REPORT

Wetlands in Peril

How Agriculture Damages Critical Ecosystems, Increasing Flood Risk in the Upper Midwest

HIGHLIGHTS

Industrial agriculture degrades and destroys wetlands. Changes to the Clean Water Act in 2023 rolled back federal wetland protections, further increasing risks from corporate agribusiness. The destruction of wetlands disrupts biodiversity, threatens fishing and farming, deteriorates water quality, and compromises climate resilience. Wetland degradation also erodes critical flooding defenses. Amid the Upper Midwest's intensive agricultural landscape, 30 million acres of wetlands provide nearly $23 billion in annual residential flood mitigation benefits. Over the long term, protecting these wetlands could prevent between $323 billion and $754 billion in flood damages in this region. These benefits are especially crucial for traditionally marginalized and overburdened communities that encounter high flood risks and face significant challenges in recovering from severe flooding. The next farm bill offers a pivotal opportunity to address the devastating damage industrial agriculture inflicts on wetlands and to support conservation efforts that protect and restore these essential ecosystems.

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Why Wetlands Matter

From the swamps and bayous of the South to the marshes, bogs, and potholes in the Northeast and Midwest United States, wetlands straddle dry land and water. Defined by saturated or inundated soils, these unique environments play a crucial role in Earth's interconnected ecosystems (Valk 2020; US EPA 2024).

Wetlands sustain an astonishing diversity of life, supporting 40 percent of the world's plant and animal species (United Nations 2024). Wetlands provide habitats and food for roughly half of the endangered species in the United States, including the American crocodile, several species of orchids, the bog turtle, and the whooping crane (Lang, Ingebritsen, and Griffin 2024). By providing habitats for 75 percent of commercially harvested fish and shellfish—such as salmon, trout, shrimp, and oysters—wetlands fuel the $5.6 billion US commercial seafood industry (NOAA Fisheries 2020). People also rely on wetlands to cultivate blueberries and cranberries, supply timber for building, and provide recreational spaces for activities such as hunting, fishing, kayaking, and bird-watching (Lang, Ingebritsen, and Griffin 2024; US EPA 2015).

Wetlands act as natural pollution filters. Water moves slowly through wetlands, allowing plant roots to trap sediments, chemicals, and other pollutants. This filter function is particularly important in agriculturally dense areas such as the Upper Midwest, where excess pesticides and fertilizer applications on cropland run off into nearby waterways. That pollution results in excessive nitrogen levels and critically low oxygen in the water, creating dead zones where fish and other aquatic life struggle to survive (Stillerman 2024). Wetlands offer a cost-effective alternative to expensive wastewater treatment plants for communities saddled with agricultural water pollution, efficiently filtering excess nitrogen and reducing coastal dead zones (DNREC, n.d.; Taylor and Druckenmiller 2022).

By regulating the timing, volume, and direction of water flow across watersheds, wetlands also provide natural barriers against flooding (Wisconsin Wetlands Association 2017). The spongy soils and water-loving plants found in wetlands can capture large volumes of water from snowmelt and heavy rainfall, gradually releasing it over time into groundwater and nearby streams. Rushing floodwaters are also slowed by hydraulic roughness, the friction that water experiences when it flows over wetland trees and plants, further reducing flood risks to nearby communities (Thomas and Nisbet 2007; Taylor and Druckenmiller 2022).

In the Midwest, flooding will worsen as climate change brings higher sea levels and more intense precipitation (Byun, Chiu, and Hamlet 2019). As effective carbon sinks, wetlands provide an important nature-based solution to climate change. Wetlands excel at carbon sequestration, trapping and storing over 30 percent of soil-stored carbon on Earth despite covering only 6 percent of the planet's surface (Stewart et al. 2024; Lang, Ingebritsen, and Griffin 2024). But the high carbon stocks of wetlands present a significant risk, as damaged or destroyed wetlands release stored carbon as methane, carbon dioxide, and nitrous oxide, powerful heat-trapping gases that accelerate climate change (Environmental Defense Fund 2022; Nahlik and Fennessy 2016; Tan et al. 2020). In turn, rising temperatures increase methane emissions, even from intact wetlands (Peng et al. 2022; Michel et al. 2024).

Threats to Wetlands

Despite the clear benefits of protecting wetlands—and the severe consequences of destroying them—wetlands are losing ground: Half of US wetlands have disappeared since the 1780s, and the pace of wetland loss has accelerated since 2004 (Lang, Ingebritsen, and Griffin 2024; Adusumilli 2015). Urban and rural development, cultivated forestry, and climate change–related disturbances to temperature, evaporation, and precipitation patterns all play a role in wetland decline (Lang, Ingebritsen, and Griffin 2024). But no factor has contributed more to wetland loss over the past few centuries than the rapid expansion of mechanized and large-scale agriculture (Stewart et al. 2024; Fluet-Chouinard et al. 2023).

Wetlands that abut commercial farming operations are at risk of being drained and converted into crop fields and livestock pastures. Even wetlands that avoid drainage and conversion suffer damage from fertilizer, pesticide, manure, and other pollution runoff from nearby agricultural fields (Keena, Meehan, and Scherer 2022; Dahl 2014). The US Environmental Protection Agency has identified agricultural runoff as a leading cause of wetland impairment in the United States (US EPA 2023). As wetlands are degraded and decimated by agro-industrial operations, they emit previously stored carbon dioxide into the atmosphere, where it traps heat, warming the planet and changing the climate (Stewart et al. 2024; NASA 2024).

Agriculture and Wetlands in the Upper Midwest

The Upper Midwest states of Illinois, Iowa, Michigan, Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin are vital to agriculture in the United States (USDA Economic Research Service 2024). Over 60 percent of the Upper Midwest—almost 230 million acres—is dedicated to agriculture (Table 1). Most of this agricultural land is used to grow corn and soybeans as commodity crops (World Business Council for Sustainable Development 2023). Amid this extensive agricultural region lies over 30 million acres of wetlands.

Wetlands in the Upper Midwest face mounting threats from agricultural expansion. Previous research identified agriculture as the leading force behind wetland destruction in the Prairie Pothole Region, which includes parts of the Upper Midwest (Dahl 2014). The researchers found the rapid spread of agriculture drove 95 percent of wetland loss in the region between 1997 and 2009.

Table 1. Acres of Wetlands and Agricultural Land in Upper Midwest

State	Wetland Area (acres)	Agricultural Area (acres)	Percentage of State in Agriculture (%)
IA	640,483	29,978,165	83
IL	1,014,199	26,292,041	71
MI	6,403,146	9,472,069	15
MN	10,787,865	25,442,625	46
ND	2,239,658	38,537,022	85
NE	1,276,851	43,975,693	89
SD	1,876,204	42,304,601	86
WI	6,130,329	13,784,678	33
Upper Midwest	**30,368,735**	**229,786,894**	**61**

Note: See methodology in appendix for details.
SOURCE: USDA National Agricultural Statistics Service 2024; US Fish & Wildlife Service 2024b.

ANALYSIS: When Protected, Wetlands Prevent Billions of Dollars in Flood Damage in the Upper Midwest

Wetlands in the Upper Midwest provide natural barriers against flooding. Unfortunately, at the same time that industrial agriculture is draining and destroying these critical defenses, record-breaking floods have become more frequent as climate change warms the planet and fuels extreme weather like the destructive and deadly floods that battered the Midwest in the summer of 2024 (Hersher and Inskeep 2024; Grumke 2024; Uribe 2024).

Protecting and restoring wetlands in the Upper Midwest offers significant economic benefits to Midwesterners grappling with intensified flooding caused by climate change. Recent research estimated that one acre of wetlands provides $745 of benefits in averted flood damage to residential properties in the United States (Taylor and Druckenmiller 2022). Using this estimate:

- We found that wetlands in the Upper Midwest provide almost $23 billion in annual residential flood mitigation benefits (Table 2).
- We further estimated that these wetlands offer between $323 billion and $754 billion in long-term residential flood mitigation benefits to the region (details in appendix).

Table 2. Flood Mitigation Value of Wetlands in the Upper Midwest

State	Wetland Acres (acres)	Annual Residential Flood Mitigation Value	Estimated Long-Term Flood Mitigation Value (low)	Estimated Long-Term Flood Mitigation Value (high)
IA	640,483	$477 million	$6.81 billion	$15.9 billion
IL	1,014,199	$755 million	$10.8 billion	$25.2 billion
MI	6,403,146	$4.77 billion	$68.1 billion	$159 billion
MN	10,787,865	$8.03 billion	$115 billion	$268 billion
ND	2,239,658	$1.67 billion	$23.8 billion	$55.6 billion
NE	1,276,851	$951 million	$13.6 billion	$31.7 billion
SD	1,876,204	$1.40 billion	$20.0 billion	$46.6 billion
WI	6,130,329	$4.56 billion	$65.2 billion	$152 billion
Upper Midwest	**30,368,735**	**$22.6 billion**	**$323 billion**	**$754 billion**

Note: Annual value using $745 per acre; low and high estimated values over time based on 7 percent and 3 percent discount rate, respectively. See methodology in appendix for details.

While the $323–$754 billion estimate for flood mitigation is staggering, it captures only a fraction of the total benefits that wetlands offer to the Upper Midwest—and what will be lost if they are destroyed. The US Fish and Wildlife Service has highlighted the growing risk of wetland habitat loss and its devastating impacts on birds, fish, plants, and other species in the Midwest, with associated costs to the outdoor recreation, tourism, hunting, and fishing industries (Lang, Ingebritsen, and Griffin 2024). Midwesterners also stand to lose invaluable water purification with wetland loss: Studies in Illinois, Minnesota, and Iowa show that wetlands effectively filter contaminants such as excess nitrogen and phosphorus from fertilizer and other agricultural runoff in these states (Lemke et al. 2022; Johnston, Detenbeck, and Niemi 1990; Tuladhar and Iqbal 2020). Even with the natural filtering of wetlands, Iowa is expected to spend up to $333 million over the next five years to remove nitrate pollution from its drinking water supply, a cost that will increase if the state's existing wetlands are further damaged or destroyed (Boehm 2021).

In addition, the wetlands of the Upper Midwest, like other freshwater inland wetlands, are especially proficient at capturing and storing climate-altering carbon dioxide (Nahlik and Fennessy 2016). Their destruction not only eliminates these powerful carbon sinks but also releases large amounts of climate-altering gases into the atmosphere (Nahlik and Fennessy 2016).

Conserving Wetlands for Environmental Justice

Wetland degradation deepens environmental injustice in the Upper Midwest. In Michigan, the loss of wetlands contributes to flooding in predominantly Black and under-resourced

neighborhoods (Napieralski, Guin, and Sulich 2024). The concentration of people living in poverty, people of color, and frequent flooding in these neighborhoods is a direct consequence of racist housing policies and poor environmental and infrastructural management (East et al. 2023; Napieralski, Guin, and Sulich 2024). As climate change increases overall flood risk in the future, these communities are projected to experience even greater flood losses compared to those in more historically resourced areas (Wing et al. 2022).

In addition to increased flood risks from wetland loss and climate change, historically marginalized people face inequitable disaster recovery following severe flooding (Kruczkiewicz et al. 2023). Homeowners living in Federal Emergency Management Agency (FEMA) designated floodplains face prohibitively expensive flood insurance, and insurance costs are increasing as climate change worsens the frequency and severity of flooding (Hersher 2019). In the wake of catastrophic flooding, socially vulnerable people are less likely to receive federal disaster relief, as evidenced by the response to the 2008 Iowa floods, which resulted in poor recovery outcomes for Latino and older community members (Muñoz and Tate 2016).

Environmental justice advocates champion wetland protection as a vital nature-based strategy for mitigating flooding and other risks for socially vulnerable people (The Pew Charitable Trusts 2023). Indigenous Peoples are at the forefront of wetland protection and restoration efforts in the Upper Midwest, where over 5 million acres of wetlands are on tribal lands (Bureau of Indian Affairs 2023). In Wisconsin, the Bad River and Red Cliff Bands of the Lake Superior Tribe of Chippewa Indians and the Oneida Nation have worked to protect and restore wetlands in the state (Wisconsin Tribal Conservation Advisory Council 2024; Vigue 2023). In Minnesota, the Upper Sioux Community is restoring native vegetation, including wild rice, to Prairie Pothole wetlands that serve as critical habitats for resident and migratory birds, and the Lower Sioux Indian Community is converting old settling ponds into new wetlands (Bureau of Indian Affairs 2023). These community efforts to preserve and restore wetlands protect wildlife habitats, support fishing and wetland farming, reduce flooding, enhance water quality, and help to combat climate change.

Wetland Policy: From Setbacks to Solutions

As the nation's primary law on water pollution, the Clean Water Act (CWA) has protected US waters since its enactment in 1972. However, political changes have reshaped the interpretation and enforcement of this landmark law over time, resulting in inconsistent wetland protections from year to year. Prior to 2001, the CWA protected most wetlands, along with streams, lakes, and other water bodies. But between 2001 and 2023, presidential administrations and the Supreme Court drastically altered how wetlands are covered by the CWA (Woods 2024).

In 2023, the Supreme Court's ruling in *Sackett v. Environmental Protection Agency*, and the subsequent CWA updates, narrowed the definition of "protected wetlands," effectively stripping federal safeguards from wetlands that are not connected to other federally designated water bodies (Howe 2023). Researchers estimate this policy shift could remove federal protections from 19 to nearly 100 percent of nontidal wetlands in the United States, with the precise number of impacted wetlands hinging on future interpretations of the revised CWA language (Gold 2024; Bligh 2024). The absence of robust state-level wetland protections has left wetlands in the Upper Midwest states of North Dakota, South Dakota, Iowa, and

Nebraska particularly vulnerable to pollution and drainage following the CWA changes (Gold 2024; Earthjustice 2024).

Industrial agriculture and leading agribusiness trade associations have a history of vigorously challenging legal protections for wetlands (Woods 2024). The rollback of these protections allows large-scale commodity growers and corporate agribusiness interests to exploit wetlands for agricultural expansion. The conversion of wetland to cropland eliminates natural flood barriers and increases flooding burdens to farmers and to nearby communities. For example, the 2019 Missouri River flood damaged and destroyed farmland, with 37 percent of impacted farms incurring over $100,000 in damages each (Skevas, Massey, and Hunt 2023). Even people who live far from drained wetlands feel the impact of their loss, since taxpayers fund the National Flood Insurance Program (NFIP), which covers 5 million policyholders (Taylor and Druckenmiller 2022). In the Midwest, flooding in the spring of 2019 brought 2,204 NFIP claims, with an average claim amount of $14,342 (Kraft, Villarini, and Czajkowski 2023).

The good news is that, while policy changes have harmed wetlands in the past, future policies offer an opportunity to restore and protect them. And since agriculture is a leading source of wetland damage, the US Department of Agriculture (USDA) is uniquely positioned to help conserve these valuable ecosystems so wetlands can continue providing flood mitigation, water purification, and other essential services to nearby communities (US EPA 2023).

The five-year federal food and farm bill, commonly known as the farm bill, establishes and funds a variety of USDA-administered farm conservation programs (UCS 2023). The 1985 farm bill created the Conservation Reserve Program (CRP), which provides funding and technical assistance for farmers to convert cropland to wetlands, grasslands, tree land, or other land uses that reduce soil erosion, improve water quality, and benefit wildlife (USDA Farm Service Agency 2020). Agricultural landowners participating in the CRP's Farmable Wetlands Program receive annual payments, along with assistance to offset costs, for restoring wetlands on land formerly used for commercial agriculture (U.S. Fish & Wildlife Service 2020). This program is particularly important to preserving small, shallow wetlands close to agricultural activities, because these wetlands are easily drained and may not be protected under existing federal or state regulations (Dahl 2014).

The 1985 farm bill also established the wetland conservation provision of the Food Security Act. Commonly called the "swampbuster provision," this program requires farmers to refrain from converting wetlands to cropland if they want to qualify for certain USDA benefits, including commodity support payments, disaster payments, and farm loans (Stubbs 2016).

The 2014 farm bill added crop insurance subsidies to the list of USDA benefits that require farmers to preserve wetlands from cropland expansion. Agricultural producers who are out of compliance with swampbuster wetland preservation requirements can regain eligibility for USDA programs through rehabilitation of the converted wetland or through wetland mitigation banking (Farm News Media 2024). In mitigation banking, noncompliant farmers pay into a fund that supports the restoration or enhancement of other wetlands in close proximity to the wetland that was drained, dredged, filled, or leveled to convert to cropland (Stubbs 2016).

With the passage of the 1990 farm bill, the USDA established the Wetland Reserve Program to further agricultural wetland conservation efforts (Natural Resources Conservation Service

2023). This program, later incorporated into the Agricultural Conservation Easement Program (ACEP) as Wetland Reserve Easements (WRE), provides financial and technical assistance to landowners to restore and enhance wetlands that have been degraded by agricultural use (Natural Resources Conservation Service 2023). The Inflation Reduction Act (IRA) provided an influx of cash to ACEP, ensuring regular program funding through 2031 and creating new "climate smart" easements to conserve wetlands and other ecosystems that help mitigate heat-trapping emissions (Natural Resources Conservation Service 2023).

In addition to programs that directly protect wetlands, the farm bill funds conservation programs such as the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP), which enhance wetlands by promoting farming methods that improve soil and water quality, reducing damaging agricultural runoff (Natural Resources Conservation Service 2023; Natural Resources Conservation Service 2024c). Healthy soil functions like a sponge, capturing pesticides, fertilizers, and other pollutants and preventing them from running off into wetlands and other nearby waterways. The CSP offers farmers technical and financial support to adopt climate-friendly practices that bolster soil health (Stillerman 2023). These methods, such as planting cover crops and reducing or eliminating tillage (plowing), prevent soil damage and decrease pollution runoff into wetlands and other water systems. A 2017 report by the Union of Concerned Scientists found that improving soil significantly reduces runoff pollution, lowers flood risk, and increases water availability in soils for crops (Basche 2017).

The Next Farm Bill Can Help Save Wetlands

When sufficiently funded and effectively employed, USDA conservation programs can protect and restore wetlands (Vandever et al. 2021). In the Upper Midwest, successful conservation programs drive the majority of newly created or rehabilitated wetlands (Dahl 2014). Farm bill conservation programs are popular with farmers, too: A recent study showed that farmers, especially agricultural landowners who link wetland conservation with improved water quality and availability, support these voluntary initiatives (Thapa et al. 2024).

Despite the popularity and success of USDA conservation programs, changes to the farm bill have modified these valued programs over time. When the CRP was established in 1985, up to 45 million acres could be enrolled in the program. By 2014, this cap had been reduced to just 24 million acres. While the most recent farm bill raised the allowable acreage to 27 million in 2023, this still represents a 40 percent reduction from the original program cap set in 1985 (NSAC 2019). At the time of this writing, only about 2 million additional acres are eligible for CRP enrollment because of the 27 million acreage cap and the amount of land already enrolled in the program (USDA Farm Service Agency 2024).

Even after the influx of funding from the IRA, the current state of conservation programs has not succeeded in curbing nutrient pollution from agricultural runoff enough to substantially decrease contamination in waterways (Stillerman 2023b; University of Illinois at Urbana-Champaign News Bureau 2024). Nutrient pollution, primarily an overabundance of nitrogen and phosphorus from fertilizer and other contaminant runoff from agricultural fields, kills wetland vegetation and decreases oxygen in wetland waters, harming aquatic life (Ballut-Dajud et al. 2022).

The next farm bill offers a pivotal opportunity to strengthen wetland protection by enhancing existing conservation programs and introducing new incentives that foster soil and water health (Kaplan, Kamrath, and Union of Concerned Scientists 2023). To accomplish this, the next farm bill should:

- **Raise the CRP cap to 45 million acres—its original limit from 1985—to enable up to 20 million new acres to qualify for enrollment.** This expansion would allow more farmers to participate in the Farmable Wetlands Program and other initiatives that improve soil and water quality.

- **Establish new incentives for implementing sustainable farming methods by linking taxpayer-subsidized crop insurance to conservation practices that improve soil quality and minimize runoff.** Currently, the Federal Crop Insurance Program (FCIP) incentivizes production at the cost of environmental stewardship, leading to increased fertilizer pollution of wetlands and other waterways (Stillerman 2024; Des Moines Register Editorial Board 2023).

- **Allocate a minimum of $700 million annually to ACEP.** Combined with IRA funding, this will assist more farmers in restoring wetlands damaged by industrial agriculture.

- **Increase CSP funding from $1 billion to $4 billion per year** to help more farmers plant cover crops, eliminate harmful tilling, and pursue other approaches that promote healthy soil and clean water by reducing fertilizer, pesticide, and other harmful runoff to wetlands and other waterways.

- **Boost EQIP funding to allow for $2 billion per year for new contracts, and direct that funding toward agricultural practices that enhance soil, protect wetlands and other waters, and provide additional environmental benefits.** Specifying sustainable practices is necessary given EQIP's history of supporting controversial agricultural methods with debatable environmental benefits, such as manure digesters (Stillerman 2022).

- **Expand equity initiatives** to provide all farmers access to federal conservation programs that preserve and restore wetlands, including:

    - Prioritizing historically underserved farmers for CSP, EQIP, and ACEP (Natural Resources Conservation Service, n.d.)

    - Designating 30 percent of CSP and EQIP funding for historically disadvantaged and new farmers

    - Increasing advance payment options to reduce the financial burden of initial capital investment and encourage greater program participation

    - Reestablishing payment limits on CSP, and creating EQIP payment limits, to ensure that the largest, most well-resourced farms do not claim an unfair share of this fundamental conservation funding source

    - Requiring the USDA to reach out to farmers of color to promote conservation programs

Implementing these recommendations demands investing only a fraction of the significant annual value wetlands deliver. A recent study estimates that wetlands contribute more than $7.7 trillion per year to fishing, recreation, water quality, and flood control in the United States (Lang, Ingebritsen, and Griffin 2024). Integrating these initiatives into the next food and farm bill will fortify USDA programs that safeguard wetlands from industrial agriculture, ensuring these vital ecosystems thrive and continue to mitigate flooding, purify water, and support our communities and our climate.

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Appendix: Data and Methods

All analyses were done in R (version 4.2.2), using the tidyverse and sf packages, and in ArcGIS Pro (Esri, version 3.2.1). The R code and data files are available online at https://doi.org/10.7910/DVN/QIKHPR.

Wetlands

We extracted the wetlands data from the National Wetlands Inventory (NWI) (U.S. Fish & Wildlife Service 2024b). NWI endeavors to map all wetlands in the United States that are 0.5 acres or larger. We downloaded the geodatabases of wetlands in the study states from the NWI website on July 29, 2024 (U.S. Fish & Wildlife Service 2024a).

To approximate "wetlands" as defined by the Clean Water Act, we retained wetland types freshwater emergent, freshwater forested/shrub, and other, and excluded wetland types riverine, lacustrine (lake), freshwater pond, and all saltwater habitats. This approach follows federal regulations for wetland management and aligns with established protocols in the relevant peer-reviewed scientific literature (Adusumilli 2015; Gage, Cooper, and Lichvar

2020). Wetlands for inclusion were identified by the "type" attribute field of the NWI data, following the US Fish and Wildlife Service wetlands classification system (U.S. Fish & Wildlife Service 2019, n.d.).

The state geodatabase NWI datasets include buffers that extend beyond state boundaries (US Fish & Wildlife Service Wetlands Team, email message to the author, July 15, 2024). We clipped the wetlands data to each state using the intersection function of the sf package in R, retaining only portions of wetland polygons that lie fully within each state boundary. We used ArcGIS Pro to calculate the geometric area for all wetland polygons in each state and to sum the individual wetland polygon acres to obtain the total wetland acres per state. We did not use the acreage data native to the NWI dataset, since these include acreage across state lines for wetlands that straddle states.

Wetlands Valuation

Wetland valuation studies generate a wide range of estimates depending on geography and the inherent characteristics of different wetlands (Hansen et al. 2015; Taylor and Druckenmiller 2022). We considered numerous per-acre wetland valuation estimates and found that the majority were either outdated or not directly applicable to the scope of our investigation. For example, while Adusumilli (2015) provided state-by-state valuation estimates, the research considered only mitigated wetlands. Another widely referenced valuation quantified only the flood value of coastal wetlands (Narayan et al. 2017).

After surveying the available wetland valuation literature, we selected the estimate of $1,840 per hectare for annual residential flood mitigation value established by Taylor & Druckenmiller (2022). We chose this estimate because it provides a valuation that is appropriate for the diverse wetland types included in our analysis. This estimate originates from a study published in a high-impact peer-reviewed economics journal and cited by researchers published in similarly high-impact journals (Luttmer 2024; Greenhill et al. 2024; Krohmer et al. 2024; Druckenmiller et al. 2024).

To obtain the estimated annual benefits per state, we converted the per-hectare value ($1,840) to a per-acre value. Since one hectare contains 2.47105 acres, the annual per-acre residential flood mitigation value of wetlands is $745. We then multiplied the annual per-acre value by the number of acres in a given state to obtain the estimated annual residential flood mitigation value of wetlands to that state.

To estimate future flood mitigation benefits of wetlands over time, we applied a 7 percent and 3 percent discount rate to derive the low and high estimates, respectively (Taylor and Druckenmiller 2022). We multiplied the annual valuation by the inverse of the discount rate to estimate long-term benefits. This is a widely accepted practice in public benefit/cost assessments, and federal agencies are required to use the 7 percent and 3 percent discount rates in regulatory analyses (Arrow et al. 2014; Li and Pizer 2021).

Agricultural Land

We extracted the acreage of land used for agriculture in each state from the 2022 Census of Agriculture (USDA National Agricultural Statistics Service 2024). State area was obtained from the US Census TIGER/Line Shapefiles database using the following search terms: Year = 2023 and Layer type = "States (and equivalent)" (US Census Bureau 2024). These data were downloaded on July 31, 2024. The TIGER/Line dataset includes area measurements for each state in square miles; these data were converted to acres for our analyses. We included both land and water area in our analyses. To compute the percentage of state area used for agriculture, we divided the agricultural acres by the total acreage and multiplied by 100.

Limitations

This project uses data from the NWI, and the limitations of that dataset apply here. The NWI is a medium resolution product with a target mapping unit of 0.5 acres, meaning that the smallest wetland that can be consistently mapped and classified in the NWI is 0.5 acres. Therefore, this study likely excludes a number of wetlands smaller than 0.5 acres (Gage, Cooper, and Lichvar 2020; Gold 2024; FGDC Wetlands Subcommittee 2009). The NWI is also limited by the age of specific wetland data (Gage, Cooper, and Lichvar 2020). Individual wetland boundaries, shapes, and sizes may change over time with seasonality and external factors, including climate change (Minnesota Department of Natural Resources 2024). Given the risks to wetlands described in this report, wetlands that existed when the data were collected may not necessarily exist today.

We used the $745 per acre ($1,840 per hectare) annual valuation of wetlands from Taylor and Druckenmiller (2022) to derive the annual residential flood mitigation value of wetlands in the Upper Midwest, and the limitations identified by the researchers apply to our estimates. Notably, the per-acre estimate is an average across different wetland types, but in reality, we expect different types of wetlands to provide differing levels, and therefore value, of flood protection (Taylor and Druckenmiller 2022). The researchers identified spatial and urbanicity heterogeneity in the data across the United States, but since our analyses were focused on assessing the regional value of wetlands, we applied the overall average per-acre estimate to obtain the valuations in this report.

We applied 7 percent and 3 percent discount rates to estimate the range of future benefits, but this approach may provide a lower-than-appropriate high-value estimate over time (The White House 2024; Cohen 2024). If, instead of applying a 3 percent discount rate, we applied a 2 percent discount rate to obtain the high estimate of future flood mitigation benefits of wetlands over time, we would obtain an upper estimate of $1.13 trillion, versus the $754 billion upper estimate we report here.

Finally, the valuation metric reported here is solely focused on quantifying the residential flooding mitigation value of wetlands; it does not attempt to evaluate the total benefits from wetlands in the Upper Midwest, including to the commercial fishing industry, water quality, and climate change mitigation (Woods 2024). Therefore, the values that we report are just a fraction of the total benefits that wetlands provide to the region.

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