	\$79,786,668,371	0.98%
Educational services, health care, and social assistance	\$7,016,745	\$60,502,238,923	0.01%
Arts, entertainment, recreation, accommodation, and food services	\$1,684,948,936	\$21,476,009,841	7.85%
Other services, except government	\$143,869,249	\$20,698,904,329	0.70%
Government	\$107,313,507	\$72,807,000,990	0.15%

Table 3: Summary Table of Ohioans Employed by Outdoor Recreation. Based on data developed for this report and analysis with IMPLAN.

	Employed by Outdoor Recreation	# of Employees in Ohio	Percent of Employees Employed by Outdoor Recreation
All Industries	132,790	7,016,742	1.89%
Private Industries	131,605	6,237,063	2.11%
Agriculture, forestry, fishing, and hunting	131	99,931	0.13%
Mining	226	33,723	0.67%
Utilities	186	20,746	0.90%
Construction	687	345,449	0.20%
Manufacturing	3,732	712,425	0.52%
Wholesale trade	1,010	267,523	0.38%
Retail trade	42,361	660,860	6.41%
Transportation and warehousing	15,745	259,829	6.06%
Information	696	87,491	0.80%
Finance, insurance, real estate, rental, and leasing	5,685	612,225	0.93%
Professional and business services	8,248	1,006,208	0.82%
Educational services, health care, and social assistance	323	1,040,175	0.03%
Arts, entertainment, recreation, accommodation, and food services	48,305	584,088	8.27%
Other services, except government	4,269	506,391	0.84%
Government	1,185	779,679	0.15%

The 1.25% contribution of outdoor recreation to Ohio's economy is smaller than the 2.2% estimate provided by the BEA for the national economy. This difference can be explained in at least two ways. First, we use a more limited definition of outdoor recreation than the BEA, which accounts for some of the difference. For instance, BEA included all activities done outdoors for enjoyment, which included amusement parks, outdoor concert, and festivals. For this report, we focused on green spaces and nature-based areas and how the activities conducted specifically using those natural assets would affect the Ohioan economy.

Second, Ohio has no ocean coast and no large mountain ranges, and a small proportion of public land per person relative to other states. Ohio thus is not a large attractor for outdoor recreation, save for some high-profile activities such as Lake Erie's walleye and yellow perch fisheries and deer hunting (both of which are relatively important contributors in the state as noted in Table 1 above). Thus, one may expect that compared to western states or coastal states, which are strong attractors for outdoor activity, including many recreational dollars from Ohioans, Ohio will have a smaller contribution of outdoor recreation to its economy than those states.

VALUING ECOSYSTEM SERVICES

One way to estimate the economic value of natural resources and assets is through use of the emerging concept of ecosystem services. Ecosystem services are provided by nature and consumed by humans, either directly or indirectly (MEA, 2005). These services include important outputs that we consume directly, like food, timber, and fresh water, or outputs that we consume indirectly, such as carbon sequestration (climate moderation), water regulation and flood control, or pollinator habitat. Cultural amenities, like recreational opportunities and benefits, are also important.

We examine the scope and size of a number of ecosystem services in Ohio, namely agricultural production, timber harvesting, carbon sequestration, and nature-based recreation. The methods for determining these values are shown in Appendix C. In total, we estimate the value of ecosystem services on forests and agricultural lands in Ohio at \$5.7 billion per year (Table 4). Agriculture provides provisioning values worth around \$1.4 billion per year, or an average of \$112 per acre per year on 12.3 million acres of cropland and pastureland. Slightly more than half the land area in agriculture, 7.7 million acres, is used for forests, which provide ecosystem services of \$4.4 billion per year. The largest component of these services is the storage of carbon, which is valued \$3.1 billion per year, followed by private forest recreation and then by public forest recreation.

Table 4: Summary Table of the Economic Valuation of Ecosystem Services in Ohio.

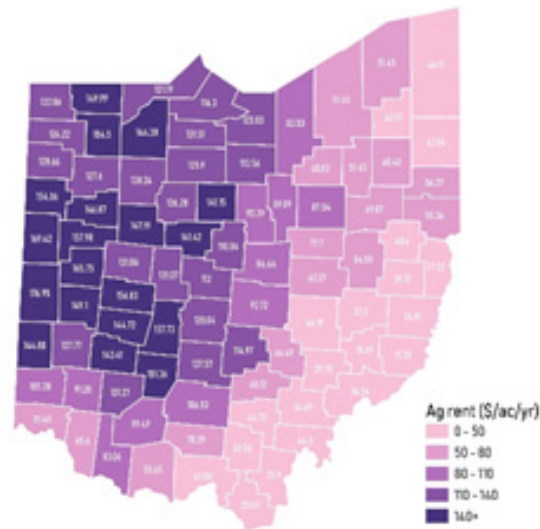
	Annual Value Per Acre (\$/acre/year)	Acres	Total Annual Value (\$/year)
Agriculture	\$112	12,274,572	\$1,379,397,391
Timber	\$62	6,843,076	\$423,792,303
Carbon Storage	\$404	7,733,533	\$3,126,488,897
Public Forest Recreation	\$309	890,457	\$274,784,889
Private Forest Recreation	\$71	6,843,076	\$487,120,029
All Ecosystem Services	\$287	20,008,105	\$5,746,729,566
<i>Breakout of Forest Based Ecosystem Services (these are included above)</i>			
All Forest Recreation	\$99	7,733,533	\$761,904,918
All Forest Ecosystem Services	\$565	7,733,533	\$4,367,332,175

The values for these ecosystem services vary across space due to supply and demand. On the supply side, the production of ecosystem services is determined by soil productivity, slope, precipitation, temperature and other geographical factors, as well as human influence such as roads, pipelines, mining, land ownership, etc. The demand for ecosystem services also influences their valuation. Factors that influence demand include population density, income, and access, to name a few. To the extent possible, we present the ecosystem service values spatially at the county level (Figures 3-6).

The lowest per acre agricultural land values occur in the southeastern part of the state, and the highest values occur in populated areas, and the western part of the state (Figure 3). The farmland values for this study are derived from US Department of Agriculture estimates of farmland cash rents (USDA NASS, 2019). We used cash rents to reflect as best possible the

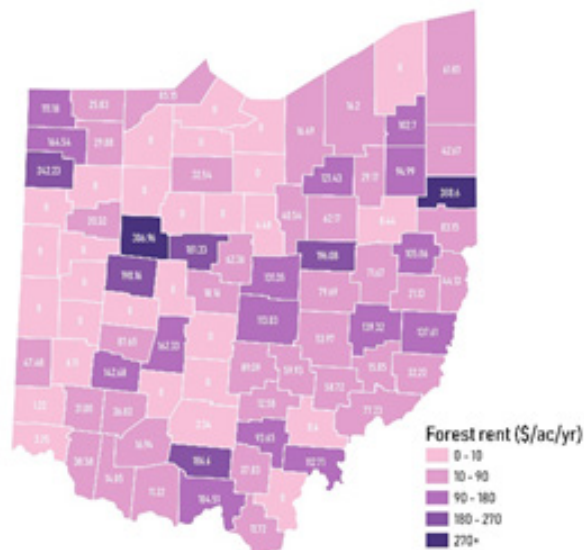
provisioning services of providing food production. We have not included the amenity benefits associated with open space, and we have not included the disamenity effects associated with the water quality damages caused by farming. These and other values will be included in future estimates as more spatially resolved information becomes available.

Figure 3: Ohio agricultural land rents, determined as the cropland rents based on the USDA cash rents survey (USDA NASS, 2019).



Forestland rents are the annual value of timber harvests (Figure 4). They range from a low of 0 where there were no timber removals to \$389 per acre per year in Mahoning county. These vary as a function of the amount of standing timber available, willingness of owners to allow harvests to occur on their property, demand for the wood, and other economic factors. While the greatest standing stock of wood exists in the southeastern part of the state, some of the highest forest rents on a per acre basis occur in the central and northwestern portion of the state.

Figure 4: Forestland rents are provided in \$ per acre per year, and are derived from annual removals from the US Forest Service (USDA Forest Service, 2017), and timber prices from OSU Extension (various years).

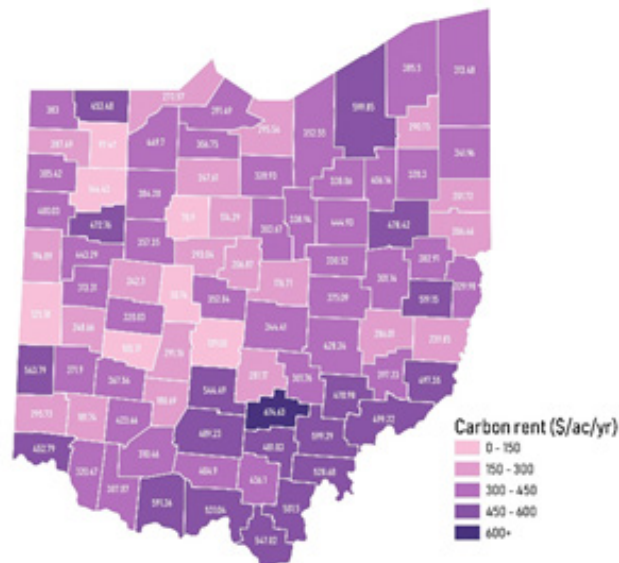


Carbon rents vary only in direct proportion to the size of the standing stock of trees (Figure 5). Carbon rents are valued using what is called the Social Cost of Carbon, a value that represents the impact of each ton of carbon released to the atmosphere on current and future generations. We have used the value of \$36 per ton of CO₂ as the value of a ton of carbon stored. Rents are the annualized value of this storage, using a 3% discount rate. The social cost of carbon is the price of carbon and does not vary spatially, so the only factors driving carbon rents are the factors that influence the area of forestland, and the accumulation of carbon on forested sites.

There are numerous other ecosystem services and resulting values associated with forests, including air and water purification, biodiversity, habitat, and other cultural benefits. As well, there may be dis-amenity values associated with land management activities undertaken in the forests, such as road building or harvesting methods. We have not included these values in this report, although we acknowledge that they are important and should be included in future estimates.

Recreational rents are determined using recreational benefit values that account for individual willingness to pay for the opportunity to recreate at given sites. In Ohio, we estimate that recreational values on forestlands range from \$48 to \$521 per acre per year, with an average of \$98 per acre per year (Figure 6). This is the value that accrues above and beyond any expenses needed by the participant to get to the site. Using data from Ohio wildlife areas, we have estimated the value per acre for recreation in six areas, including the five Ohio DNR wildlife management zones, and the counties along the Lake Erie shoreline. The Lake Erie counties were treated separately because there is significantly higher value associated with the state lands there, likely due to wildlife viewing opportunities. These values apply to public lands. For private forestlands, we have assumed that recreational values are 20% of the public values.

Figure 5: Carbon rents, determined as the annual rent on the tons of carbon stored in standing forests, valued at \$36 per ton CO₂ and discounted at 3% per year.



One of the interesting elements of the forest recreational rents is that the greatest value accrues to forested areas in northern Ohio, which is also the region of the state with the lower proportion of forestland. This illustrates the element of scarcity. Forests provide highly valued benefits for recreational uses, and these values are highest when the supply of the resources is low. Thus in places with lower than average forest area, the value of marginal increases in the area of the ecosystem type is very high.

The total value of ecosystem services on natural land in Ohio ranges from \$336 per acre per year to over \$1100 per acre per year, with an average value of \$481 per acre per year (Figure 7). Values are concentrated in a few areas in the northern part of the state, the south-central part of the state and the western edge of the state. These values accrue for different reasons in each region. Along Lake Erie, the values arise due to exceptionally high recreational value, largely derived from wildlife viewing (e.g. birding). In the south central part of the state, the main driver is forest rents associated with carbon and recreational value. In the western part of the state, agriculture drives the value.

Figure 6: All forest recreational rent.

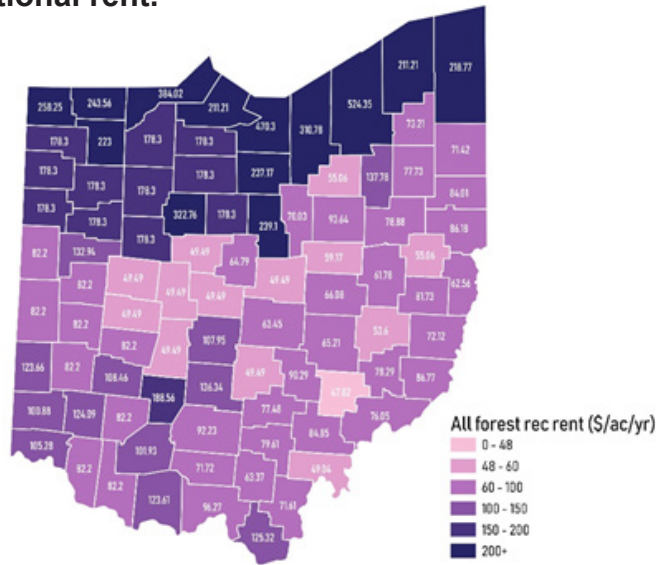
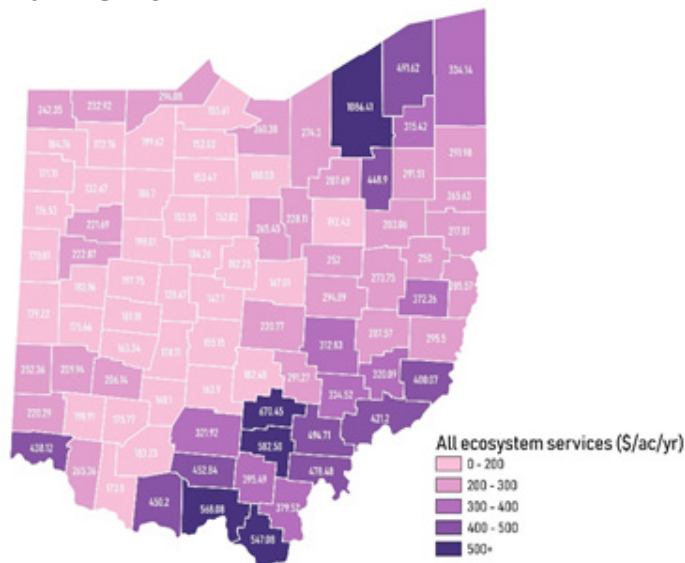


Figure 7: All ecosystem services rent. This sums the value of the ecosystem services shown in figures 2-5 on natural land in Ohio.



CONCLUSION

Ohio's outdoor recreation scene is developing rapidly. With a diverse array of activities, from rock climbing to skiing to motor boating, and a diverse array of place to recreate, from Lake Erie to Hocking Hills, Ohio offers opportunities for citizens to get out and explore the outdoors. This study quantifies the value of Ohio's outdoor recreation, determines the contribution it makes to Ohio's

economy, and it maps out the value of Ohio's ecosystem services across the counties, including recreation. The results illustrate that outdoor recreation and ecosystem services facilitate vital, and likely growing, contributions to the economic well-being of the state. Collectively, we have estimated that Ohioans take over 170 million outdoor recreational trips per year, or nearly 15 trips per person per year. These trips provide economic value to the participants of over \$3.5 billion per year. Recreational expenditures are nearly \$6 billion. Further, the outdoor recreation sector adds a value of over \$8 billion to Gross State Product, or income, for Ohioans. Thus, this sector accounts for 1.3% of Ohio's economic output annually; all indications state that this sector is expected to continue to grow.

When considered in terms of ecosystem services, we calculate that Ohio's landscape provides ecosystem services valued at \$5.8 billion. This includes agricultural land, which constitutes about 24% of the value. Natural forestlands, covering about a third of the state, provide about \$4 billion per year in ecosystem service values. These results suggest that Ohio's natural areas are providing enormous value to Ohioans, in terms of direct and indirect jobs, money flows in the economy, provisioning services, regulating services, and cultural services.

The results suggest that undeveloped lands are extremely important in Ohio, providing significant value both for the users of the land and for society in terms of economic development opportunity. As an example, the Ohio Department of Natural Resources manages 640,000 acres of land, including 74 state parks, 21 state forests, 136 state nature preserves, and 144 designated wildlife areas (Wert, 2017). The budget for the primary divisions within the agency that manage these land-based resources is \$156.2 million per year, suggesting costs of \$244 per acre per year. The recreational benefits of public forests alone, \$309 per acre per year, exceed these costs, and if we add in the carbon benefits of \$404 per acre per year, the benefits of state forests exceed the costs by nearly 3 to 1. This suggests that the provision of public land for Ohioans to use for outdoor recreation is an extremely valuable component of government expenditure. This responsibility may become more important as incomes rise in the future, more people retire and opportunities for outdoor recreation increase.



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APPENDIX A: ESTIMATING TRIPS, CONSUMER SURPLUS AND EXPENDITURES

To calculate outdoor recreational trips in Ohio, we used a variety of data sources.

Local park visits: Trips to local parks were estimated by obtaining annual visitor estimates from a number of the major park districts, including Toledo MetroParks (Trust For Public Lands, 2019), Cleveland Metro Parks (Mclaughlin, 2018), Columbus Metro Parks (Columbus and Franklin County Metropolitan Park District, 2016), and Summit Metro Parks (Summit MetroParks). We used these visitation numbers combined with population estimates to determine that each person in those metropolitan areas visits their park on average 5 times per year. We applied this number to other metropolitan areas in Ohio, such as Cincinnati, to estimate a total number of visits for the rest of the metropolitan areas. For the 2.1 million people living in non-metropolitan areas, we assumed they take 1 visit to a local park person per year. This is likely a conservative estimate.

Bicycling: The Outdoor Foundation (2018) reports that 16% of Americans participate in bicycling, and they take an average of 48 trips per year. If this applied to Ohio, it would suggest that there are 69.8 million biking trips in Ohio per year. However, a recent study by MORPC on the Columbus Greenways suggests that there are 189,880 riders in Columbus, or 9% of the metro area population, and that these riders take 71.6 trips per year on average. Applying this estimate to Columbus and Cincinnati, assuming 22% fewer trips per year in Cleveland due to weather, 40% fewer trips per year in other rural areas due to lower access, and only a third as much participation in rural areas, we calculate a total of 39 million trips in Ohio. Some of the trips occur in parks, so are including in local park visits. We assume 15% of trips occur in local parks, leaving 34.2 million unique biking trips.

State/National Park Day Use: Estimates for state, the Wayne National Forest, and the Cuyahoga River Valley National Park are derived from various sources. For Ohio State Parks, we rely on data Ohio reported to the National Association of Park Directors Annual Information Exchange (NAPD, 2016). For Ohio State Forests, data are obtained from the Ohio Outdoor Statewide Recreation Plan (Ruhil et al, 2018). For Ohio wildlife lands we rely on an analysis by Bruskotter and Pettis (2014). For the Wayne National Forest we rely on Ruhil et al. (2018) and for the Cuyahoga River Valley National Park we rely on the National Park Service web page. In total we estimate that there are 34.3 million trips per year to state and national outdoor recreational lands in Ohio. These numbers are adjusted from the totals provided by these separate sources to eliminate the fishing and hunting trips that occurred on these lands.

Fishing: The US Fish and Wildlife Service estimated that there were 16.8 million fishing trips in Ohio in 2011 (United States Fish and Wildlife Service, 2011). We used the results of a survey by Zajac et al. (2011), however, to estimate that there were 23.9 million fishing trips in Ohio in 2011, based on the nearly 800,000 fishing licenses sold. We used the average between these two estimates to derive the total fishing day estimate.

Hunting: The US Fish and Wildlife Service estimated that there were 9.0 million hunting and trapping trips in Ohio in 2011 (United States Fish and Wildlife Service, 2011). We do not have any other sources to compare and so use this estimate directly.

Hiking/camping: Based on Bruskotter and Pettis (2014), we assumed that 35% of the trips to state lands other than State Parks (e.g., state forests or wildlife areas) were hiking or camping trips that did not involve hunting, resulting in 396,821 hiking/camping trips. USDA Forest Service (2018)

provides information on what visitors do in the Wayne National Forest and was used to calculate that 158,641 of the total trips to the Wayne National Forest are hiking trips. NAPD (2015) reports 1.8 million campers at Ohio State Parks. Finally, we assume that 92,797 additional hikers/campers at Muskingum Valley Conservation District lands (54,000 acres) and Miami Conservancy District lands (3300 acres) based on visitation intensities on visitation intensity at non-State Park state owned lands (1.8 visits per acre per year).

Boating: Boating trips include only boating trips that are primarily boating trips. Boating trips that are fishing trips are included in the fishing trip estimates. Boating trips are determined from the US Coast Guard (2012). From this survey, we calculated total boating trips in Ohio per year at 5.2 million. With 2.7 people aboard, this amounts to 14 million person-trips. These estimates can be further broken down into trips with different types of boats as shown in Table A1. A recent study by the Outdoor Foundation suggests a far higher number of trips in the canoeing and kayaking category for Ohio, as shown in Table A1. For this analysis we use the average of the two.

Table A1: Breakdown of recreational boating trips.

	US Coast Guard (2012)		Outdoor Foundation (2015)	
	Trips	Person-Trips	Participants	Person-Trips
Powerboat	3,605,493	10,589,392		
Sailing	110,018	253,041		
Canoe/Kayak	1,517,532	3,302,731	1,200,576	8,334,768
Total	5,233,043	14,145,163		

These total trips include both fishing and boating trips. Based on Sommer and Sohngen (2007) and Zajac et al (2011), we assume that 61% of power boating trips are fishing trips. We do not have similar data for nonpower boating trips. We assume no sailing trips are fishing trips, and we assume 10% of canoeing and kayaking trips are fishing trips.



Table A2: Annual primarily boating trips in Ohio, adjusted as noted above.

		Person-Trips
Powerboat	0.39	4,129,863
Sailing	1.00	253,041
Canoe/Kayak	0.90	5,236,874
Total		9,619,778

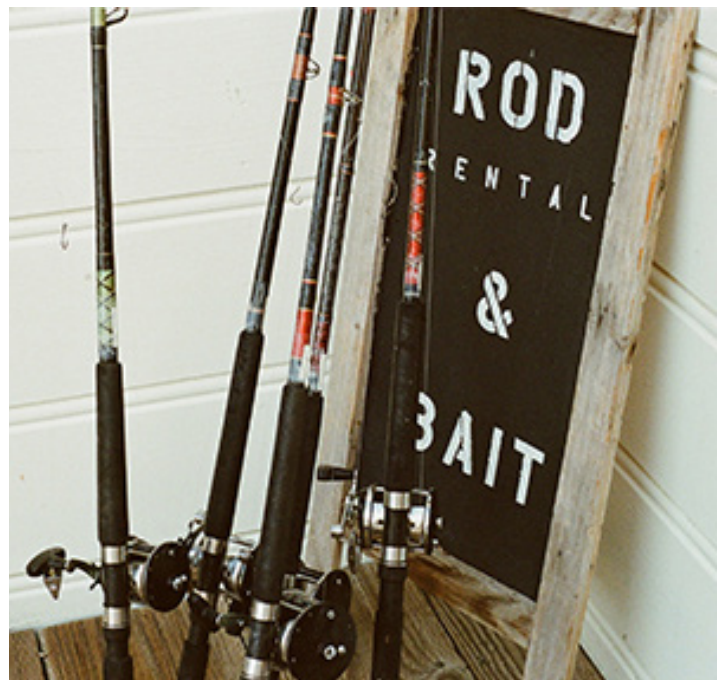
Off Highway Vehicle Use: OHV use is very difficult to estimate as there are not reliable statistics available. Using data from USDA Forest Service (2018) for the Wayne National Forest, and Ruhil et al. (2018) for state forests, we estimate 52,319 OHV trips per year on state or federal lands. This undoubtedly underestimates the full range of OHV use on public and private land.

Consumer surplus and expenditure values per trip are shown in Table A3. These estimates are derived from a number of sources and estimates which have been made over the years. All estimates have been updated to 2016 US \$ using the Consumer Price Index. In a number of cases we have used results from Rosenberger et al. (2017). From that study we have only used estimates made on or after 1995 up to the end of the dataset in 2011, and we use an average of the values. Further, we have only used estimates from census region 2, which includes Ohio.

Values for bicycling trips have been estimated using three studies in the literature: Betz et al. (2003), Bowker et al. (2007) and Sideralis and Moore (1995). The average consumer surplus per trip in their estimates is \$34.83 per trip and their average expenditure is \$13.67 per trip. The sites they studied, however, are unique and likely are not representative of the site for the average bicycling trip in Ohio. We therefore adjust the per trip CS to 30% of the average value from those studies for our analysis. For expenditure we use \$3.10, which is derived from the study by Lindsey et al. (2015) for Columbus bicycle trips.

Motorized and non-motorized boating CS are obtained from Rosenberger et al. (2017). Expenditure estimates are derived from the fishing expenditures estimates provided by the United States Fish and Wildlife Service (2011) study. That study suggested that fishing trip expenditures were \$113.50 per trip. We assumed expenditures for boating only trips were less than that, assuming that people would drive less distance on average to boat, and spend less time and money on bait and tackle and other inputs during the trip. We adjusted motorized boating expenditures to 35%, and we adjusted non-motorized boating to 22%.

Fishing CS is from Rosenberger et al. (2017) and trip expenditure is from the United States Fish and Wildlife Service (2011) study. The estimate we use from Rosenberger et al. (2017) \$34.40 per trip, which we believe to be a reasonable estimate of average trip value in Ohio. It is similar to the estimates for fishing values for Lake Erie estimated in Zhang and Sohngen (2018). Their estimates ranged from \$14 per trip to \$59 per trip, with a weighted average of \$35.56.



Hiking and camping CS on state lands that are not State Parks is from independent estimates made by the authors of this study and an undergraduate research assistant Ryan Brune using the data from Bruskotter and Pettis (2014). CS on the Wayne National Forest, National

Parks, and State Parks non-hunting day use is derived from Rosenberger et al. (2017). Ohio State Park camping CS is derived from Rosenberger et al. (2017) but is specific for camping trips that do not necessarily include hiking. Other state lands hiking and camping CS is the average of the \$24.55 and \$12.67, given that these trips include some camping trips and some hiking trips. Expenditures are assumed to be \$40.05. This is based on data from Bruskotter and Pettis (2014) suggesting that the roundtrip mileage to and from Ohio wildlife lands is 160 miles. Assuming 24 miles per gallon and \$3 per gallon for gasoline, the gasoline costs are \$20. We double this to include additional expenditures as well as the possibility that gas mileage is lower if individuals are driving trucks with trailers in some cases. We further increase the Ohio State Park camping expenditures to \$100 per trip, given that individuals must buy groceries and other inputs to camp, and also bring a camping trailer in many cases.

For ORV use on federal or state land, CS is obtained from Rosenberger et al. (2017). Expenditures are assumed to be \$50, assuming a 160 mile roundtrip distance, and an additional \$10 for the fuel for the ORV. Local park visits we assume CS of \$6 and expenditure of \$6. Hunting CS is obtained from Rosenberger et al. (2017) and expenditures from the United States Fish and Wildlife Service (2011) study.

Table A3: Value per trip estimates for consumer surplus and expenditure (2016 US\$).*See discussion above for description of datasets used.*

Value Per Trip		CS/Trip	Expenditure/Trip
Bicycling		\$10.45	\$3.10
Boating	Motorized	\$56.26	\$40.00
	Canoeing/Kayaking	\$27.45	\$25.00
	Sailing	\$27.45	\$25.00
Fishing		\$34.40	\$113.50
Hiking/Camping			
	State lands (Non State Park)	\$91.55	\$40.05
	Wayne National Forest	\$24.55	\$40.05
	Other State	\$18.61	\$40.05
	State Parks Camping	\$12.67	\$100.00
	National Park	\$24.55	\$40.05
	State Parks Day-Use (Non-Hunting)	\$24.55	\$40.05
ORV Use on State or Fed Land		\$9.93	\$50.00
Local Park Visits		\$6.00	\$6.00
Hunting/Shooting/Trapping		\$82.72	\$89.61

APPENDIX B: METHODS TO CALCULATE THE CONTRIBUTION OF OUTDOOR RECREATION TO OHIO'S ECONOMY

This appendix reports on the methods used to determine how outdoor recreation contributes to value-added in the state of Ohio. We have generally followed the methods presents in ORSA (2018), but have deviated, as noted in the main text, in a couple of important ways. First, we have defined outdoor recreation more narrowly, and second, we have used the IMPLAN model to measure the flow of funds from the initial expenditure in outdoor recreation to other supporting industries.

The BEA chose to define outdoor recreation as, “all recreational activities undertaken for pleasure that occur outdoors” (2). This means the ORSA data includes categories such as amusement parks, outdoor concerts, and outdoor festivals. We have narrowed this to outdoor recreation that occurs primarily in natural areas and green-space environments in Ohio. Our definition of outdoor recreation is thus “all recreational activities undertaken outdoors that occur in nature-based environments.” This eliminated activities like amusement park visits, outdoor concerts, and outdoor festivals from the scope of this study.

The first step in our analysis involved assessing the IMPLAN sectors, of which there are 506, to determine which ones contain direct economic activity based on our definition of outdoor recreation.

We then determined a percentage of each of those categories that involved outdoor recreational expenditures. Table B1 presents the set of sectors we included as direct contributors to outdoor recreation in Ohio, and the proportions of those sectors that we assumed resulted from outdoor recreation.

The adjustments to each sector are drawn from several different sources. For footwear manufacturing we took the total outdoor recreational trips in Ohio estimated above, and compared that to the total possible trips Ohioans could take (11.5 million people times 365 days per year), which is 4%, or 0.04. We thus assumed that 4% of the footwear manufacturing in Ohio results from outdoor recreation demand. For motor home, trailer, camper and boat manufacturing, we assumed 100% of output in those sectors is outdoor recreation. For motorcycles, bikes, and parts as well as all other transportation equipment manufacturing, we assume 85% is related to outdoor recreation.

For the retail sectors, we assumed 6% results from outdoor recreation activity. This is adjusted compared to the Bureau of Economic Analysis (2018) ORSA report, which assumes that 8% of retail is related to outdoor recreation. The Ohio proportion is assumed to be 79% of the national proportion based estimates from USFWS which suggests that Ohio per trip hunting and fishing expenditures are 79% of national per trip hunting and fishing expenditures. This estimate is applied equally to all retail sectors.

For museums, historical sites, zoos and parks we assume 100% is outdoor recreational based. For restaurants we assume 3.6%. Similarly to the retail sector, we used the United States Fish and Wildlife Service (2011) study, which suggests that Ohioans spend 72% as much as nationally on hunting and fishing trips. Scenic and sightseeing transportation is assumed to be 50% outdoor recreation. General and consumer goods rental is assumed to be 6%, following the retail sector assumptions above. Other amusement and recreation industries is assumed to be 100%. Note that this does not include amusement parks. Hotels and other accommodations are adjusted as 72% of the national ORSA number.

Then, IMPLAN was used to estimate the indirect value added by the industries chosen. This would include a gas station's purchase from the gasoline wholesaler, their purchase from an oil refinery, their purchase from the transporter, and so on as a result of a consumer purchasing gas at this station. This table of direct and indirect value added is shown in Appendix A. We used this sector specific economic data for Ohio and adjusted it using proportions for each sector chosen based off of 1. ORSA's assumptions on the national level and 2. characteristics of outdoor recreation in Ohio compared to the nation (based off of USFWS survey and state-wide trip data), in order to extract data on value added by outdoor recreation in Ohio. These adjustments and assumptions are further discussed below.

Below represents the sectors out of IMPLAN's dataset of 529 which consumers that participate in outdoor recreation would directly add value to, according to this report. The second column represents how this report adjusted these values in order to extract outdoor recreation's added value to each of these sectors. Below represents the assumptions and logic used to attain these adjustments.

The contribution of outdoor recreation in sectors aside from these is determined using IMPLAN as the indirect effects. We do not include induced effects, or the demands derived from income provided to individuals employed in the sectors. Table B2 shows the full set of direct and indirect value-added that is estimated to be attributable to outdoor recreation activity in Ohio.

Table B1: IMPLAN Sector Adjustments

IMPLAN Sector Description	Adjustment
Footwear manufacturing	0.04
Motor home manufacturing	1.00
Travel trailer and camper manufacturing	1.00
Boat building	1.00
Motorcycle, bicycle, and parts manufacturing	0.85
All other transportation equipment manufacturing	0.85
Retail - Motor vehicle and parts dealers	0.06
Retail - Furniture and home furnishings stores	0.06
Retail - Electronics and appliance stores	0.06
Retail - Building material and garden equipment and supplies stores	0.06
Retail - Food and beverage stores	0.06
Retail - Health and personal care stores	0.06
Retail - Gasoline stores	0.06
Retail - Clothing and clothing accessories stores	0.06
Retail - Sporting goods, hobby, musical instrument and book stores	0.06
Retail - General merchandise stores	0.06
Retail - Miscellaneous store retailers	0.06
Retail – Non-store retailers	0.06
Museums, historical sites, zoos, and parks	1.00
Full-service restaurants	0.04
Limited-service restaurants	0.04
Scenic and sightseeing transportation and support activities for transportation	0.50
General and consumer goods rental except video tapes and discs	0.06
Other amusement and recreation industries	1.00
Hotels and motels, including casino hotels	0.14
Other accommodations	0.14
All other food and drinking places	0.04

Table B2: Full Table of Value Added by Outdoor Recreation to Ohio's GSP

All Industries	8,133,751,411
Private Industries	8,026,437,904
Agriculture, forestry, fishing, and hunting	4,156,546
Farms	3,017,184
Forestry, fishing, and related activities	1,139,362
Mining	39,101,524
Oil and gas extraction	14,942,634
Mining, except oil and gas	1,393,104
Support activities for mining	22,765,787
Utilities	110,833,732
Construction	54,865,066
Manufacturing	385,892,077
<i>Durable goods</i>	313,472,483
Wood products	4,221,951
Nonmetallic mineral products	4,374,070
Primary metals	6,208,562
Fabricated metal products	11,111,386
Machinery	3,304,276
Computer and electronic products	621,284
Electrical equipment, appliances, and components	3,766,750
Motor vehicles, bodies and trailers, and parts	210,740,010
Other transportation equipment	65,655,665
Furniture and related products	501,712
Miscellaneous manufacturing	2,966,818
<i>Nondurable goods</i>	72,419,593
Food and beverage and tobacco products	13,574,573
Textile mills and textile product mills	442,285
Apparel and leather and allied products	68,226
Paper products	4,030,256
Printing and related support activities	19,181,122
Petroleum and coal products	15,449,719
Chemical products	8,813,453
Plastics and rubber products	10,859,958
Wholesale trade	147,045,013
Retail trade	2,326,201,528
Transportation and warehousing	1,437,754,116
Air transportation	7,316,880
Rail transportation	4,372,610
Water transportation	133,681
Truck transportation	45,366,935
Transit and ground passenger transportation	1,360,340
Pipeline transportation	4,890,233
Other transportation and support activities	1,271,041,079
Warehousing and storage	103,272,357

Table B2: Full Table of Value Added by Outdoor Recreation to Ohio's GSP (continued)

Private Industries (continued)		
Information		101,240,160
Publishing industries, except internet (includes software)		27,295,563
Motion picture and sound recording industries		1,666,339
Broadcasting and telecommunications		50,913,037
Data processing, internet publishing, and other information services		21,365,222
Finance, insurance, real estate, rental, and leasing		798,329,608
Finance and insurance		230,454,074
Federal Reserve banks, credit intermediation, and related activities		99,847,946
Securities, commodity contracts, and investments		9,781,394
Insurance carriers and related activities		120,458,822
Funds, trusts, and other financial vehicles		365,912
Real Estate and rental leasing		567,875,534
Real estate		492,537,881
Rental and leasing services and lessors of intangible assets		75,337,653
Professional and business services		781,027,059
Professional, scientific, and technical services		187,663,859
Legal services		23,324,208
Computer systems design and related services		21,033,015
Miscellaneous professional, scientific, and technical services		143,306,636
Management of companies and enterprises		309,918,092
Administrative and waste management services		95,781,250
Administrative and support services		71,391,099
Waste management and remediation services		24,390,150
Education services, health care, and social assistance		7,016,745
Educational services		7,003,864
Health care and social assistance		12,881
Ambulatory health care services		-
Hospitals		-
Nursing and residential care facilities		-
Social assistance		-
Arts, entertainment, recreation, accommodation, and food services		1,684,948,936
Arts, entertainment, and recreation		929,746,487
Performing arts, spectator sports, museums, and related activities		11,849,354
Amusements, gambling, and recreation industries		917,897,133
Accommodation and food services		755,202,449
Accommodation		254,962,062
Food services and drinking places		500,240,387
Other services, except government		143,869,249
Government		107,313,507

APPENDIX C: ASSUMPTIONS FOR ECOSYSTEM SERVICES ANALYSIS

Agriculture: The annual value per acre for agriculture is determined using the USDA Cash Rents Survey (USDA NASS 2017). An alternative approach could use the value of agricultural land and buildings from the US Census of Agriculture (2017), but this value would include other values besides just the value of farm outputs, including the value of buildings, speculative values related to the future benefits of owning farmland, and location rents. Our interest lies in the assessing the provisioning value of the agricultural land related to the farm outputs produced.

We have not considered other ecosystem services on farmland, which would influence this annual value. For instance, agricultural soils do contain carbon, which is kept out of the atmosphere and thus has value. We do not have spatial estimates of the amount of carbon maintained in Ohio soils so do not attempt to calculate these benefits. Similarly, we do not include any additional value for open space, which could increase the value of farmland. We do not account for the water quality impact of agriculture, which would reduce the flow of ecosystem services from farmland and we do not include other dis-amenities, such as smells or air quality impacts that could arise from livestock operations.

Timber: We can use the US Forest Service FIA data (2017) along with stumpage prices from OSU Extension to determine the value of timber removals. The FIA data provides estimates of timber removals from 2015. The value of each type of timber was calculated with the price data from OSU Extension. The total value of timber removals per county was then be calculated by multiplying types of timber with their stumpage price and then summing. This value represents a flow, so can be interpreted directly as the annual value, and can be adjusted to a per acre basis by dividing through by all the timberland acres in a county.



Carbon storage: The first step of our analysis involves measuring tree biomass by county. Tree biomass is calculated as a function of measured growing stock volume, which is derived from the US Forest Service FIA data (2017). Growing stock volume is the live tree volume in m³ for trees that are greater than 5" in diameter. Growing stock is converted to carbon using equations from Smith et al. (2003). There is significant debate about how to price carbon. The EPA study on social cost of carbon (USEPA, 2016) used three well-known integrated assessment models to calculate the social cost of carbon. These models found that the price of carbon ranged from \$36 and \$105 dollars per imperial ton of carbon dioxide in the current period, depending on the discount rate assumed by the model. We assume in this paper the price is \$36 a metric ton of carbon dioxide.

Public Forest Recreation: To value public forest recreation using the concept of consumer surplus described above. For this analysis we have estimated consumer surplus uniquely for Ohio based trips with the data from Bruskotter and Pettis (2014). The data support separate estimates for each of six regions in Ohio and the estimated public land values range from \$239 per acre per year in Southeastern Ohio to \$1049 per acre per year along the Lake Erie coastline (Table C1). These calculations are estimated for data collected from ODNR Division of Wildlife wildlife areas, but have been extrapolated to other similar public forests for the purposes of this analysis. Given the distribution of public forests around the state, the average value per acre for public forests around the

state is \$309 per acre per year. Importantly we have also applied these estimated values to all State Parks, which have more visitors in most cases than other recreational lands. Ohio does not collect visitation data by State Park and by activity at State Park, so we cannot account for the potentially higher value of public forestlands at State Parks. We have thus used more conservative estimates of use values from Division of Wildlife lands and applied them to forests on State Park lands.

Private Forest Recreation: Private forest recreation is valued at 20% of the value of public forest recreation. This is a strong assumption that may under- or over- estimate the value of private forest recreation in Ohio. Clearly, on lands where owners engage in widespread recreational activity, the value would be much higher. We do not know the proportion of land in Ohio in which owners are actually recreating and how much. Future research should address this question.

Table C1: Public forestland values and estimated trips per acre based on data in Bruskotter and Pettis (2012). The region numbers correspond to ODNR regions, except region 6, which was added as the counties on the Lake Erie coastline.

ODNR Region	Value (\$/yr)	Acres	\$/acre/yr	Trips/acre/yr
1	\$3,462,056	13,992	\$247	8.2
2	\$10,395,093	11,660	\$892	2.5
3	\$8,321,257	30,227	\$275	5.4
4	\$27,317,591	114,248	\$239	1.4
5	\$7,795,634	18,967	\$411	5.5
6*	\$10,342,891	9,794	\$1,056	13.7
* Region 6 is not an ODNR region				

