H2Ohio and the Value of Restoring Watersheds

An Economic Valuation of Ohio's Agriculture and Wetland Restoration Programs

2026

EARTH ECONOMICS

The Nature Conservancy

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EXECUTIVE SUMMARY

The H2Ohio initiative is delivering measurable results for Ohio's people, economy, and environment. The goal of the initiative is to tackle the harmful impacts of excess phosphorus in surface waters, improving water quality through wetland restoration, reducing nutrient runoff, and promoting agricultural best management practices (BMPs), among other programs. Analysis by Earth Economics demonstrates that H2Ohio generates strong returns on investment from H2Ohio's work restoring wetlands and supporting farmers to reduce nutrient runoff, as the program remediates harmful algal blooms, improves drinking water security, and strengthens local economies.

Wetland Restoration

More than 180 projects covering 11,000+ acres[1] now generate over **$300 million in annual benefits**. Wetlands improve water quality, reduce flooding, protect biodiversity, and create recreation opportunities, among other benefits. **Every $1 invested in wetlands returns $8 in public value.**

Investments in H2Ohio's wetland restoration program support more than **270 full- and part-time jobs**, providing over **$17 million in wages for Ohio workers**. These investments also add **$28 million to Ohio's GDP**. Altogether, annual investments ($26.7 million) generate over **$48 million in total economic activity each year**. For every dollar spent on wetland restoration, **the program returns $2.16 to Ohio's economy.**

Agricultural Best Management Practices

Over 3,200 farmers enrolled 2.2 million acres, preventing **420,000 pounds of phosphorus** from entering waterways in 2024.[2] These reductions provide an average of **$32 million in benefits each year**, including healthier communities, higher property values, and stronger recreation economies. **Every $1 invested yields $1.21 in benefits**, even before counting soil and climate co-benefits.

Why It Matters

Together, these findings confirm that H2Ohio is a cost-effective investment in Ohio's future that pays off for Ohioans. The program not only safeguards water resources and public health but also delivers measurable economic value to residents, businesses, and industries across the state. By reducing harmful algal blooms and restoring natural systems, H2Ohio strengthens local economies, enhances community resilience, and supports a healthier environment for generations to come.

1 According to the 2024 Annual Report. The 2025 Annual Report includes an additional 65 wetland projects started in fiscal year 2025.

2 The 2024 Annual Report estimated phosphorus load prevention of 420,000 pounds. The 2025 Annual Report updates these estimates to 532,000 pounds in 2024, and 550,000 pounds in 2025. The results in this report are based on the 2024 Annual Report.

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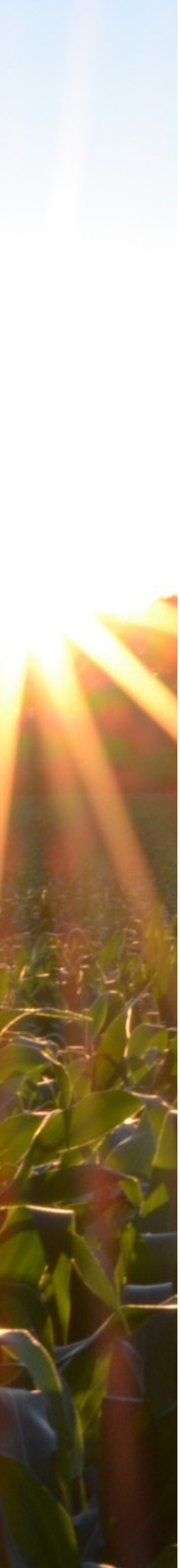


1. THE H2OHIO APPROACH TO **IMPROVING OHIO'S WATERS**

1.1. What is H2Ohio

H2Ohio is a comprehensive initiative aimed at improving water quality across Ohio through agricultural best management practices (BMPs), restoration of wetlands, conservation of rivers, and improvements to infrastructure for drinking water and wastewater. H2Ohio also funds statewide river testing for forever chemicals (e.g., "PFAS"), removal of hazardous dams through the Rivers program, lead pipe replacement through Ohio EPA, though this report only evaluates the cost-effectiveness of H2Ohio's efforts in wetlands restoration and promoting conservation farming practices.

Because wetlands provide natural water filtration, the program focuses on wetland restoration as a means to remove excess nutrients and pollutants that might otherwise enter waterways. To address pollution at the source, the program also aims to reduce human-derived phosphorus from both point and nonpoint sources. In collaboration with local farmers, conservation groups, and government agencies, H2Ohio has enrolled more than 2.2 million acres of farmland into voluntary programs focused on BMPs for reducing nutrient runoff that contributes to harmful algal blooms, especially those in Lake Erie.

A key part of the program is Voluntary Nutrient Management Plans (VNMPs), among other agricultural best management practices (agricultural BMPs), by which farmers manage fertilizer use and optimize nutrient application on their fields. These BMPs have been successful at reducing phosphorus runoff. Specifically, the 2025 H2Ohio Annual Report projects that 550,000 pounds of phosphorus will be prevented from entering waterways in 2025. H2Ohio's success is evident in the significant participation of Ohio farmers, with over 3,200 producers enrolled in the program, the highest number since its inception in 2020.

To capture excess phosphorus from human activities, Ohio's Department of Natural Resources (ODNR) has been pivotal in restoring wetlands, leveraging state, federal, and private funding to support over 458 projects as of June 2025—322 of which have already been completed. These wetlands provide numerous benefits to both people and wildlife, including flood prevention, recreational opportunities and critical habitats for native species. Through the Water Quality Incentive Program, ODNR partners with landowners to restore wetlands and streambanks, further expanding program impacts.

1.2. Cost-effectiveness

The Nature Conservancy commissioned Earth Economics to estimate the cost-effectiveness of the H2Ohio program. Cost-effectiveness is evaluated by several means: 1) valuing the co-benefits (also known as "ecosystem services") of H2Ohio's restored wetlands as well as the value of reduced phosphorus from the program's agricultural BMPs; 2) estimating a return-on-investment (ROI) by comparing these benefits to money spent by the state implementing the program; 3) and finally, determining the economic impact of spending on wetlands restoration on the state economy.

What makes the H2Ohio strategy effective at improving water quality also bolsters its cost-effectiveness, because this multifaceted approach to tackling excess phosphorus problems in Ohio watersheds produces valuable co-benefits. For example, reduced phosphorus loading by agricultural BMPs can reduce the risk of harmful algal blooms (HABs) in Lake Erie, leading to more fishing opportunities and sustained revenues for boat charters.

1.3. How to Read This Report

This report is intended to increase understanding of the cost-effectiveness of the H2Ohio's wetlands and agriculture programs. However, the valuations in this report are limited by the available data and literature that ties the benefits of these activities to economic values—the benefits valued here are not exhaustive and additional, uncounted benefits are likely to exist. In other words, these figures *underestimate* the full value of benefits produced by the H2Ohio program. The authors would also caution readers against comparing one program's effectiveness with another, especially for decision-making, as these valuations and ROIs have not been estimated in consistent ways, owing to differences in underlying processes, as well as the available data and supporting literature. The wetlands analysis estimates the value of general improvements to water quality (i.e. not focused specifically on phosphorus) alongside many other co-benefits provided by wetland restoration. The agriculture analysis focuses solely on the value of reducing phosphorus. For similar reasons, comparisons of different benefits within each analysis should also be avoided.

Report Structure

Chapter 1: The H2Ohio Approach to Improving Ohio's Waters—a primer on the goals of the H2Ohio program and the objectives of this study.

Chapter 2: Key Concepts—introduces the underlying concepts for identifying, quantifying, and valuing ecosystem services benefits; locating and quantifying who benefits from the H2Ohio wetlands program; and conducting an economic impact analysis

Chapter 3: Wetlands Restoration—describes the value of co-benefits of H2Ohio's completed and in-progress wetlands restoration projects, as well as quantifying who benefits.

Chapter 4: Agricultural Best Management Practices—describes the intersection of phosphorus, agricultural BMPs, and water quality while providing the value of benefits derived from reduced phosphorus loading.

Chapter 5: H2Ohio: Water Quality is the "Heart of It All"—summarizes the key findings of the report while discussing the relationship between these two programs' effectiveness.

Chapter 6: Works Cited—provides references for all literature cited in this report.

Appendix A: Wetlands Ecosystem Service Valuation Methodology—Details the methodology for producing ecosystem services values for wetlands restoration projects.

Appendix B: County-Level Wetlands Ecosystem Service Benefits—Provides a county-level detail of wetlands results from the ecosystem services valuation.

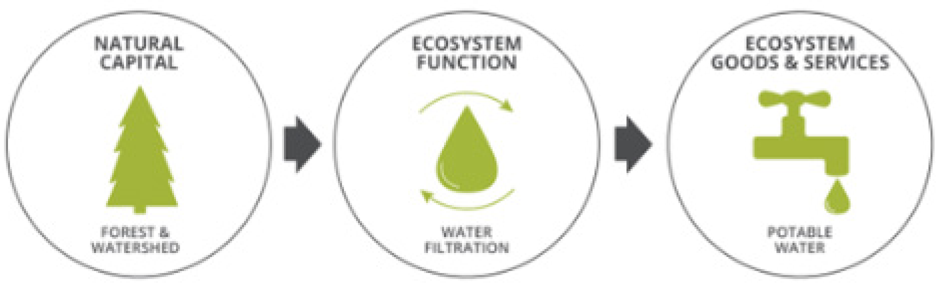
Appendix C: Economic Impact Analysis Assumptions—Details the assumptions that were necessary to perform the economic impact analysis of wetland restoration investments.

2. KEY **CONCEPTS**

2.1. Natural Capital and Ecosystem Services Valuation

Natural capital refers to the planet's stock of natural resources and geochemical, ecological, and biological processes. This includes Earth's geology, chemistry, soil, water, air, flora, fauna, bacteria, and fungi. Forests, watersheds, mountains, and shorelines are all natural capital assets, and each contains multiple ecosystems that perform a range of ecosystem functions. These functions in turn provide goods and services that enrich the human experience. As natural capital degrades, ecosystem functions are impaired and the value of ecosystem goods and services available for humans declines. Most ecosystem services—breathable air, drinkable water, fertile soils, pollination, disaster resiliency—are critical to human survival. Where these services are lost, the economic impacts can be estimated in a variety of ways, including adverse health impacts, decreased productivity, and property or income losses. The flow of ecosystem goods and services from natural capital is illustrated in Figure 1.

Figure 1. Natural capital, ecosystem function, and economically valuable ecosystem goods and services



Ecosystem service valuation is the process of quantifying the monetary value of these benefits. Some ecosystem goods and services are traded in markets (e.g., foods, natural fibers, wetland credits), and for these, there are mechanisms to assign or impute monetary values using market prices. However, other ecosystem benefits are not traded in markets ("non-market" goods and services) and must use other means by which to estimate their value.

Over the past several decades, economists have developed multiple methods for estimating the value of non-market benefits. Most non-market valuation methods are derived from either *stated preferences* or *revealed preferences*. Stated preference methods estimate value by directly asking people what they would be willing to pay for a particular resource (or accept for its loss). Revealed preference methods infer values by observing actual spending behaviors in related markets, such as travel costs or differences in property values associated with specific amenities.

Secondary methods may also be used to estimate the value of ecosystem services. In such instances, researchers generalized estimates reported in published studies to "transfer sites with similar ecological and social characteristics. This is known as Benefit Transfer Method (BTM), which is broadly defined as "...the use of existing data or information in settings other than for what it was originally collected" (Richardson et al., 2015). BTM is frequently used to estimate the value of nonmarket goods or services, as it is often the most pragmatic option available for quickly generating reasonable estimates at-scale and at a fraction of the cost of conducting multiple primary studies.

A common application of BTM are property appraisals, in which the value and features of comparable neighboring homes that have recently sold (e.g., two bedrooms, garage, one acre, recently remodeled) are used to estimate the value of off-market homes. Again, such results can be somewhat imprecise; their value comes from the ability to generate reasonable results (appropriate to support initial decision making) in a timely and cost-effective manner.

Two common categories of BTM are *point-value* transfers and *value function* transfers. Point-value transfers convert estimates reported in primary research into unit values (e.g., $/acre/year), which are then scaled by the number of equivalent units at the transfer site. Value function transfers build from statistical models reported in the valuation literature, substituting transfer site attributes for the value of explanatory variables (e.g., median income, distance to surface waters) to produce new, semi-tailored estimates. Later chapters use both BTM approaches to estimate the value of ecosystem service benefits.

Including the non-market values of ecosystem services leads to stronger, more informed decision-making. Traditionally, these benefits have been excluded from accounting frameworks—effectively valued at $0—resulting in incomplete assessments of a program's or project's true worth. Ignoring these values can lead to inefficient investments, higher long-term costs, and poor asset management. When natural systems are degraded, communities become more vulnerable to flooding and other disasters, and taxpayers must often pay to replace lost services, such as water filtration, with other expensive built infrastructure. In many cases, lost ecosystem goods and services are irreplaceable. Recognizing and quantifying these benefits is now a common and necessary practice for evaluating environmental programs like H2Ohio, ensuring that decision-makers account for the full range of values wetlands provide.

2.2. Mapping Who Benefits

Ecosystem services benefits can accrue on-site or flow across landscapes. Ecosystem functions related to water may strongly influence storage capacity (benefiting landowners within shared shallow aquifers, for example), or may influence surface water flows (affecting downstream residents). Similarly, ecosystem functions associated with the atmosphere tend to follow prevailing winds (affecting downwind locations) or influence local, regional, or global climates (providing localized shade and evapotranspiration, or sequestering and storing atmospheric carbon). Benefits requiring direct interaction such as recreation may require travel, or aesthetics can affect both nearby beneficiaries and those within line-of-sight. In these ways, the distribution of ecosystem service benefits is influenced by topography, hydrology, meteorology, and other contextual factors, including social, cultural, and technological practices.

The spatial footprint of specific benefits can be described as *servicesheds*. Again, some benefits are likely to affect populations who live or work within those servicesheds, while others are tied to the ease of access (including travel time). The persons affected by a given ecosystem function within each serviceshed are the *beneficiary population*. Many ecosystem services are both *non-excludable* (meaning that access to those benefits is not limited by property rights) and *non-rival* (meaning that their value is not affected by the number of beneficiaries). For instance, the flood protection provided by wetlands benefits all downstream residents; one person benefiting from natural flood protection does not inhibit others from that protection. In this way, nature provides valuable services for free, benefiting everyone downstream.

Residents across Ohio are expected to experience a wide range of benefits resulting from H2Ohio wetland restoration projects. Some benefits (e.g. water quality, water supply) may be experienced more or less constantly, while others (e.g. reduced flooding, recreational opportunities) may be more periodic, associated with storms or seasons. The extent to which these benefits are experienced will depend on multiple factors, such as proximity to restored wetlands, and the movement of water and people through landscapes.

To identify and quantify the spatial distribution of benefits, Earth Economics used 2020 WorldPop dasymetric population maps, 2021 Census data and other data sources to identify appropriate boundaries and populations likely to benefit from restored wetlands. The likely extent of beneficiaries (modeled as buffers around and downstream of wetlands) were identified for each of the seven ecosystem services included in the Ghermandi et al. model. The beneficiary populations of all H2Ohio wetland restoration sites were estimated by benefit (as some servicesheds tend to be more localized than others), and then reported at both benefit and county levels. It is important to note that these beneficiary populations should not be summed across services, as some individuals benefit from multiple services (i.e., they live within overlapping buffers). For example, a resident may benefit from improved water quality and flood risk reduction, enhanced aesthetics, and from recreational opportunities. Overlapping servicesheds reflect the multifunctionality of wetlands and underscore their broader public value.

2.3. Economic Impacts

To understand how spending on H2Ohio wetland restoration projects affects Ohio's economy, Earth Economics conducted an economic impact analysis using the industry-standard IMPLAN input-output (I-O) modeling software (IMPLAN, 2025). An economic impact analysis estimates how spending in one sector—such as ecological restoration—circulates to other sectors through interconnected supply chains and household spending. For example, when money is invested in wetland restoration projects, that spending ripples through the economy: construction firms buy materials, suppliers hire workers, and employees spend their wages in local communities.

These "ripple effects" are captured through three types of effects:

- **direct** effects (the immediate spending on restoration projects),
- **indirect** effects (business-to-business purchases as industries resupply), and
- **induced** effects (household spending by workers whose income depends on those industries).

Together, these effects show the total economic impact of that initial spending.

These types of effects are shown across several economic indicators:

- **Output** is known as the overall value of goods and services generated.
- **Value added to GDP** represents the net contribution to Ohio's economy after accounting for intermediate inputs (i.e., intermediate inputs are subtracted from total economic output).
- **Employment** counts the number of full-, part-time, and seasonal jobs supported by spending (i.e., jobs are not in full-time equivalents--two part-time seasonal positions are counted as two jobs, even if those positions amount to only one full-time equivalent position).
- **Labor income** is defined as wages earned by workers in affected industries; and
- **Tax revenues** at the local, state, and federal level generated by the direct, indirect, and induced spending.

Together, these effects and indicators form a comprehensive picture of the impact spending can have on Ohio's economy.

3. WETLAND **RESTORATION**

3.1. Summary

Wetlands generate substantial benefits for local communities, including improved water quality, enhanced flood control, increased biodiversity, and recreational and aesthetic opportunities. Restoration efforts directly improve quality of life for communities across the state, benefitting millions of Ohio residents while supporting jobs and local economic activity.

Restored wetlands through the H2Ohio program generate **$297 million to $308 million in annual ecosystem service benefits.** Habitat and biodiversity provide the largest share—**$82 million to $85 million annually** (28 percent of total benefits)—reaching nearly **90 percent of the entire state's population**, as well as residents in neighboring states. Water quality and supply improvements contribute **$79 million to $82 million annually** (27 percent of the total benefits), **serving nearly 8.9 million Ohioans** who rely on affected water sources. Furthermore, every $1 that H2Ohio invested in wetlands restoration spurred $2.16 in spending within Ohio's economy. This spending also supported over 270 of jobs that provided over $17.7 million in wages, all while driving about $27.9 million in value added to GDP. This spending also raised over $6 million in tax revenue.

These findings confirm that H2Ohio's wetland restoration not only restores critical ecosystems but also delivers economic and social value to Ohio's people and communities.

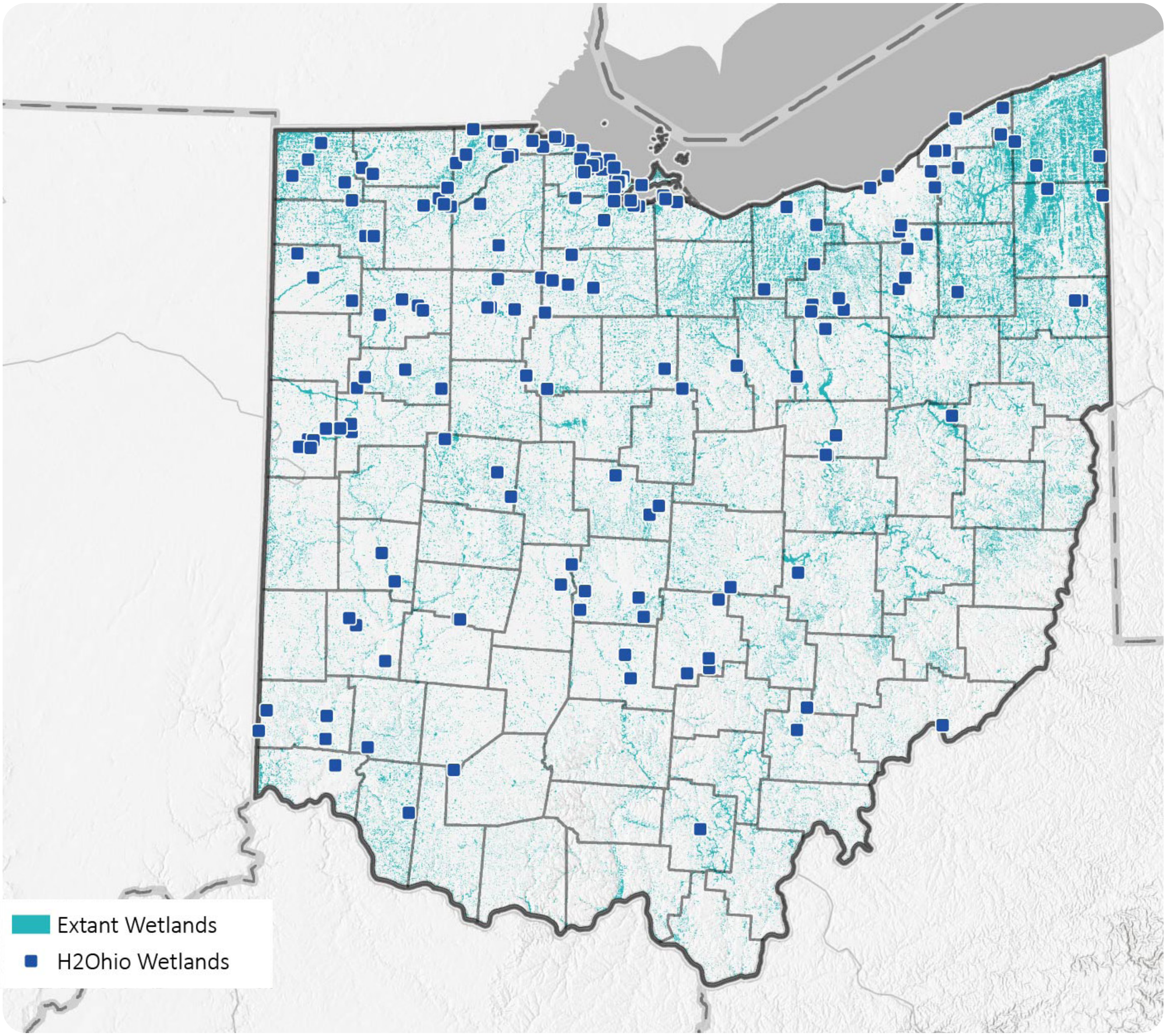
3.2. Wetlands in Ohio

The Ohio Environmental Protection Agency (2023) defines wetlands as "areas that are inundated or saturated by surface or ground water often enough to support plants adapted for life in saturated soil conditions." To be considered a wetland, an undisturbed area must meet three conditions:

1) Soils remain either saturated or flooded during part of the growing season.
2) Soils are poorly drained and low in oxygen (hydric soils).
3) Vegetation is dominated by species adapted to life in saturated or flooded soils.

Ohio has lost 90 percent of its original wetland resources since the late 18th century (Ohio Environmental Protection Agency, 2023). Initiatives such as H2Ohio work to preserve and expand the valuable benefits that wetlands provide through restoration. As of June 2025, there were 458 completed or in-progress wetland restoration projects. Due to data limitations, this report is based on completed or in-progress wetland restoration projects reported in FY 2024 (Figure 2). Note that these projects are not evenly distributed, so restoration efforts (and associated benefits) tend to be greater where projects are more concentrated (e.g., the Lake Erie basin).

Figure 2. Map of FY 2024 project sites and existing wetlands



SOURCES: TNC Ohio; NOAA; USGS, Esri

3.3. Economic Impacts of Wetland Restoration Spending

As described in Chapter 2.3, spending on wetland restoration projects ripples throughout Ohio's economy, stimulating business activity and household incomes. This analysis of the economic impacts of spending on H2Ohio wetland projects captures this full range of effects to jobs, labor income, value added to GDP, economic output, and tax revenues.

Total H2Ohio project costs are obtained from Ohio Checkbook (2025) for the lower estimate and personal correspondence with Ohio Department of Natural Resources for the higher estimate. The lower estimate from the checkbook was not necessarily complete, and the authors decided to give a range based on conversation with ODNR. These costs are distributed to individual industries based on the wetland restoration spending profile developed by Nielsen-Pincus and Moseley (2010). These industry allocations were then multiplied by industry-specific IMPLAN multipliers to estimate the direct, indirect, and induced economic effects of program spending. The resulting outputs quantify employment, labor income, value added to GDP, and tax revenues supported by H2Ohio project spending.

Table 1 describes the economic impacts of wetland restoration investments on Ohio's economy, while Table 2 provides the estimated tax revenues from that activity. Because geographic details of project spending were not available, the analysis was conducted at the state level. It is also important to note that tax revenues may be slightly overestimated, as some public institutions and nonprofits may qualify for exemptions not captured by the model.

Overall, H2Ohio's wetland restoration investments generate more than $48 million in annual economic activity (a.k.a. "output"). For every $1 invested, an additional $1.16 in spending is generated, producing $2.16 in total economic output. In addition, the program supports over 270 jobs[3] that provide over $17 million in wages and contributes $28 million to the state's GDP every year. While state and federal governments invest tax dollars into this program, they also receive at least $6 million back each year in the form of tax revenue.

These results show that H2Ohio's wetland restoration efforts not only deliver the environmental and social benefits described earlier in this chapter but also provide a strong and measurable return for Ohio's economy.

Table 1. Annual Economic Impacts of H2Ohio Wetland Investments

Impact	Jobs	Labor Income (millions)	Value Added to GDP (millions)	Economic Output (millions)
Direct	163–227	$10.8–$15	$15.3–$21.3	$26.2–$36.6
Indirect	45–63	$3.2–$4.4	$5.5–$7.7	$10.2–$14.2
Induced	65–91	$3.7–$5.2	$7.1–$9.9	$11.6–$16.1
Total	273–381	$17.7–$24.6	$27.9–$38.9	$48–$66.9

Table 2. Annual Tax Revenues from H2Ohio Wetland Investments in millions

Local Taxes	County Taxes	State Taxes	Federal Taxes	Total Taxes
$0.77–$1.07	$0.22–$0.31	$1.19–$1.66	$3.86–$5.39	$6.04–$8.43

3 The IMPLAN model does not distinguish between jobs which are full-time, part-time, or temporary. These numbers have not been converted to full-time equivalents. Instead, this report uses job-year, where 1 job-year = 1 job for 12 months = 2 jobs for 6 months, and so on.

3.4. Value of Wetland Benefits

The FY 2024 project database included 182 completed or in-progress projects, covering 7,027 restored wetland acres. Confidential projects[4] covered 4,327 restored wetland acres, for a total of 11,354 wetland acres restored by the program to-date. While the overall extent of restoration projects is greater (areas surrounding wetlands have also been restored), this report focuses exclusively on wetland restoration.

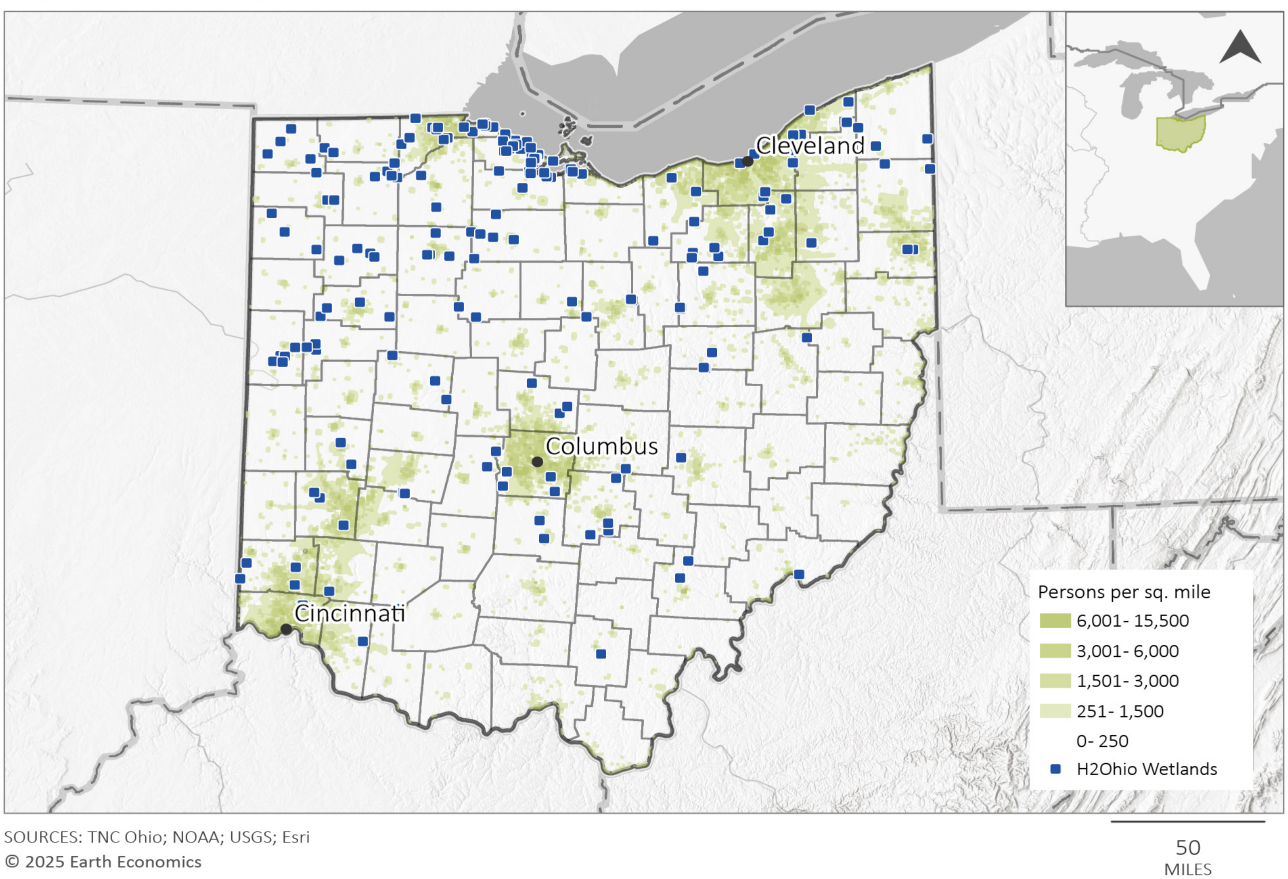
Earth Economics estimated the value of H2Ohio's wetland restoration projects using a model that connects wetland features (e.g. the size and location of each contiguous wetland) to the benefits those wetlands provide. This helps to capture how wetlands benefits can be valued differently, depending on location (e.g., flood risk reduction has more value when located near built infrastructure). For a more detailed methodology, see Appendix A. Results show that the program provides benefits between $296.8 million and $307.5 million in ecosystem service benefits every year (Table 3). Appendix B provides totals for each county.

The following sections address the populations who benefit from each service valued.

Table 3. Total annual ecosystem service benefits, in millions (2024 USD/year), provided by FY 2024 wetland projects, by service

County	Non-Confidential Projects	Confidential Projects	Total
Water Quality Improvement	$41.2	$14.8–$17.0	$56.0–$58.1
Water Supply	$18.0	$4.7–$5.4	$22.7–$23.5
Flood Control and Storm Impact Reduction	$30.6	$8.8–$10.1	$39.5–$40.8
Natural Beauty	$33.8	$11.9–$13.6	$45.7–$47.3
Low-impact Recreation	$38.9	$8.9–$10.3	$47.7–$49.1
Waterfowl Hunting	$0.92	$2.4–$2.7	$3.3–$3.6
Fish and Wildlife Habitat	$62.4	$19.7–$22.7	$82.1–$85.1
Grand Total	$225.7	$71.1–$81.8	$296.8–$307.5

Figure 3. Population density and H2Ohio FY 2024 wetland restoration project sites.



SOURCES: TNC Ohio; NOAA; USGS; Esri

4 Confidential wetlands projects are on private land and acreage was reported by count.

Water Quality Improvement and Water Supply

Wetlands naturally clean water by trapping dirt and filtering out pollutants like excess fertilizer, making water healthier for people and wildlife. That water is also stored by wetlands itself, slowly seeping underground, or flowing on to surface waterways. This helps refill wells, groundwater, and provides a source of clean water that people rely on. While this analysis does not isolate phosphorus removal in the valuation of water quality, the model do include the ability of wetlands to filter and metabolize nutrient pollutants.

Restored wetlands in FY 2024 of the H2Ohio program provide $23 million in water supply benefits and $56 million to $58 million in water quality improvement every year, totaling $79 million to $82 million in water-related benefits every year.

To estimate beneficiaries of water supply and water quality services provided by H2Ohio wetlands, researchers identified populations and economic sections that rely on surface water or groundwater within counties containing restoration projects. Given the close relationship between water supply and quality, these benefits were analyzed together but disaggregated by water source and use category. Two beneficiary groups were characterized, (1) residential and commercial users, and (2) primary facility-level water users. The second group is reported as top industries reliant on surface and groundwater.

For residential and commercial use, researchers used the U.S. Environmental Protection Agency's Safe Drinking Water Information System (SDWIS) database, which reports the number of people served by public water systems by county and by water source (surface water, groundwater, surface water purchased and groundwater purchased; EPA, 2025). Only direct surface water and groundwater sources were included in this analysis, as the purchased water cannot be tracked to its source location. This allowed for the identification of county-level populations directly reliant on surface and groundwater. To further characterize groundwater reliance, the analysis also included Forest to Faucet data to estimate the number of groundwater wells in each county.

For facility-level use, the team used the Ohio Water Withdrawal Facility tool to identify the top industry types by volume of surface and groundwater withdrawal within each HUC 8 watershed. Sectors include agriculture, gold courses, hydrofracturing, industry, mineral extraction, power generation, public supply, and other miscellaneous uses. It is important to note that the analysis did not quantify the volume of water used by these sectors and instead list the primary industries depending on each water source type within the county. Since HUC 8 watersheds span multiple counties, some counties share the same dominant water-using industries.

There are 8,867,995 residents who rely on water sources within the 56 counties containing restored wetlands. These residents will all benefit from the increased supply and quality of water as a result of the restored wetlands.

- **5,637,257 residents rely on surface water**
- **1,682,540 residents rely on ground water**
- **1,272,628 residents rely on purchased surface water**
- **95,570 residents rely on purchased ground water**

Across the state of Ohio, the top three sectors of groundwater use are public supply (primary use of 50 percent of water withdrawal sites), agriculture (primary use of 14 percent of withdrawal sites), and industrial (primary use of 12 percent of withdrawal sites).

Figure 4. Beneficiaries of surface drinking water, by county

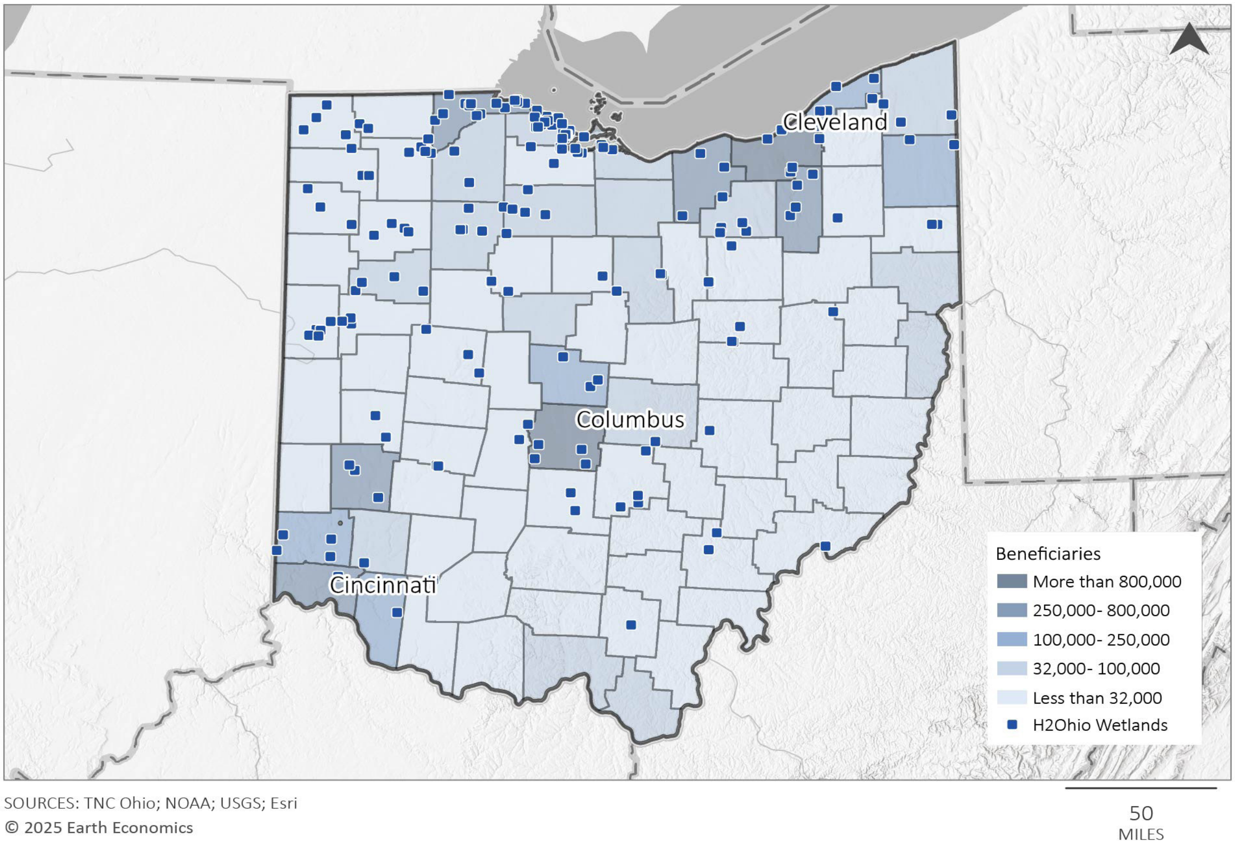
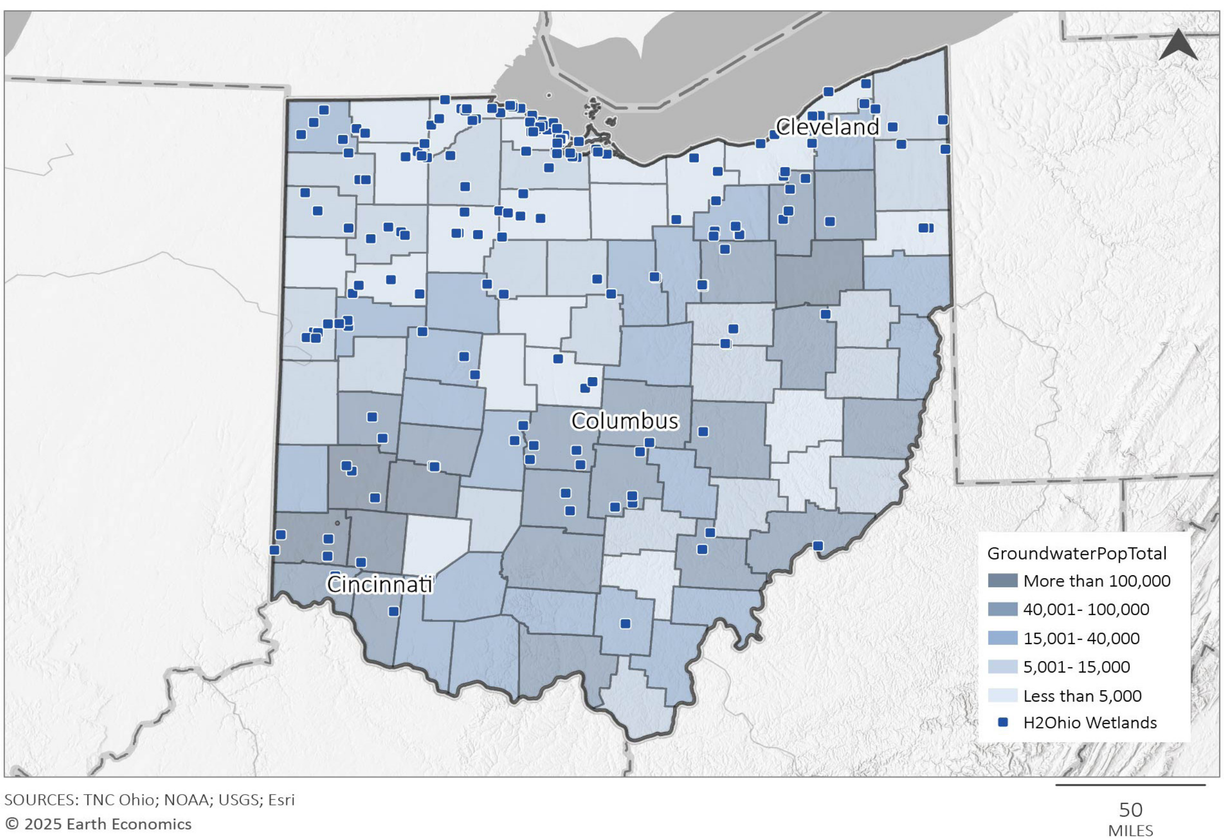


Figure 5. Beneficiaries of ground drinking water, by county



Flood Control and Storm Impact Reduction

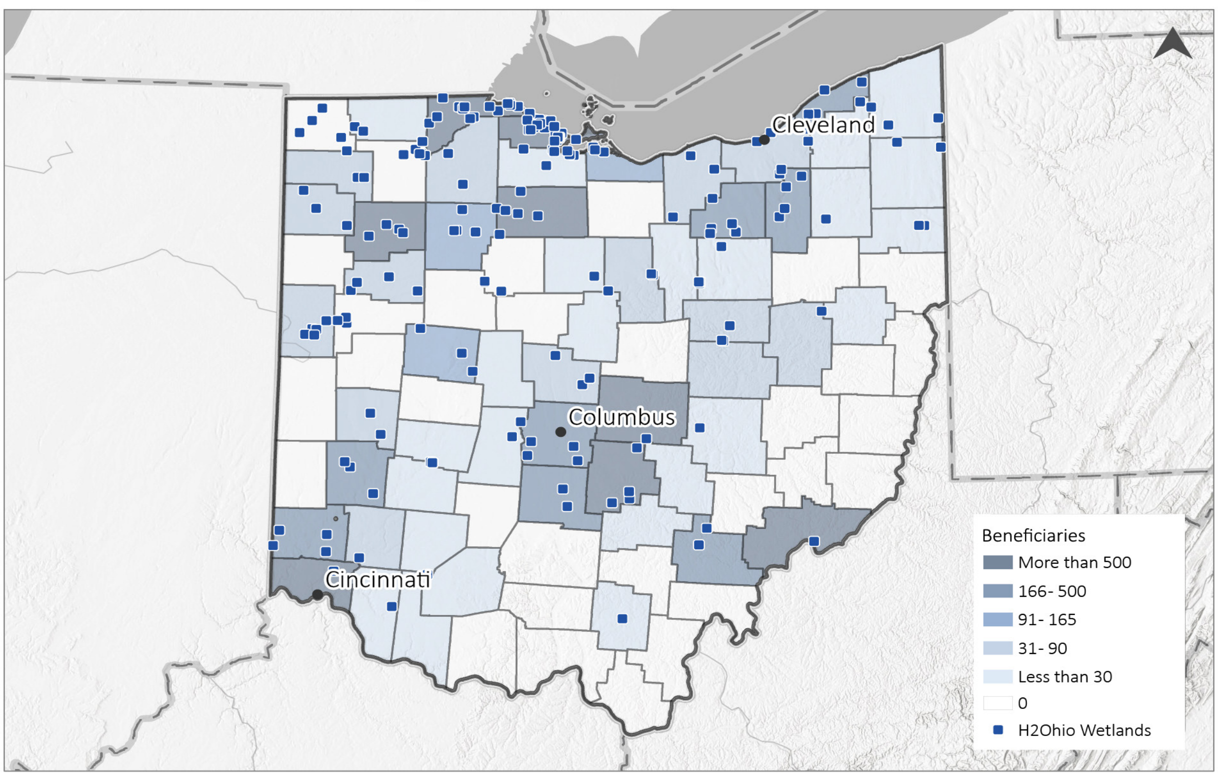
Wetlands act like natural sponges, soaking up extra rain and stormwater. They can also help soften the impact of waves and strong winds during storms, protecting nearby communities.

Restored wetlands in FY 2024 of the H2Ohio program provide $39 million to $41 million in flood control and storm buffering benefits every year.

To identify beneficiaries of storm buffering and flood control services provided by H2Ohio wetland restoration projects, populations located downstream of each wetland site and within areas vulnerable to flooding were mapped. Following the approach outlined in the Environmental Protection Agency source, Bousquin and Hychka (2015), downstream areas were defined as those within four kilometers downstream of the wetland site. 100 year floodplains were obtained from The National Flood Hazard Layer (FEMA) and clipped to a 4km buffer around wetland projects. Downstream areas were identified using stream flow direction from the National Hydrography Dataset (USGS), ensuring that only populations within flood-prone areas were considered. Population counts within these storm and flood benefit areas ere estimates using a combination of 2020 WorldPop dasymetric data and 2023 U.S. Census data. Results are reported by county, representing the number of individuals downstream and within a 100-year flood hazard zones who may benefit from the storm buffering and flood mitigation function of wetlands.

There are 9,202 residents across 57 counties who will benefit from risk reduction as a result of the restored wetlands. Beneficiaries are predominantly located in rural areas.

Figure 6. Beneficiaries of flood control and storm impact reduction, by county



SOURCES: TNC Ohio; NOAA; USGS; Esri

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MILES

Natural Beauty

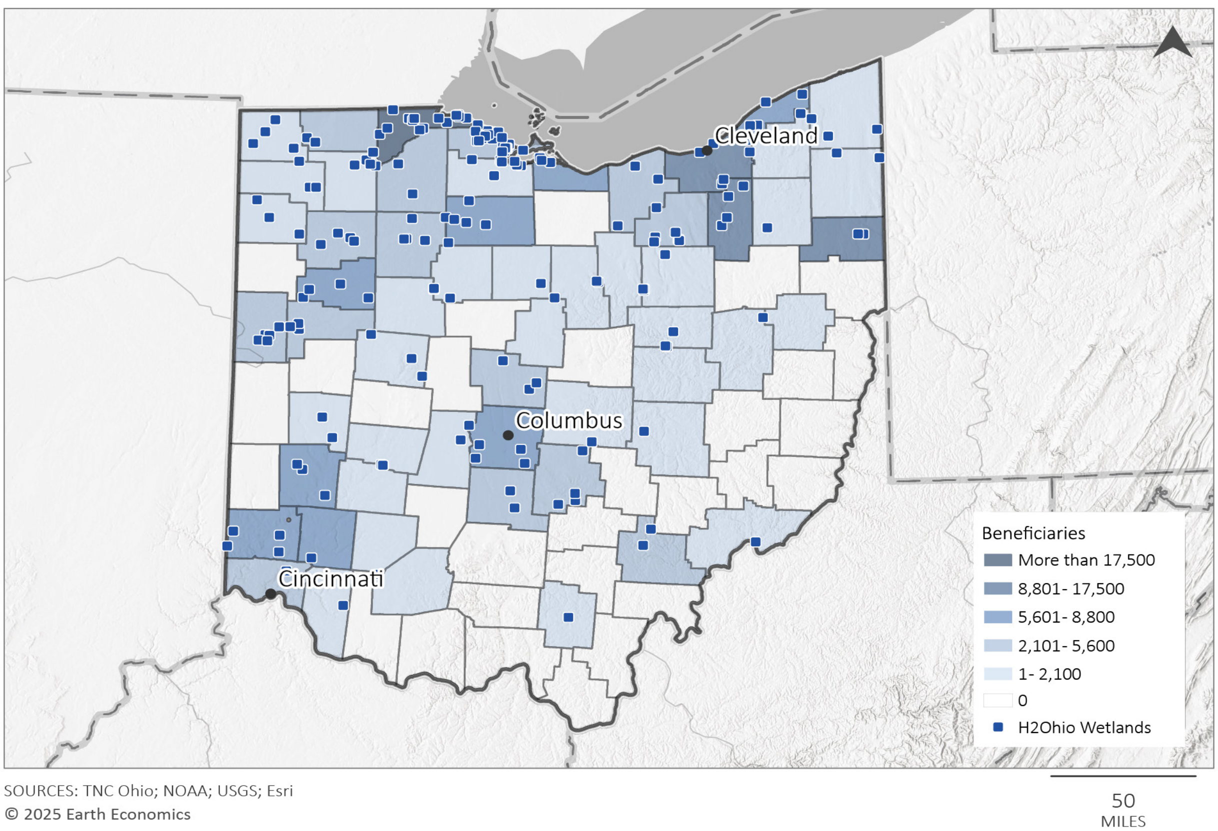
Wetlands make places more beautiful and enjoyable to live in. Homes near wetlands often have higher value because people enjoy the views and peaceful surroundings.

Restored wetlands in FY 2024 of the H2Ohio program provide $46 million to $47 million in aesthetic benefits every year.

To estimate the beneficiaries of amenity and aesthetic services from wetlands, a spatial analysis was conducted using Model Builder in ArcGIS. The process identified populations within proximity to TNC's both in-progress and completed wetland projects. Each project site was buffered using a 1-mile radius and then dissolved into a single feature to prevent overlapping areas from being counted more than once in subsequent analysis. Using dasymetric population data, the analysis estimates population distribution within the radius. Beneficiary data was then aggregated by county, with any out-of-state population combined into a single total entry.

There are 218,804 residents across 58 counties who will directly benefit from increased home values as a result of the restored wetlands.

Figure 7. Natural beauty beneficiaries, by county



SOURCES: TNC Ohio; NOAA; USGS; Esri

Low-impact Recreation

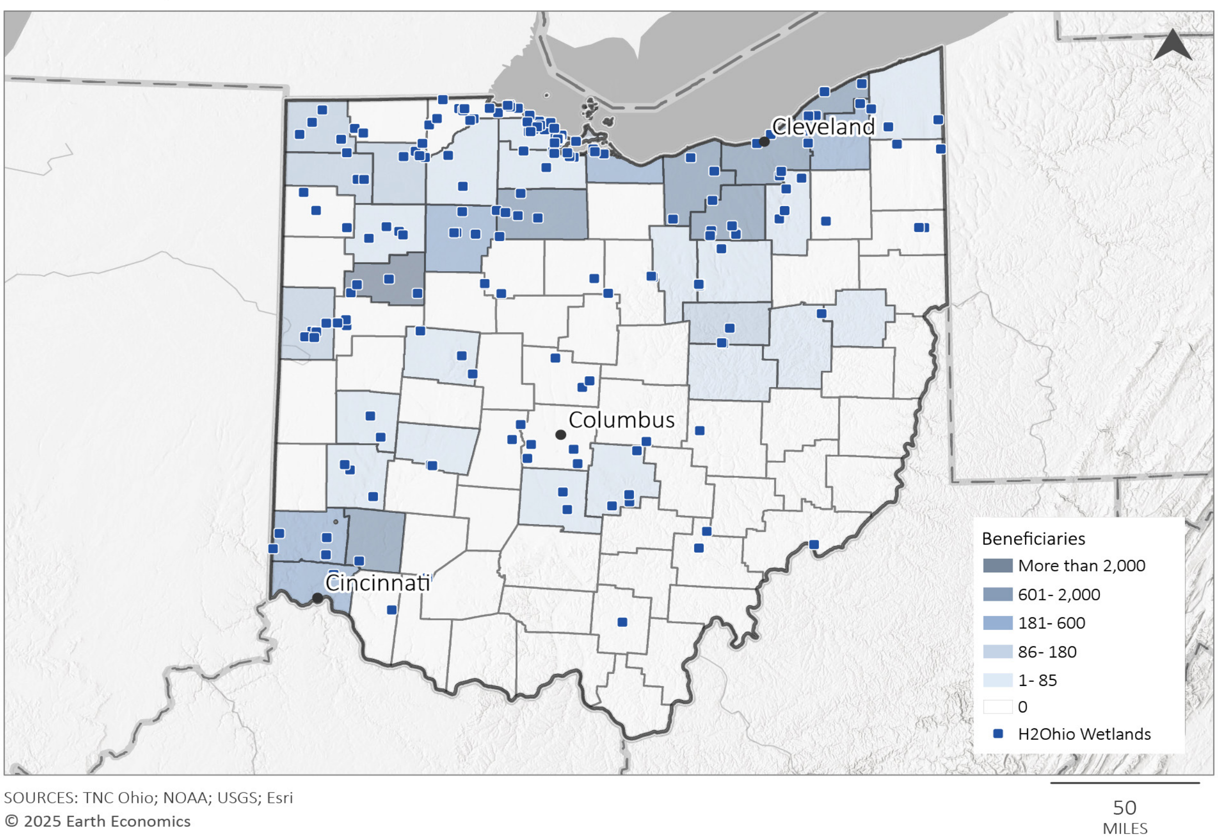
Wetlands are popular places for activities like hiking, birdwatching, and photography. Low-impact recreational activities like these represent ways people enjoy nature without taking plants or animals.

Restored wetlands in FY 2024 of the H2Ohio program provide $48 million to $49 million in low-impact recreational benefits every year.

To estimate beneficiaries of nonconsumptive recreation, primarily wildlife watching, the team focused on individuals who engage in such activities near their homes. The analysis used data from the USFWS survey, which estimated that 57 percent of individuals in the East-North Central region participate in wildlife watching "around the home". To model access to nearby wildlife viewing opportunities, Earth Economics used a network-based buffer rather than a radial distance. Using Service Area Analysis tool and ArcGIS's Network Data Source, a 1-mile driving distance service area was generated around each wetland site. Population estimates within each service area were derived using dasymetric population data. Results were aggregated by county and then scaled by the 57 percent participation rate to estimate the number of nonconsumptive recreation beneficiaries.

An estimated 17,419 Ohio residents across 35 counties will benefit from increased access to outdoor recreation as a result of the restored wetlands.

Figure 8. Low-impact recreation beneficiaries, by county



Waterfowl Hunting

Some wetlands provide places for people to hunt waterfowl recreationally.

Restored wetlands in FY 2024 of the H2Ohio program provide $3 million to $4 million in hunting benefits every year.

Recreational hunting is not included in the beneficiary map so as not to confuse the public on where hunting is or is not allowed.

Fish and Wildlife Habitat

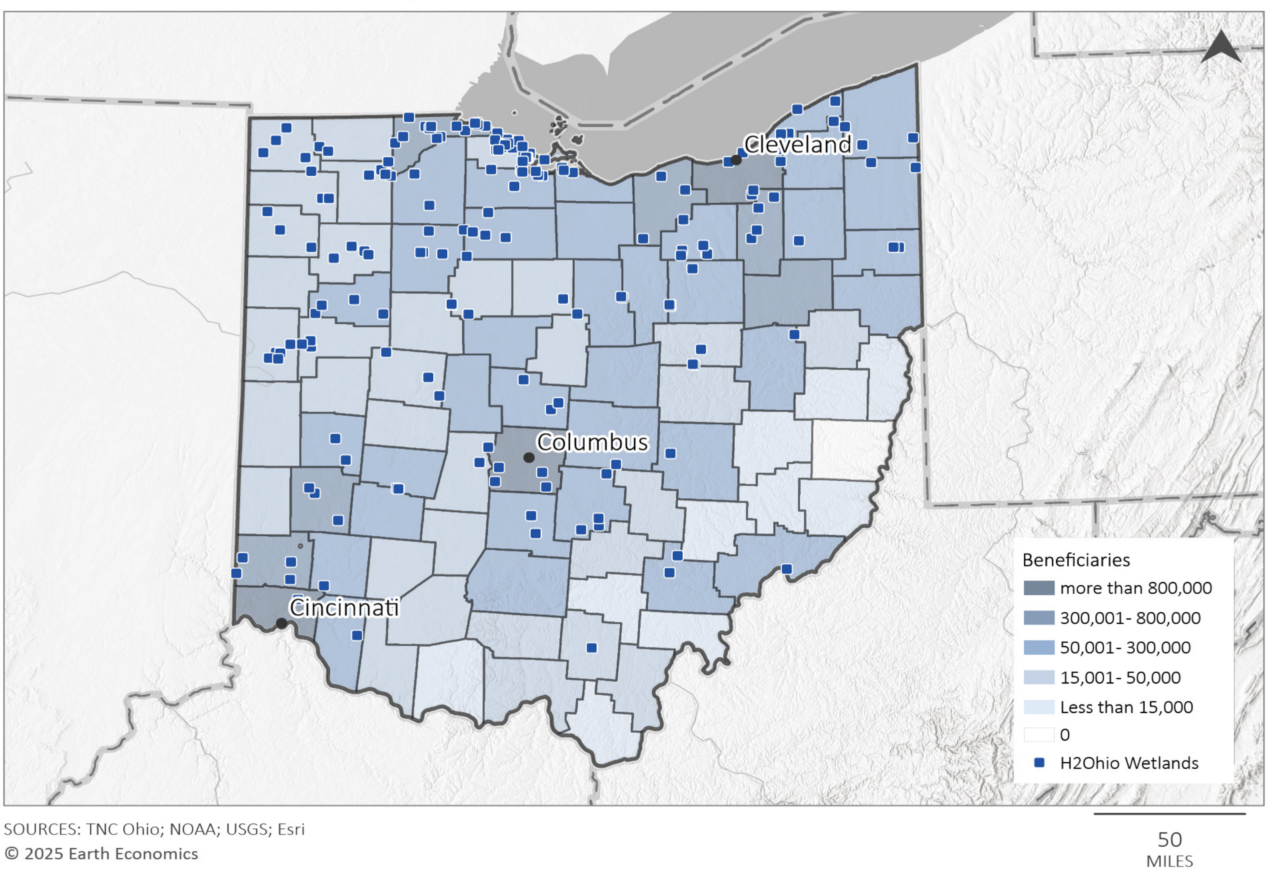
Wetlands are home to a wide variety of plants and animals. Even people who never visit wetlands value knowing that these ecosystems and species have their homes protected for the future.

Restored wetlands in FY 2024 of the H2Ohio program provide $82 million to $85 million in habitat and biodiversity benefits every year.

To identify beneficiaries of the natural habitat and biodiversity services provided by H2Ohio wetlands, a spatial buffer analysis was used to represent non-use value beneficiaries. A 25-mile radius was drawn around each wetland and project site to approximate the area which individuals are likely to experience an improved sense of place or satisfaction from knowing that nearby natural systems are being protected and restored. Using dasymetric population data, the analysis estimates population distribution within the radius. Where 25-mile buffers from multiple wetland sites overlapped, population within the overlapping areas was counted only once to avoid double-counting. Beneficiary data was then aggregated by county.

There are 11,382,143 residents across 87 of Ohio's 88 counties who will benefit from increased habitat and biodiversity as a result of restored wetlands. That represents 89% of Ohio's population. An additional 1,397,014 people in surrounding states will see these same benefits as well.

Figure 9. Beneficiaries of habitat and biodiversity, by county



SOURCES: TNC Ohio; NOAA; USGS; Esri

4. AGRICULTURAL **BEST MANAGEMENT PRACTICES**

4.1. Summary

The goal of this chapter is to estimate the economic value of benefits from H2Ohio's agricultural phosphorus reductions. The H2Ohio agriculture program run by Ohio Department of Agriculture (ODA), as part of the larger H2Ohio strategy, focuses on reducing excess phosphorus contributions from human agricultural activities by incentivizing producers to voluntarily implement best management practices (BMPs) for reducing phosphorus on their farms and ranches.

Ohio farmers remain dedicated to improving water quality through Voluntary Nutrient Management Plans (VNMPs), which use soil testing to determine the most effective quantities of nutrients to apply, at the right time and right place. VNMPs are a cornerstone of H2Ohio and are a requirement for all farms or ranches participating in H2Ohio. ODA also incentivizes other proven, science-based, and cost-effective BMPs focused on water quality management, such as conservation ditches, overwintering cover crops, and manure management.

Since 2020, the program has continuously enrolled farmers to implement BMPs. **In 2024, H2Ohio's Annual Report estimated that the agriculture program reduced phosphorus loading by an estimated 420,000 pounds, providing an estimated $32 million in benefits (based on average values) to Ohio residents. In 2025, estimated phosphorus load reductions grew to 550,000 pounds, however, due to data availability, this report focuses on 2024 contributions.** The true value of ecosystem benefits is likely much greater than those reported here, as this study only includes those which researchers have been able to quantify and value based on available data, omitting other known co-benefits associated with these BMPs.

Over the program's lifespan, ODA has invested an average of $27 million per year on the H2Ohio BMP program. **This means that Ohio residents received $1.21 in phosphorus reduction benefits for every $1 spent on the program.** Again, this excludes the economic impacts the incentive program has had on farmers, as well as additional co-benefits (unrelated to phosphorus) produced by BMPs (e.g., nitrogen reduction impacts water quality, greenhouse gas emissions, and soil quality). Even without including these known co-benefits, H2Ohio's investments in phosphorus reduction BMPs demonstrate a positive return-on-investment.

4.2. Phosphorus and Agriculture

Harmful algal blooms (HABs) can form when excess nutrients (especially phosphorus) combine with certain environmental conditions (e.g. warmer temperatures, sunlight) in lakes, ponds, and slow-moving rivers. In addition to reducing the dissolved oxygen plants and fish need to survive, HABs also impact water quality. Human activity has contributed significant quantities of phosphorus to Ohio waters for decades, most notably Lake Erie.

A key H2Ohio strategy is to reduce contributions from agriculture by incentivizing BMPs that voluntarily reduce phosphorus loading. H2Ohio has implemented their agricultural BMP program across 2.2 million acres of farmland in 25 counties (Table 4). In 2023, ODA estimated that agricultural producers in the Western Lake Erie Basin (WLEB) reduced phosphorus runoff by more than 332,000 pounds. As ODA expanded farmer enrollment across the state, H2Ohio practices may have reduced phosphorus by as much as 420,000 pounds in 2024.

Crops require phosphorus to grow, but soil phosphorus levels in Ohio have been in steady decline for decades. This has led farmers to amend their soils through fertilizers or manure (the same is true of nitrogen), making agriculture a major source of phosphorus, alongside other human contributions, such as sewage discharge. This means that farmers can play a major role in solving Ohio's phosphorus problem.

To tackle this problem at the source, BMPs help farmers to precisely target when, where, and how much to apply through soil and manure testing (i.e., VNMP). This can limit phosphorus loads while also reducing producer costs. BMPs can also help capture phosphorus that might otherwise end up in runoff (i.e., cover crops and conservation ditches), extending its value to growers. By implementing BMPs, farmers can retain soil phosphorus, maintaining yields while improving water quality, preventing excess phosphorus from entering waterways and contributing to HABs.

Table 4. Counties with producers enrolled in the H2Ohio agriculture program

Allen	Ottawa
Auglaize	Paulding
Crawford	Putnam
Defiance	Richland
Erie	Sandusky
Fulton	Scioto
Hancock	Seneca
Hardin	Shelby
Henry	Van Wert
Huron	Williams
Lucas	Wood
Marion	Wyandot
Mercer	

4.3. Benefits of Reducing Phosphorus

Phosphorus loading has downstream effects, with pathways described in MacDonald et al. (2016), which helped shape the framework of this analysis. Included here are economic benefits of reduced phosphorus on property values, human health, recreation, drinking water quality, and water quality in lakes and ponds.

Overall, the benefits of phosphorus removal by H2Ohio's agricultural BMPs in FY 2024 contribute an average of at least $32.4 million in benefits ($8.5 million to $56.3 million) each year (Table 5). The Legislative Budget Office reports that the average annual cost of the H2Ohio program is $26.7 million. This means that **each dollar spent on the H2Ohio agricultural BMPs yields $1.21 in phosphorus reduction benefits for Ohio residents, businesses, and governments.**

Table 5. Total ecosystem service benefits, in millions (2024 USD/year), provided from reduced phosphorus loading in FY 2024

Benefit	Low	High	Avg
Amenity (Property Values)	$0.35	$5.03	$2.69
Charter Boats (Avoided Revenue Loss)	$0.77	$3.57	$2.17
Human Health[1]	$0.03	$24.39	$12.21
Recreation (Fishing and Swimming)	$0.07	$15.89	$7.98
Water Quality (Drinking Water)	$6.90	$6.90	$6.90
Water Quality (Clean up)	$0.34	$0.34	$0.34
Total[2]	$8.47	$56.29	$32.38
Benefit Cost Ratio[3]	0.32	2.11	1.21

[1] Benefits reported per harmful algal bloom (HAB) contamination event instead of annual value.

[2] Totals may not sum due to rounding.

[3] Benefits are compared to the average cost per year of running the H2Ohio program for agricultural BMPs from 2020 to 2024 (Ohio Department of Agriculture 2024, budget item 700670). This ratio includes only the known, quantifiable, and valued benefits of human-related phosphorus reductions, which are not inclusive of all co-benefits achieved by these BMPs, which is likely much greater.

It's important to restate that these estimates likely *underestimate* the total value of program benefits, as there are other BMPs' co-benefits indirectly tied to phosphorus and water quality. For example, cover cropping also improves soil health by adding soil organic matter, which benefits crop production. Similarly, this analysis also does not account for practice impacts associated with improved nitrogen management. Excess nitrogen can also degrade water quality and increase water treatment costs, as there are direct human health impacts associated with high nitrates in drinking water. While benefits with such clear economic value could be included in future studies, the benefits of phosphorus reductions alone already demonstrate a positive return on investment for H2Ohio's investments in agricultural BMPs.

These benefits were estimated based on unit values reported in the valuation literature, and scaled based on phosphorus or *microcystin*—the toxin produced by harmful algal blooms—among other variables to best fit those values to the H2Ohio program. Details on how the variables for each benefit were scaled are described in Table 6, along with supporting literature. The following sections of this chapter detail the methods and results of each benefit.

Table 6. Description of variables used to scale values, and value sources, by benefit

Benefit	Value Source(s)	Scaling Variable(s)
Amenity (Property Values)	Low value: Sampat et al. (2020)	Phosphorus removed (ODA et al. 2025); Number of lakefront properties (OGRIP n.d.)
	High value: Wolf and Kleiber (2017)	Microcystin detection (Ohio EPA 2025b); Number of lakefront properties (OGRIP n.d.)
Charter Boats (Avoided Revenue Loss)	Ohio Sea Grant (2023)	Algal bloom advisory days (ODH 2025)
Human Health[1]	Low value: Kouakou & Poder (2019)	National Outbreak Reporting System (NORS) HAB-toxin related illnesses in Ohio (CDC 2025); Distribution of illness severity (Kouakou & Poder 2019)
	High value: Kouakou & Poder (2019)	Reported symptoms (as a percentage of households) following a contamination event (McCarty et al. 2016); Distribution of illness severity (Kouakou & Poder 2019)
Recreation (Fishing and Swimming)	Low value: Sampat et al. (2020)	Phosphorus removed (ODA et al. 2025); Participants (USFWS 2022)
	High value: Zhang and Sohngen, 2018	Phosphorus removed (ODA et al. 2025); Angler trips (ODNR-DOW 2025)
Water Quality (Drinking Water)	Low Alliance for the Great Lakes (2022)	Primary surface water users in Ohio (EPA 2025)
Water Quality (Ponds and Lakes Clean-up)	Sampat et al. (2020)	Phosphorus removed (ODA et al. 2025)

Amenity Values

Amenity, Lower Estimate

To provide a low-end estimate of the value of phosphorus BMPs to property values, Earth Economics evaluated the losses avoided by improving water clarity. This draws on a 2021 study linking phosphorus loads in agricultural runoff to HABs, measured as reductions in water clarity and associated impacts on lakefront property values (Sampat et al., 2021). That study linked higher total phosphorus (TP) concentrations in Lake Mendota, Wisconsin to declines in Secchi depth, where water clarity is measured as the depth at which a black-and-white marker lowered into the water is no longer visible to the naked eye. That research cited earlier studies that showed the value of lakefront property declines for every one-meter decline in Secchi depth.

Secchi depth data and modelling were not available for water bodies near H2Ohio sites, so the effects of H2Ohio phosphorus reductions on water quality could not be directly measured. Instead, Earth Economics used Sampat's reported total property value loss, the number of lakefront properties analyzed, and the total kilograms of excess phosphorus released in the study to calculate property losses per kilogram of excess phosphorus, rescaled to dollars per pound of phosphorus reductions.

This unit value was then scaled by the phosphorus reductions achieved through the H2Ohio BMP program. The 2024 dataset reported a total of 420,000 pounds of phosphorus reduced statewide, but did not include county-level totals (H2Ohio, 2025). Following Sampat et al. (2021) which estimated that just 10 percent of excess phosphorus in farm runoff reaches surface waters, Earth Economics analysts applied the same rate to H2Ohio phosphorus reductions. County-level allocations for 2024 were derived from each county's share of total phosphorus reductions in 2023 (H2Ohio, 2025). Although Scioto County was reported in the 2024 data, it was not included in 2023; accordingly, it was excluded here.

Those estimated phosphorus reductions were then associated with lakefront property values, using GIS data to count the parcels located within 50 feet of lake shorelines within each county. Lake features were identified from the National Hydrography Dataset (NHD) and refined to exclude waterbodies smaller than 5 acres, consistent with Ohio Department of Natural Resources definitions (USGS, 2023; ODNR, 1991). Avoided property value losses per pound of phosphorus were then multiplied by both the county-level contributions to overall phosphorus reductions in 2024 (again, just 10 percent of the statewide total) and the number of lakefront properties in each county, to estimate total avoided property value losses attributable to reduced phosphorus loading.

This approach estimated that 2024 H2Ohio phosphorus reductions avoided $349,000 in lakefront property losses. Again, this represents a lower-bound estimate.

Amenity, Higher Estimate

Wolf and Kleiber (2017) estimated the economic impacts of HABs on lakefront property values in Ohio, showing that single-family homes near lakes with microcystin levels above 1 microgram per liter (µg/l) sell for 22 percent less than comparable homes on cleaner lakes. Their analysis was limited to single-family homes within 20 meters of lake shorelines, though such impacts likely extend further and include other property types.

The average loss in value was $62,200 per affected property (2024 dollars). Tax records were then used to identify the number of lake-adjacent homes located in counties with H2Ohio participants. These numbers were paired with Ohio EPA water quality data from 2016–2024 to determine where microcystin levels exceeded the 1 µg/l threshold. Property losses were then scaled by the number of years each county recorded detections above 1 µg/l during that period, multiplied by the number of affected homes, and annualized over a standard 30-year mortgage to reflect the ongoing cost to property owners.

Interestingly, during this analysis, an inverse correlation was discovered between counties with H2Ohio-funded BMPs and microcystin detections (2025b). Of the 17 counties with farms enrolled in the BMP program, 14 counties saw fewer microcystin detections in 2021–2024 (post-H2Ohio) compared to 2016–2020 (pre-H2Ohio).

The avoided property value loss per year attributed to microcystin detections in counties with farms and ranches participating in the H2Ohio BMP program is estimated at $5,031,000 per year.

Charter Boat Revenue

Information on fishing trips, revenues, and the timing of algal bloom advisories were used to quantify the impact of HABs on Ohio's charter fishing businesses. Ohio Sea Grant records the charter fishing season (March–November), the busiest months (June–July), and average revenue per trip. Ohio's Department of Health tracks the number of days algal bloom advisories are in effect each year. By matching these datasets, it is possible to estimate the number of fishing trips likely to be canceled when HABs make the water unsafe.

Most charter activity happens during the summer peak season, when HABs also tend to be worse. A low estimate can be derived by distributing HAB impacts evenly throughout the fishing season, while a high estimate can be generated by associating HAB closures with the peak charter season. Using trip revenue values (adjusted to 2024 dollars) and the average number of trips per year, it is possible to estimate total revenue losses for charter operators under each scenario, providing a range of HAB costs for Ohio's charter fishing businesses.

If BMP reductions in phosphorus loading are able to eliminate HABs in Ohio, then charter boat companies could avoid **$774,000 to $3.6 million** in revenue losses each year.

Human Health

Health, Lower Estimate

Agricultural BMPs to reduce phosphorus pollution lower the risk of HABs, which present known risks to human health. Data were collected on the number of HAB-related illnesses, hospitalizations, and deaths reported in Ohio using the National Outbreak Reporting System (NORS) from the Centers for Disease Control and Prevention (CDC) (CDC, 2025). This dataset documents illnesses linked to HAB toxins such as microcystin. Because NORS relies on voluntary reporting, many residents may not submit a report or may not connect their symptoms to water quality issues, so these values may underestimate the true number of cases. Within the past fifteen years, NORS recorded a total of 55 HAB-related illness cases across three separate years. The highest number of reported illnesses occurred in 2014, coinciding with the Toledo water crisis.

Costs for each HAB-related illness have been studied by Kouakou and Poder (2019). That study reported costs for both respiratory and digestive illnesses, providing separate estimates for mild, moderate, and severe cases. Across both illness types, reported costs averaged about $50 for mild cases, $500 for moderate cases, and $10,000 for severe cases (2019 USD). These values include direct treatment expenses, income losses from missed workdays, reduced productivity, and Quality of Life impacts. The study assumed that across a hypothetical population of 1,000 affected individuals, 75 percent would experience mild symptoms, 24 percent would have moderate illnesses, and 1 percent would die.

The average number of HAB-related illnesses reported in NORS was scaled by this distribution of severity to estimate the number of cases in each category. These estimates were multiplied by the corresponding costs reported in Kouakou and Poder. Since no deaths were reported in the NORS data, cases that would have been classified as deaths were reassigned as severe cases, to avoid inflating cost estimates. This produces conservative estimates of the potential avoided annual health costs associated with HAB-related illnesses, a low-end health benefit of reducing phosphorus pollution.

For this analysis, reported illnesses could not be disaggregated by county, nor was it possible to scale avoided health costs by the phosphorus reductions from the H2Ohio agriculture program.

The lower-bound estimate of $33,000 reflects average annual HAB-related health costs at the statewide level in Ohio. This does not account for county-level variation, or program-specific impacts under H2Ohio, but rather represents potential benefits associated with reducing phosphorus to limit HAB events.

Health, Higher Estimate

Because voluntary reporting on HAB-related illnesses likely understates their prevalence in Ohio, an alternative method was developed. The CDC conducted a household survey in Lucas County after the A 2014 Toledo water crisis, documenting the proportion of households with respiratory and digestive symptoms following the contamination event. These rates provide a proxy for the share of the population likely to experience

HAB-related illness during future contamination events that may otherwise go unreported.

Counties at heightened risk were identified using data from the Ohio Environmental Protection Agency's raw water monitoring program. HAB toxin reports from the past five years identify counties where microcystin concentrations exceeded 3.19 µg/L—the concentration detected in Lucas County during the Toledo crisis (CDC, 2024). Although these detections occurred in raw water rather than treated (drinking) water, they indicated areas where HAB toxins posed a potential threat to public water supplies.

County population totals were then divided by Ohio's average household size to estimate the number of households in each county (Ohio Department of Development, 2021). This analysis assumed that just one individual per affected household would experience respiratory or digestive symptoms during a future HAB contamination event. The impacted households were then divided into respiratory and digestive cases, based on the proportion of households which reported each symptom type in the Lucas County survey.

The estimated cases for each county were scaled by illness severity following the method described in using the previous section, based on Kouakou and Poder (2019). Again, because there were no reports of HAB-related deaths, mortalities were reclassified as severe cases. Per-case cost estimates for respiratory and digestive illness were also based on figures from the Kouakou and Poder article.

Since the Lucas County survey records just a single contamination event, these estimates represent avoided costs *per contamination event* rather than overall annual costs. This approach captures the broader scale of illness that could occur during future HAB contamination events. Again, avoided health costs could not be directly scaled by phosphorus reductions. As a result, these estimates represent the total risk in affected counties, rather than the direct contribution of H2Ohio interventions.

The estimate of **$24,388,000** reflects potential avoided healthcare costs from a single HAB contamination event in counties with H2Ohio program participants that showed microcystin concentrations exceeding 3.19 µg/L in raw water within the past five years.

Recreation (Fishing and Swimming)

Recreation, Lower Estimate

The potential recreation benefits of reducing phosphorus loading were estimated based on avoided reductions in fishing and swimming due to improved water clarity. This analysis built on Sampat et al. (2020), which modeled the effects of excess phosphorus in agricultural runoff on HABs, measured as Secchi depth (water quality). That study applied a model to show how declines in water clarity reduce both participation in and frequency of recreational activities (Vesterinen et al., 2010). Sampat drew on recreation data from National Park Service Sites to assign a consumer surplus value to days spent fishing and swimming in the Wisconsin Census Region, allowing the study to link declines in water clarity to losses in recreation value.

Since Secchi depth data and modeling were not available for H2Ohio counties, it was not possible to link phosphorus reductions to changes in water clarity, or subsequent effects on recreational visits. Instead, recreational impacts per pound of phosphorus reductions were estimated based on Sampat's calculations, linking recreational losses (participation and frequency rates) to county populations and the total phosphorus reductions. The estimates were calculated by identifying the ratio between the excess phosphorus reported in Sampat and the associated change in partition, frequency, and consumer surplus.

The ratio was applied to the pounds removed in H2Ohio's BMP program in 2024 to estimate the impacts to participation and frequency as a result of H2Ohio practices. Again, Sampat et al. (2020) assumed that just 10 percent of phosphorus runs off to reach nearby surface waters; this factor was again applied to phosphorus reductions reported for H2Ohio. To estimate county-specific reductions in 2024, statewide values were allocated by county based on their proportional share of total phosphorus reductions in 2023. Scioto county was excluded since it was not included in the 2023 county data.

To better reflect Ohio recreation, participation and frequency rates from Wisconsin (as reported by Sampat et al. 2020) were replaced with Ohio-specific data (ODNR, 2024) to estimate overall fishing and swimming participants and days in Ohio (USFWS, 2022; ODNR, 2024). These estimates were then scaled by the 10 percent of total phosphorus removed in each county, following Sampat et al. (2020). The resulting shifts in recreational demand were then multiplied by estimates of consumer surplus for fishing and swimming reported in Kaval and Loomis (2003) to estimate the total surplus value of recreation associated with the phosphorus removal associated with H2Ohio BMPs.

This produces a lower-bound estimate of **$73,000**, reflecting the avoided losses to consumer surplus for recreational fishing and swimming across all counties that participated in the H2Ohio BMPs program in 2024.

Recreation, Higher Estimate

This method estimates economic benefits of H2Ohio's phosphorus reduction efforts to recreational fishing based on a study of Lake Erie anglers by Zhang and Sohngen (2018). In that survey, anglers reported their willingness to pay (per trip) to support policies to reduce phosphorus pollution in the lake. For a 40 percent reduction—the same goal set by H2Ohio—anglers valued each trip between $40 and $60 (in 2013 dollars). These values were then rescaled, based on phosphorus reductions reported in the original study, to yield of willingness-to-pay of $4 to $16 per angler-trip.

H2Ohio's reported reductions were then converted into the same phosphorus measure used in the survey, and the per-pound values were adjusted to 2024 dollars. Combining these with the total number of angler-trips reported by Ohio DNR yields an estimate of the total recreational fishing value supported by H2Ohio BMPs. While this captures the benefits anglers place on cleaner water, these may be slightly overstated, as county-level data on angler origins was not available for finer-scale adjustments.

The value Lake Erie anglers are willing-to-pay to reduce phosphorus loads, scaled to actual H2Ohio BMP reductions in 2024, is **$3.5 million to $15.9 million**. Were the 40 percent goal to be met, the value would increase to $30.6 million to $45.8 million, based on current frequency of angler trips. Furthermore, it can be assumed that angler trips could increase as water quality conditions improved, producing even greater value.

Water Quality (Drinking)

Reducing the number of HABs can be expected to lower water treatment costs for utilities and ultimately, ratepayers. This analysis focused on communities that rely on surface water for their primary drinking water supply, as such systems are most vulnerable to HAB-related contamination. The EPA's Safe Drinking Water Information System (SDWIS) tracks the number of residential and commercial users in Ohio counties who are (primarily) served by surface water systems, including both purchased and unpurchased sources (EPA, 2025).

Counties at heightened risk of HAB-related treatment costs were identified using raw water monitoring data from the Ohio Environmental Protection Agency (Ohio EPA). HAB toxin reports from the past five years were reviewed to select counties where microcystin concentrations exceeded 3.19 µg/L—again, the level detected in Lucas County during the 2014 Toledo water crisis (Ohio EPA, 2025). Though these detections occurred in raw (untreated) water, they signaled instances where HAB toxins threatened public water supplies, requiring additional treatment.

To estimate the added costs of HAB contamination, cost estimates reported by the Alliance for the Great Lakes were used (2022), based on a 2020 Ohio EPA Division of Drinking and Groundwater survey of 108 public water supplies (121 facilities) across the Western Lake Erie Basin. That survey documented HAB-related expenses for capital upgrades, source water monitoring, treatment technologies, and residuals disposal (non-recyclable or reusable waste). The Alliance found that public water systems drawing from Lake Erie faced significantly higher costs following the 2014 water crisis, with Toledo residents paying nearly double the annual per-capita costs of other Ohio communities. These findings illustrated how HABs substantially increase drinking water treatment costs that are ultimately passed on to ratepayers (Alliance for the Great Lakes, 2022).

This analysis applied these cost differences as avoided costs per surface water user in counties in which raw water monitoring reported microcystin concentrations above 3.19 µg/L. The number of (primary) surface water users in each of these counties (EPA, 2025) was multiplied by the estimated cost differences to calculate the total avoided treatment costs to ratepayers associated with lowering HAB risks.

For this analysis, avoided treatment costs could not be scaled to phosphorus reductions from the H2Ohio BMP program. As a result, the avoided drinking water costs represent the total risk in the affected counties but not the direct contribution of the H2Ohio program.

In H2Ohio counties where microcystin levels exceeded 3.19 µg/L in the last five years, had the H2Ohio BMP program been successful in reducing phosphorus to the point where microcystin levels remained healthy, the avoided increased drinking water costs for ratepayers would be valued at **$6,904,000.**

Water Quality (Clean-up)

This analysis estimated the avoided costs of clean-up efforts that might otherwise be required to address excess phosphorus loading and its contribution to HABs, based on Sampat et al. (2021) links between phosphorus runoff and water clarity, as well as increased need for costly remediation actions. That study used dredging costs from Wisconsin's Upper Yahara watershed to develop an average cost to clean up a kilogram of excess phosphorus.

The reported cost per kilogram of excess phosphorus (converted to dollars per pound) was applied as a proxy for the cost of clean-up actions that would otherwise be needed if excess phosphorus entered local water systems. Again, this analysis assumed that only 10 percent of the phosphorus reduced through the H2Ohio BMP program would otherwise have reached waterbodies and thus require removal.

County-level estimates were developed by scaling the 2024 total pounds of phosphorus reduced across counties based on their 2023 share. Scioto county was excluded since county level phosphorus reductions were not reported for 2023. These adjusted phosphorus reductions for each county were multiplied by the per-pound clean-up cost to estimate the avoided clean-up costs attributable to H2Ohio BMPs. This method was applied to all H2Ohio BMP counties (excluding Scioto) rather than limiting the analysis to those with reported HAB toxin detections, reflecting the broader link between phosphorus loading and water quality degradation.

The estimated benefit of avoided clean-up costs is **$335,000**, reflecting potential outcomes across all H2Ohio program counties from 2024 phosphorus reductions.

5. H2OHIO: WATER QUALITY IS **“THE HEART OF IT ALL”**

Since 2019, H2Ohio has been a driving force in addressing the complex issues impacting Ohio’s waters. As state and federal funding priorities shift, funding for large programs becomes increasingly competitive. The goal of this report was to determine whether investment in **the H2Ohio program is money well spent**. In this analysis, Earth Economics has applied robust economic methodologies to value the non-market benefits of H2Ohio and the ripple effect of program spending. While the H2Ohio program does not generate direct revenue, it does create demonstrable benefits and economic stimulus that flow to a majority of Ohioans. It is essential that these values be recognized and included in decision-making.

This study found that benefits from H2Ohio’s agriculture and wetland programs in FY 2024 outweigh the costs of running these programs: on average, the H2Ohio BMP program returns $1.21 for every dollar invested, while wetlands restoration returns $8 for every dollar invested each year.

H2Ohio BMPs have been applied to 2 million acres of farmland, preventing 420,000 pounds of phosphorus from entering surface waters and generating an average of $32 million per year in benefits. Restored wetlands have captured excess phosphorus before it can reach sensitive waterways, generating an average of $302 million in ecosystem services benefits annually. To put this value into perspective, the annual ecosystem service benefits provided by the H2Ohio program are about 1.8 times greater than the economic losses from the 2011 and 2014 HAB events that caused the Toledo Water Crisis ($182 million in 2024 USD; Bingham et al., 2015). These results highlight how investments in wetland restoration and nutrient reduction can pay off by keeping Ohio’s water clean and communities safe.

Furthermore, the 2025 Annual Report shows that more wetlands are being restored and more phosphorus is captured each year, indicating that benefits will expand as the program continues into the future.

Beyond the benefits studied in this report, other reports further highlight additional value generated by the H2Ohio program. For example, Ohio EPA has invested heavily in replacing lead service lines across the state. A 2023 study by Scioto Analysis found that these efforts yield substantial social benefits through improved health and reduced water waste amounting to $32 to $45 for every dollar invested in lead pipe removal—31 times the implementation costs.

With H2Ohio, Ohioans have implemented coordinated, systemic, and effective solutions that have reduced phosphorus loading to Ohio’s lakes, ponds, and rivers. H2Ohio includes not only the programs addressed in this report, but also river clean-ups, water quality monitoring, drinking water infrastructure, and watershed management plans. The success of each H2Ohio program reinforces the others and supports the common goal of improving water quality to help both nature and humans thrive.

6. WORKS **CITED**

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APPENDIX A: WETLANDS ECOSYSTEM SERVICE VALUATION METHODOLOGY

TNC Ohio provided a database of planned, in progress and completed wetland restoration projects throughout the state. The database included project locations, acres restored, project cost, and related details. The analysis limited the dataset to projects with latitude and longitude data that were completed or in-progress and had non-zero restored wetland acres.

The team used the function transfer type of the benefit transfer method to value the benefits of H2Ohio wetland restoration projects . By applying value functions to each ecosystem feature independently (i.e., individual wetland "projects"), the model can account for contextual factors that vary across the H2Ohio wetland projects. For example, smaller wetlands in highly developed areas—where wetlands are relatively scarce—are expected to have higher unit value ($/acre/year) than larger wetlands in less-developed areas dominated by wetlands. GIS data and technologies, especially high-precision landcover and land-use data, made this possible.

Earth Economics applied the statistical function reported in a global study by Ghermandi et al. (2010), which reviewed 170 valuation studies reporting 418 valuation estimates across 186 wetland sites. The authors developed a meta-analysis to estimate the value of thirteen ecosystem services across six wetland types, producing multiple models. Of these, the full and reduced models demonstrated the highest goodness-of-fit statistics (R^2 = 0.47−0.49; adjusted R^2 = 0.44−0.45). The reduced model was selected because it provided the most reliable estimates and excluded many extraneous, non-significant methodological variables.

Because the study by Ghermandi et al. included study sites based in the Ohio region and reported each statistical model in full (including coefficients and standard error for each explanatory variable), and because the explanatory variables allow for inclusion of Ohio-specific factors (e.g., GDP per capita), the Ghermandi et al. study served as a good candidate for value-function transfer.

Five explanatory variables make these models especially useful and present an opportunity to produce high-resolution estimates that vary by context: wetland type, wetland size, wetland abundance (the spatial extent of wetlands within 50 km of each patch), population density (population within 50 km of each wetland patch), and the magnitude of human presence for each wetland patch. Because these factors influence the value of ecosystem services (e.g., economies of scale, relative scarcity, likelihood of human impacts and human influence) and vary across Ohio's landscape, the models can estimate differences in the value produced by wetlands across Ohio.

The research team determined wetland type based on the restored wetland acres. According to the *Classification of Wetlands and Deepwater Habitats of the United States*, one characteristic of lacustrine wetlands is an area greater than 20 acres, while a characteristic of palustrine wetlands is an area less than 20 acres. Based on these definitions, projects with a restored wetland acreage greater than 20 were assigned palustrine while projects with a restored wetland acreage less than 20 were assigned lacustrine.

The team determined wetland abundance by compiling wetland locations from the National Wetland Inventory (NWI), the National Land Cover Dataset (NLCD), the National Hydrography Database (NHD), and completed H2Ohio wetland projects into a single spatial dataset. First, they merged the following shapes into one dataset:

- From NWI, wetlands with a system name of Lacustrine or Palustrine.
- From NHD, waterbodies classified as Swamp/Marsh.
- From NLCD, areas with a landcover type of Emergent Herbaceous Wetland or Woody Wetland.

Next, Earth Economics' team identified and removed bodies of water from the merged dataset. They identified these waterbodies as follows:

- From NHD, waterbodies classified as Lake/Pond or Constructed Reservoir.
- From NLCD, areas with a landcover type of Open Water.

Once they removed the bodies of open water from the merged wetlands dataset, researchers used the results as an authoritative wetlands layer for the state of Ohio.

Population density was measured using dasymetric population data provided by EPA, which distributes population counts within census tracts to a 30-meter raster based on land use and landcover. The dasymetric data rely on the 2020 census, so the team used 2023 population estimates from the American Community Services to project population growth trends in each census tract and update the 2020 dasymetry data to the latest population totals.

The Ghermandi et al. (2010) model uses three variables to measure human presence:

- Water is categorized as either artificial or natural. Because all H2Ohio wetland projects are the result of human effort, they are counted as artificial.
- Locations are categorized as either urban or rural, based on the American Census Bureau's classification. Urban areas experience a greater degree of human pressure.
- Locations are categorized as protected or not protected, based on the USGS Protected Areas Database. Non-protected areas experience a greater degree of human pressure.

The research team used the acres of wetland restored from the project database for the wetland size variable.

Of the thirteen ecosystem services for which Ghermandi et al. estimated value, seven are relevant to a H2Ohio wetland context: flood control and storm buffering, water supply, water quality improvement, hunting, low-impact recreation, amenity and aesthetics, and habitat and biodiversity. The Ghermandi et al. study estimates the value of other services (commercial fishing and hunting, recreational fishing, harvesting of natural materials, and fuelwood) that are not commonly practiced in the wetland project sites; these services were not valued in this project. The team ran the model for all 7 services for each wetland in the H2Ohio projects database.

H2Ohio also provided a list of confidential wetlands projects, where Earth Economics could not discern exact locations. For these, they only knew project acres by county. The team valued these projects by creating a profile of a "characteristic wetland project" for each county, using averages for the model variables from wetland projects in the project database for each county. For confidential projects with no project database data within the same county, researchers used state averages. They ran the model for all 7 services for each county.

In this model, factors influencing higher per-acre values include greater human pressure and location in more densely populated areas. In addition, larger wetlands provide diminishing returns. Factors that influence smaller per-acre values include greater proximity to surrounding wetlands. Consequently, one could expect wetland projects conducted in highly-populated counties, such as Cuyahoga and Franklin Counties, to provide higher per-acre values.

APPENDIX B: COUNTY-LEVEL WETLANDS ECOSYSTEM SERVICE BENEFITS

Table 7. Total annual ecosystem service benefits (2024 USD/year) provided by wetland projects in each county

County	Non-Confidential Projects	Confidential Projects	Total
Allen	$2,803,000	$433,000–$444,000	$3,236,000–$3,247,000
Ashtabula	$4,119,000	$0	$4,119,000
Athens	$1,604,000	$0	$1,604,000
Auglaize	$1,747,000	$5,464,000–$5,512,000	$7,211,000–$7,259,000
Butler	$4,476,000	$0	$4,476,000
Clark	$1,037,000	$0	$1,037,000
Clermont	$209,000	$0	$209,000
Clinton	$23,000	$0	$23,000
Crawford	$212,000	$2,108,000	$2,320,000
Cuyahoga	$915,000	$0	$915,000
Defiance	$3,453,000	$1,532,000	$4,985,000
Delaware	$4,672,000	$0	$4,672,000
Erie	$1,304,000	$338,000–$357,000	$1,642,000–$1,661,000
Fairfield	$5,923,000	$0	$5,923,000
Franklin	$5,954,000	$0	$5,954,000
Fulton	$469,000	$177,000–$184,000	$646,000–$653,000
Geauga	$27,000	$0	$27,000
Hamilton	$34,000	$0	$34,000
Hancock	$4,923,000	$4,174,000–$4,465,000	$9,097,000–$9,388,000
Hardin	$0	$752,000–$1,634,000	$752,000–$1,634,000
Henry	$4,441,000	$1,767,000–$1,884,000	$6,208,000–$6,325,000
Holmes	$8,392,000	$0	$8,392,000
Huron	$0	$558,000–$1,213,000	$558,000–$1,213,000
Jackson	$239,000	$0	$239,000
Lake	$3,036,000	$0	$3,036,000

County	Non-Confidential Projects	Confidential Projects	Total
Licking	$69,000	$0	$69,000
Logan	$2,149,000	$0	$2,149,000
Lorain	$4,548,000	$840,000–$1,048,000	$5,388,000–$5,596,000
Lucas	$37,763,000	$4,702,000–$4,754,000	$42,465,000–$42,517,000
Madison	$376,000	$0	$376,000
Mahoning	$896,000	$0	$896,000
Marion	$0	$182,000–$396,000	$182,000–$396,000
Medina	$14,611,000	$0	$14,611,000
Mercer	$2,961,000	$9,256,000–$9,610,000	$12,217,000–$12,571,000
Miami	$2,202,000	$0	$2,202,000
Montgomery	$526,000	$0	$526,000
Muskingum	$177,000	$0	$177,000
Ottawa	$39,405,000	$10,979,000–$15,645,000	$50,384,000–$55,050,000
Paulding	$1,003,000	$1,494,000–$1,788,000	$2,497,000–$2,791,000
Pickaway	$5,380,000	$0	$5,380,000
Portage	$3,503,000	$0	$3,503,000
Putnam	$2,945,000	$2,373,000–$2,432,000	$5,318,000–$5,377,000
Richland	$6,808,000	$0	$6,808,000
Sandusky	$5,737,000	$3,570,000–$5,005,000	$9,307,000–$10,742,000
Seneca	$4,759,000	$2,168,000–$2,317,000	$6,927,000–$7,076,000
Shelby	$0	$247,000–$536,000	$247,000–$536,000
Summit	$10,027,000	$0	$10,027,000
Trumbull	$3,423,000	$0	$3,423,000
Tuscarawas	$106,000	$0	$106,000
Van Wert	$0	$638,000–$1,384,000	$638,000–$1,384,000
Warren	$175,000	$0	$175,000
Washington	$86,000	$0	$86,000
Wayne	$5,263,000	$0	$5,263,000
Williams	$4,412,000	$850,000–$926,000	$5,262,000–$5,338,000
Wood	$1,205,000	$2,214,000–$2,240,000	$3,419,000–$3,445,000
Wyandot	$5,205,000	$14,237,000–$14,378,000	$19,442,000–$19,583,000
Total	**$225,730,000**	**$71,053,000–$81,792,000**	**$296,783,000–$307,522,000**

APPENDIX C: ECONOMIC IMPACT ANALYSIS ASSUMPTIONS

The research team used spending profiles from Nielsen-Pincus and Moseley (2010) to distribute H2Ohio spending across specific industries. The original article focuses on restoration projects occurring in the state of Oregon, thus the authors are assuming the breakdown of industry spending of a wetland restoration project in Ohio is the same as it is in Oregon. There may be differences in the purchasing behavior of Ohio projects, in which case the distribution to other industries could change. Depending on which industries receive spending, all economic impacts could be over- or under-estimated.

The I-O model also depends on the geography of where spending takes place. This study assumes all spending took place in the state of Ohio or at Ohio businesses. While the team is confident nearly all spending did take place within the state after conversations with state agency staff and wetlands restoration contractors, if substantial amount of spending took place *outside* of Ohio, the economic impacts in this report would be overestimates.

The I-O model did not refine spending geography, since the team did not have detailed spending data from contractors who implemented wetlands projects. Instead, the I-O model presents state-level impacts. The research team tested the difference in multipliers for county-level "multi-regional input-output" (MRIO) and state-level analysis and found that state-level results are likely the more conservative approach.