Drained Natural Assets:
Pricing the Ecosystem Services of U.S. Peatlands

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Abstract

Peatlands hold roughly twice the carbon of the world's forests on three percent of its land, and drained peat now emits over a gigatonne of CO_2 a year. This paper takes a first step toward pricing the ecosystem services of U.S. peatlands, valuing the two for which parcel-level measurement now exists: carbon and flood mitigation. Combining a 30 m USDA Forest Service raster of peatland CO_2 reduction potential with the Nolte (2020) land-value raster and the Taylor and Druckenmiller (2022) wetland flood-mitigation raster, we compute the cost of conserving every peatland cell in the conterminous United States and trace the national supply curve. At a 25-year contract and 4 % discount rate, 79 % of U.S. peatland can be conserved at or below $50 per tonne CO_2, securing 28.6 $MtCO_2$ per year—93 % of national peatland emissions—for $14.0 billion in present value while displacing under two percent of U.S. corn output. Wetland flood-mitigation benefits, which accrue downstream and go unpriced in land markets, add roughly $15 billion in present value over the same set and are concentrated almost entirely in the cheapest quarter of peatland, which is worth conserving on flood protection alone. Because biodiversity, water purification, and recreation remain unpriced, these figures understate the value of conservation.

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1 Introduction

Climate budgets are finite, so the question of where to spend them is empirical. Protecting and restoring ecosystems that store carbon is widely believed to be among the cheapest options available (Griscom et al., 2017). The belief is probably right, but the evidence for it is assembled at national or continental aggregates—the wrong resolution for the decision it is meant to inform. An agency with a budget does not need to know what the average hectare costs. It needs to know which hectares to buy, and an average is precisely what conceals that.

This paper builds the missing object for one asset class: a cost of abatement for every peatland cell in the conterminous United States, from which the national supply curve follows directly. We frame the exercise as ecosystem-service valuation in its most operational form: of the services drained peatland destroys, we price the two that can now be measured at the parcel—carbon storage and, through the wetland subset, flood mitigation—and we are explicit that the remainder stay unpriced, so the value of conservation reported here is a floor.

Peatlands are worth the attention. They hold roughly 600 GtC on about three percent of global land—approximately twice the carbon in all the world's forest biomass (Xu et al., 2018)—and drained peat emits on the order of 1.3 $GtCO_2$ per year, close to five percent of anthropogenic greenhouse gas emissions (Dommain et al., 2012). Drainage is also reversible: drained peat oxidizes continuously, and rewetting stops it, so conservation buys the cessation of an ongoing, observable emission.

Three data products, none of them built for this purpose, turn out to be sufficient when combined. A 30 m raster of U.S. peatland extent and annual CO_2 reduction potential from the USDA Forest Service (Lilleskov, 2025) says what each hectare would abate. The 480 m raster of estimated fair market land values from Nolte (2020) says what it would cost to acquire. And the 480 m raster of wetland flood-mitigation benefits from Taylor and Druckenmiller (2022), identified from flood-insurance claims, says what else it produces. Overlaying them gives an annuitized cost per tonne for each cell—acquisition, restoration, and maintenance, net of the flood benefit the parcel supplies downstream—and ordering cells by that cost traces the national supply curve. The exercise is a spatially disaggregated descendant of the revealed-preference approach to sequestration cost in Stavins (1999), with the parcel rather than the region as the unit of observation. What is new is not the idea but the resolution, and at this resolution the curve stops being a summary statistic and becomes a map: it shows not only what conservation costs but where the cheap hectares are.

Three results follow. The first concerns scale and price. 79 % of U.S. peatland—1.05 million hectares—can be conserved at or below \$50 per tonne CO_2, delivering 28.6 $MtCO_2$ per year, or 93 % of everything drained U.S. peat currently emits, at a gross cost of \$14.0 billion in present value. That is cheaper than most of what the United States has actually scaled (Gillingham and Stock, 2018) and well below prevailing estimates of the social cost of carbon. Whether to buy this abatement is not, on these numbers, a close call.

The second result concerns what conservation is worth beyond carbon. Wetland peat absorbs floodwater, sparing downstream properties damages the owner is never paid for and the land market never prices. Valued at Taylor and Druckenmiller (2022) estimates, that service adds roughly $15 billion in present value across the conservable stock—more than the entire land and restoration bill of the cheapest quarter of U.S. peatland, which is therefore worth conserving on flood protection alone, with 17 $MtCO_2$ a year of abatement as an uncosted byproduct. Section 4 shows that these benefits are concentrated almost entirely at the bottom of the supply curve, which sharpens the case for starting there.

The third result concerns what conservation would displace. Wetland-classified peatland enters the conserved set first, its land values low and its flood benefits high; agricultural peatland enters between $20 and $50/$tCO_2$, where large emission reductions offset higher land values. Applying county-average corn yields to the converted cropland, displacement at the $50 threshold is under two percent of recent U.S. corn production, concentrated in a small number of peat-fringe counties in the Upper Midwest.

Related literature

The paper extends the cost-of-sequestration literature (Stavins, 1999; Griscom et al., 2017) from regional aggregates to parcel-level supply curves, replacing assumed opportunity costs with estimated market values. It builds on the measurement advances in Nolte (2020) and Taylor and Druckenmiller (2022), combining a cost raster and a benefit raster not previously used together, and prices a natural asset whose carbon value has been studied by natural scientists (Humpenöder et al., 2020; Günther et al., 2020) but not by economists at policy-relevant resolution. Relative to the economics of tropical deforestation (Balboni et al., 2023; Hsiao, 2025), where enforcement capacity and international coordination bind, the U.S. peatland problem is almost purely one of mechanism design under cost heterogeneity: property rights are secure, monitoring is feasible, and the obstacle is that the regulator does not know which hectares are cheap.

Section 2 describes the setting and the data. Section 3 sets out the valuation framework. Section 4 presents the supply curve and the value of conservation, and Section 5 reports robustness. Section 6 concludes.

2 Setting and Data

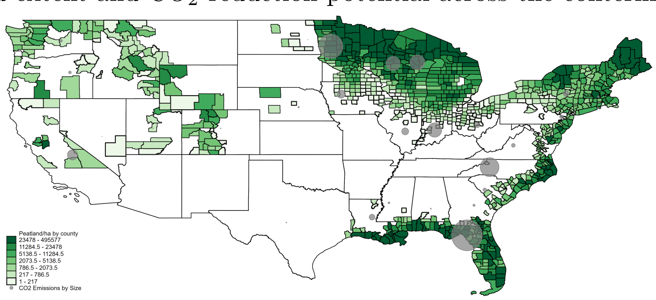
Peatland economics in brief

Peatlands are waterlogged ecosystems in which anaerobic conditions suppress decomposition, so organic matter accumulates as peat over millennia; intact systems sequester on the order of 10 tCO_2/ha/year (Günther et al., 2020). Drainage admits oxygen to saturated organic soil and converts the system from a sink into a source emitting 20–40 tCO_2-equivalent/ha/year, depending on water-table depth, climate, and tillage (Couwenberg et al., 2008; Dommain et al., 2012). The process is reversible: blocking drainage restores anaerobic conditions and eventually net sequestration, and although rewetting releases a transitional pulse of CH_4, its warming potential is dominated by the avoided CO_2 over policy-relevant horizons (Wilson et al., 2016; Günther et al., 2020).

One further feature matters for implementation: emissions depend on the water table, a continuous and observable state variable, so compliance with a conservation contract can be monitored remotely rather than inferred from land-use classification.

U.S. peatlands cluster in three regions (Bridgham et al., 2006): the Upper Midwest, which holds the largest contiguous extent and meets the Corn Belt along its southern fringe; the Southeast, comprising the Everglades, the North Carolina pocosins, and Gulf Coast wetlands; and New England, smaller but intersecting high-value coastal land markets. Figure 1 maps extent and reduction potential.

Figure 1: Peatland extent and CO_2 reduction potential across the conterminous United States



Notes. County-level peatland area in hectares (choropleth) with state-level annual CO_2 reduction potential (proportional circles). Source: USDA Forest Service peatland raster (Lilleskov, 2025), aggregated by the authors.

Reported restoration costs span an order of magnitude—\$200–\$7,500/ha for initial works and \$50–\$200/ha annually for maintenance (IPCC, 2022; Taillardat et al., 2020; Andersen et al., 2017)—reflecting both heterogeneity of restoration costs and the absence of a deep U.S. contracting market. We adopt a baseline of \$3,300 initial and \$100 annual and treat the high end (\$6,100 and \$200) as a robustness scenario.

Data

The analysis sample is every peatland pixel in the conterminous United States after overlaying three primary rasters and one land-cover layer.

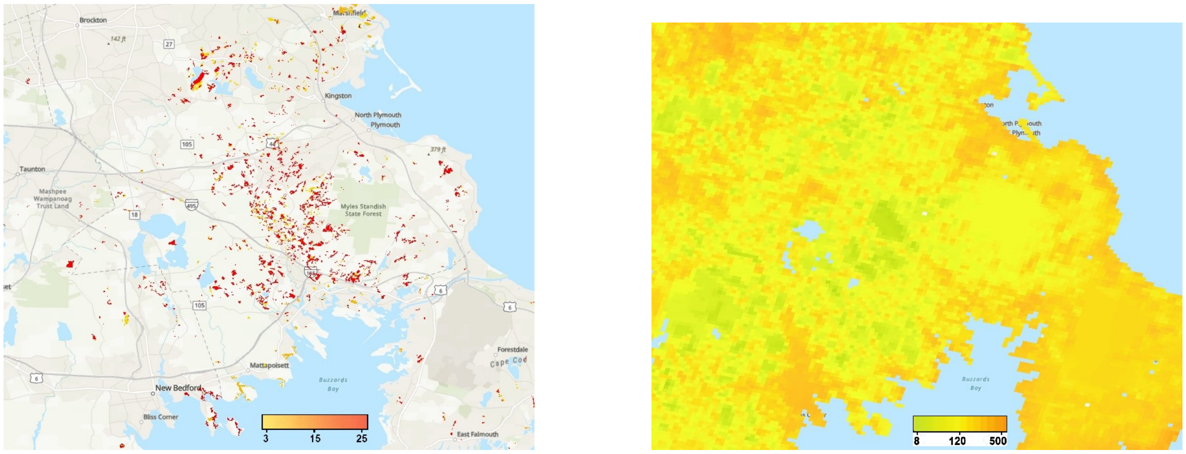
The peatland layer is a 30 m raster from the USDA Forest Service (Lilleskov, 2025) recording peatland presence and the annual CO_2 reduction potential achievable through restoration—the avoidable emission *flux*, in the terminology of the source literature; we say "emissions" throughout—derived from soil maps, land-cover overlays, and emission-factor models following Couwenberg et al. (2008) and Wilson et al. (2016). Land values come from Nolte (2020), who estimates fair market values for U.S. private land from approximately 140 million parcel transactions over 2000–2019 at 480 m resolution; the estimand is the price relevant to vacant-parcel transactions with conservation intent—what a conservation buyer would expect to pay, not an assessed or agricultural-use value.[1] Flood-mitigation benefits come from Taylor and Druckenmiller (2022), who use parcel-level NFIP claims to estimate the marginal reduction in flood damages attributable to an additional upstream wetland hectare; approximately 40 % of peatland in our sample is classified as wetland in that layer, so the term is informative for a substantial subset and identically zero elsewhere. We classify each cell by land use using the 2019 USGS National Land Cover Database and merge cropland cells to county-average yields.

Figure 2 shows the two surfaces that drive the results, for Plymouth County, Massachusetts: emission intensity and land value both vary across adjacent cells and are not strongly aligned with one another.

All layers are reprojected to a common Albers Equal-Area projection at 30 m, and the two 480 m rasters are assigned to each 30 m cell by parent-pixel containment with no smoothing. Cells without a valid Nolte (2020) value—water, urban, federal or tribal land—receive the county-mean land price, and results are robust to dropping them (approximately 1.2 % of total peatland area). Monetary values are deflated to 2024 dollars with the BEA implicit PCE deflator. Table 1 reports summary statistics.

[1] The Nolte (2020) layer enters our raster overlay with $\ln P_{\text{land}}$ recorded as integers—eleven bins across the sample—an artifact of the integer-raster overlay step. Aggregate results are insensitive to this: assigning every cell the lower and then the upper edge of its bin brackets the \$50 share between 60 % and 82 %, and because each cell's position within its bin is idiosyncratic, the errors largely offset in sums over cells.

Figure 2: Granularity of the underlying data: Plymouth County, Massachusetts



(a) Peatland by CO_2 reduction potential

(b) Nolte (2020) land values

Notes. Left panel: peatland cells classified by annual CO_2 reduction potential (tCO_2/ha/yr). Right panel: estimated fair market land value per pixel. The two surfaces are only weakly aligned.

Table 1: Summary statistics for U.S. peatland cells and overlaid layers

Layer	Variable	Value
Peatland cells (30 m, 0.09 ha)	Total area (million ha)	1.32
	Total annual emissions ($MtCO_2$/yr)	30.8
	Mean CO_2 reduction potential (t/ha/yr)	23
	Median CO_2 reduction potential (t/ha/yr)	24
	Interquartile range (t/ha/yr)	14–30
Land values (Nolte, 2020)	Median per-hectare value	\$10,147
Flood benefits (Taylor and Druckenmiller, 2022)	Share of cells with $B^j_{\text{flood}} > 0$	$\sim$40 %
	Mean benefit per ha/year (within subset)	$\sim$\$1,840
Land cover (NLCD 2019)	Wetland / cropland / pasture / other	40 / 25 / 8 / 27 %

Notes. Computed over the conterminous United States at 30 m resolution. Land values are deflated to 2024 USD using the BEA implicit PCE deflator (footnote 1). Flood benefits are computed for the subset of peatland cells overlapping the Taylor and Druckenmiller (2022) wetland raster. Values marked $\sim$ are approximate pending the final pipeline run.

3 Valuation Framework

The cost of abatement at a parcel

Index peatland cells by j, each of area $a_j = 0.09\,\text{ha}$ with annual reduction potential Q^j in tonnes CO_2 per hectare per year—the difference between emissions under drainage and under restoration. Conserving cell j requires acquiring the land at per-hectare value P^j_{land}, an initial restoration outlay $C_{\text{rest},0}$, and annual maintenance C_{rest}; the cell supplies an annual flood-mitigation benefit B^j_{flood}, zero outside the wetland subset. Annuitizing the up-front components over horizon t at discount rate i,

$$P^j_{\text{CO}_2} \;=\; \frac{(P^j_{\text{land}} + C_{\text{rest},0})\,a(t,i) \;+\; C_{\text{rest}} \;-\; B^j_{\text{flood}}}{Q^j}, \qquad a(t,i) = \frac{i\,(1+i)^t}{(1+i)^t - 1}, \tag{1}$$

in dollars per tonne CO_2. Ranking cells by ascending $P^j_{\text{CO}_2}$ traces the supply curve; at carbon price p, cumulative enrolled area and abatement are $A(p) = \sum_{j:P^j_{\text{CO}_2} \le p} a_j$ and $E(p) = \sum_{j:P^j_{\text{CO}_2} \le p} a_j Q^j$. These are sums over cells rather than averages scaled by extent, which matters because $P^j_{\text{CO}_2}$ and Q^j are strongly negatively correlated: cheap abatement is cheap in part *because* its emissions are high, so applying mean emissions to a mean cost would misstate both the level and the curvature of the curve.

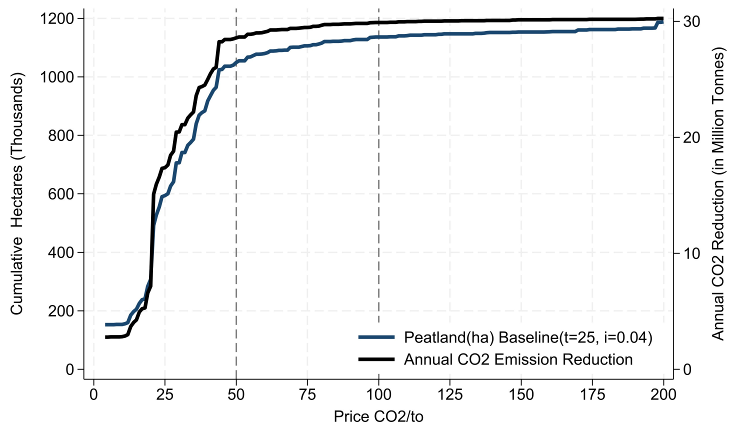
Three properties of (1) determine how the resulting number should be read, and all three make it conservative. The land price is an upper bound on opportunity cost, since an easement extinguishing drainage and development rights leaves the residual value with the owner and costs less than the fee-simple acquisition we price. Applying $a(t,i)$ to the full purchase price prices a contract in which the land is worthless at t, whereas a state that holds the parcel or resells at an unchanged real price bears only the carrying cost $i\,P^j_{\text{land}}$—at $t = 25$ and $i = 4\,\%$ that is 6.4 % against 4 %, so we charge land opportunity cost some sixty percent above the perpetual-hold rate. And the flood benefit is an externality rather than a capitalized amenity: the damages avoided in Taylor and Druckenmiller (2022) accrue to downstream properties, which is why the owner does not internalize them and why the market underprovides wetland retention.

4 The Cost of Peatland Conservation

Figure 3 plots the national supply curve: steep between roughly \$15 and \$50/tCO_2, flat thereafter. Under the baseline calibration ($t = 25$, $i = 4\,\%$, $C_{\text{rest},0} =$ \$3,300/ha, $C_{\text{rest}} =$ \$100/ha/year), 79 % of total peatland area lies below \$50/tCO_2 and 45 % below \$25/tCO_2. Implied annual abatement at the \$50 enrollment is 28.6 MtCO_2—93 % of the 30.8 MtCO_2/year total emissions from U.S. peatland, and on the order of half a percent of national greenhouse gas emissions from an asset class occupying a small fraction of national land area. Table 2 reports cumulative area, share, abatement, and cost at four thresholds.

The flatness beyond \$50 is economically meaningful rather than an artifact of truncation: raising the price from \$50 to \$200 buys a further 13 % of peatland area but only 1.7 MtCO_2/year of additional abatement, because marginal hectares in that range combine

Figure 3: The U.S. peatland conservation supply curve



Notes. Cumulative peatland area conservable (left axis) and cumulative annual CO_2 abatement (right axis) as a function of the CO_2 price. Baseline: $t = 25$ years, $i = 4\,\%$, $C_{\text{rest},0} = \$3{,}300$/ha, $C_{\text{rest}} = \$100$/ha/year, net of flood-mitigation benefits. Each cell enters at its own cost per tonne from equation (1).

Table 2: Cumulative U.S. peatland conservation under the baseline calibration

CO_2 price	Cum. area	Share	Abatement	Present value (billion 2024 USD)		
($\$/tCO_2$)	(000 ha)	(%)	($MtCO_2$/yr)	Gross cost	Flood benefit	Net cost
≤ 25	594	45	17.4	7.8	15.4	−7.5
≤ 50	1,048	79	28.6	14.0	15.4	−1.4
≤ 100	1,136	86	29.9	15.5	15.4	0.1
≤ 200	1,188	90	30.3	16.4	15.5	0.9

Notes. Cumulative peatland area, annual emissions averted, and present value of gross program cost (land acquisition, restoration, maintenance), of Taylor and Druckenmiller (2022) flood-mitigation benefits accruing to the enrolled set, and of their difference. Present values discount the annuitized stream at $i = 4\,\%$ over $t = 25$ years; Figure 4(a) plots the same cost undiscounted, which is larger by a factor of $t\,a(t, i) = 1.6$. Shares are computed against total peatland area of 1.32 M ha; the land-value data are recorded in log bins (footnote 1).

high land values with low emissions. A program sized to the steep segment captures nearly all the available abatement; one sized to the flat segment spends most of its budget on hectares that abate little. Since central estimates of the social cost of carbon used in U.S. regulatory analysis exceed $\$100/tCO_2$, and Gillingham and Stock (2018) document that many scaled U.S. programs deliver abatement at $\$100/tCO_2$ or more, the $50 enrollment is not a marginal proposition.

Figure 4 pairs the cost and benefit schedules. Panel (a) decomposes cumulative *gross* cost—land acquisition, restoration, and financing, before any ecosystem-service credit—which reaches roughly $14.0 B in present value at the $50 enrollment. Acquisition dominates and increasingly so in the right tail, while restoration is close to constant per hectare and therefore matters most at the cheap end. Panel (b) reports the annual benefit flow, valuing abated tonnes at the prevailing carbon price and adding flood mitigation. The flood component is the flat band at the base: it is invariant to the carbon price, so its relative importance is greatest exactly where the carbon term is smallest.

The flood-benefit column of Table 2 contains the more interesting pattern, and it is not the one the aggregate suggests. Flood benefits accruing to the enrolled set are \$15.4 B in present value at the \$25 enrollment and \$15.5 B at \$200—essentially the same number. Raising the carbon price from \$25 to \$200 adds \$8.6 B of gross cost and \$0.13 B of flood benefit. *Virtually the entire flood-mitigation value of U.S. peatland is captured by the cheapest quarter of it.*

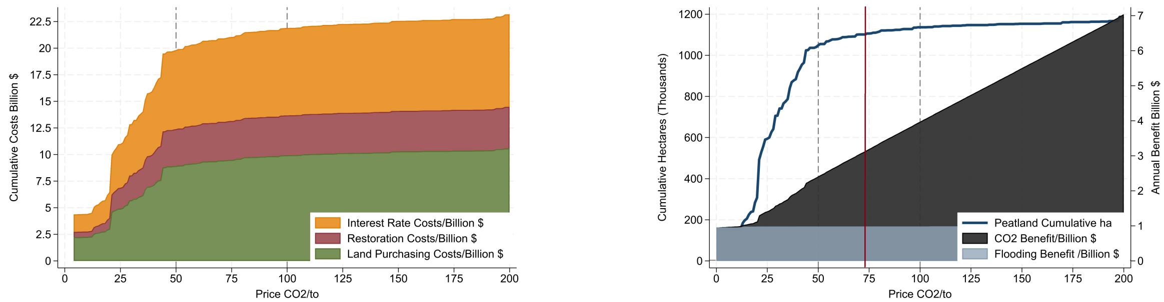
The mechanism is immediate from (1): B^j_{flood} enters the numerator with a negative sign, so a cell with large flood benefits has a low—often negative—cost per tonne and enters at the very bottom of the supply curve. Co-benefits and cheapness are not independent; the same term that makes a parcel socially valuable makes it cheap to enroll.

Two consequences follow, pointing in opposite directions. Because the co-benefit is concentrated in the inframarginal set, it dominates the average cost of a small program: at \$25/tCO_2 the flood benefit of \$15.4 B exceeds gross cost of \$7.8 B, so a program of that scale is worth undertaking on flood grounds alone, with 17 $MtCO_2$/year of abatement as an uncosted by-product. But it contributes almost nothing to the case for *expanding* the program, since beyond that point the marginal hectare delivers carbon and little else. A cost-benefit test applied to the average recommends a much larger program than one applied at the margin, and the margin is the correct test.

We state the aggregate carefully because it depends on an extrapolation: Taylor and Druckenmiller (2022) identify a marginal flood-damage reduction within their estimation sample, and applying it to the roughly 40 % of national peatland their raster classifies as wetland will overstate the total if marginal value declines in wetland extent, as one would expect. Gross cost is the figure we would defend. The concentration result, by contrast, is robust to the level: scaling every flood benefit by a common factor changes the column's magnitudes but not its flatness.

Figure 5(a) decomposes the enrolled area by land use. Wetland-classified peatland dominates at low carbon prices, for two reasons the framework separates cleanly: its land values are lower, and it is the subset for which $B^j_{\text{flood}} > 0$ reduces the effective cost. Agricultural peatland enters predominantly between \$20 and \$50/tCO_2, where high emissions offset higher land value. Since a non-trivial share of the enrolled set is cropland, the program displaces agricultural output. Applying county-mean corn yields to converted cropland cells, displaced output at \$50/tCO_2 is under two percent of recent annual U.S. production (Figure 5b), con-

Figure 4: Costs and benefits of peatland conservation by CO_2 price



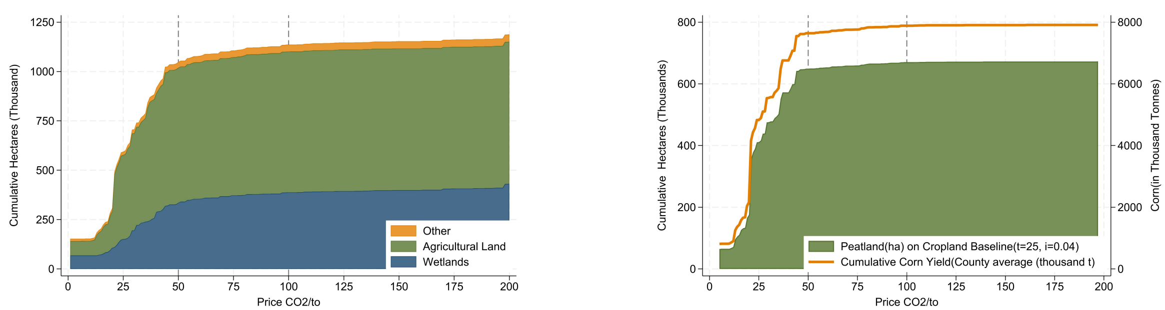
(a) Cumulative cost by component

(b) Annual benefit flow

Notes. Panel (a): cumulative gross cost decomposed into land acquisition, restoration, and financing, expressed as the undiscounted sum of annuitized payments over the 25-year contract; this exceeds the present values in Table 2 by the factor $t\,a(t,i) = 1.6$. Panel (b): annual benefit flow from the enrolled set, valuing avoided emissions at the prevailing carbon price and adding Taylor and Druckenmiller (2022) flood-mitigation benefits; the solid vertical line marks recent EU ETS allowance prices. Dashed lines mark the \$50 and \$100 thresholds.

centrated in the peat-fringe counties of Minnesota, Wisconsin, North Dakota, and Michigan—small enough that the induced price response should be modest, though we have not modeled it. A full leakage accounting would require embedding the enrollment in a land-use model (Humpenöder et al., 2020); we regard this as bounding the problem rather than resolving it.

Figure 5: Composition of the conserved set and agricultural displacement



(a) Conserved area by land use

(b) Displaced corn output

Notes. Panel (a): cumulative conserved peatland area by underlying NLCD land-use class. Panel (b): cumulative conserved cropland area (left axis) and displaced corn output (right axis), applying county-average corn yields to converted cropland cells.

The aggregate result above has a cell-level counterpart. Wherever the annualized flood benefit exceeds annualized land and restoration cost, the numerator of (1) is negative and the implied abatement cost non-positive: the parcel is worth conserving on flood-mitigation grounds alone, at a zero carbon price. 153,000 ha—11.5 % of U.S. peatland, delivering 2.8 $MtCO_2$/year—

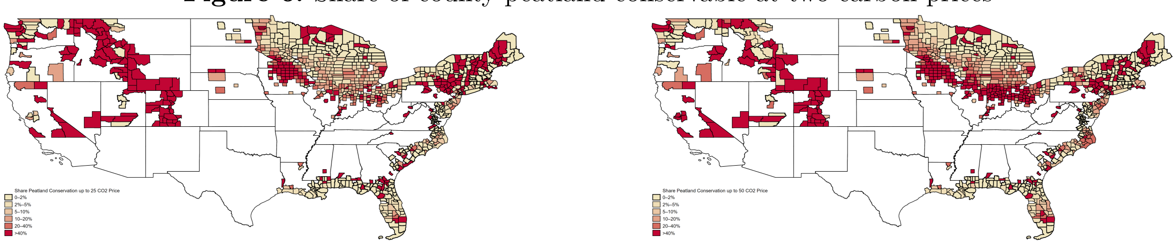
satisfy this condition, concentrated in the lower Mississippi, the Atlantic coastal plain, and the New England river systems, where Taylor and Druckenmiller (2022) benefit estimates are largest. These are the cells that drive both the negative net cost of the \$25 enrollment and the flatness of the flood-benefit column.

The general point survives the extrapolation caveat even if the magnitude does not. Where several ecosystem services are jointly produced and accrue to different beneficiaries, no single-service instrument recovers the full social value—and the parcels where the gap is largest are systematically those a carbon-only instrument serves worst, since a high flood benefit lowers social cost without lowering the price a carbon buyer must pay.

Where the cheap peatland is

Parcel-scale costs aggregate into geography, and Figure 6 maps it: the share of each county's peatland conservable at \$25 and \$50/tCO_2. The low-cost stock is concentrated in the Upper Midwest peat complex and along the Gulf and southern Atlantic coastal plain, where emissions are high and land values moderate; peatland embedded in high-value coastal land markets—southern New England above all—remains expensive at any plausible carbon price. Maps of this kind are the operational payoff of building the curve from parcels: they show not only what conservation costs but where a program's budget would actually go.

Figure 6: Share of county peatland conservable at two carbon prices



(a) Conservable at $\leq$ \$25/tCO_2 **(b)** Conservable at $\leq$ \$50/tCO_2

Notes. Share of within-county peatland area with cell-level abatement cost at or below the stated threshold, baseline calibration.

5 Robustness

Table 3 collects the sensitivity of the headline shares to the calibration.

Calibration. Extending the horizon to $t = 50$ raises the \$50 share to 82 %, since the annuity factor falls from 6.4 % to 4.7 % (Appendix Figure A.4a); this is not merely a sensitivity but the correct calibration if the acquired land retains its real value, so our baseline is the

Table 3: Sensitivity of the headline shares

Specification	Share ≤ \$25 (%)	Share ≤ \$50 (%)
Baseline ($t = 25$, $i = 4\,\%$)	44.8	79.1
Horizon $t = 50$	57.1	82.4
Horizon $t = 10$	11.0	48.5
High restoration cost	16.3	68.0
Excluding flood benefits	33.7	73.4
Discount rate $i = 7\,\%$	21.0	65.5

Notes. Share of total U.S. peatland area conservable at or below the stated CO_2 price. High restoration cost sets $C_{\text{rest},0} = \$6{,}100$/ha and $C_{\text{rest}} = \$200$/ha/year; all rows hold remaining parameters at baseline. Bounds under the land-value binning are given in footnote 1.

conservative end of the defensible range. Halving the horizon to $t = 10$ is the most damaging single perturbation, cutting the share to 49 %. Doubling restoration costs gives 68 %, removing flood benefits 73 %, and raising i to 7 % gives 66 % (Appendix Figure A.4b). The \$50 headline is a majority under every specification we consider.

Land-price endogeneity. The land values entering equation (1) are prices under the current allocation. A program enrolling a substantial share of regional land would shift them: withdrawing farmland raises the value of the cropland that remains, and public acquisition at scale is itself demand pressure in thin rural land markets. Both effects push realized acquisition costs above the estimates here, increasingly so with program size, so the supply curve should be read as the marginal cost schedule for incremental conservation rather than the price of buying the stock at once. The concentration of low-cost peatland in a small number of counties (Figure 6) sharpens the concern: a program small relative to national land markets can be large relative to the local ones where it would actually buy. Quantifying the response requires embedding enrollment in an equilibrium model of land use in the spirit of Lubowski et al. (2006), which we leave as the natural next step on the cost side.

What is not tested. Emission-factor uncertainty in the underlying inventory is not propagated; since Q^j enters the denominator of (1), proportional error in measured emissions maps directly into proportional error in cost. The land-price raster is itself an estimated surface with spatially correlated prediction error, and assigning 480 m values to 30 m cells induces error common within parent pixels; both are second order for the aggregate shares reported here.

6 Conclusion

We construct a parcel-scale estimate of the cost of conserving U.S. peatland, and a first pricing of two of the services conservation would secure. Roughly 79 % of national peatland is conservable at or below \$50/tCO_2 over a 25-year horizon—securing 28.6 MtCO_2 per year at a gross present-value cost of \$14.0 B—placing peatland protection well inside the cost-effective frontier of U.S. climate mitigation and below prevailing estimates of the social cost of carbon.

The valuation is deliberately partial, and partial in an informative way. Of the services drained peat destroys, we price carbon storage and flood mitigation because both can now be measured at the parcel. Flood benefits alone are worth some \$15 B in present value and are concentrated almost entirely in the cheapest quarter of the stock, which is worth conserving before any carbon valuation. Biodiversity, water purification, and recreation remain unpriced, and all push in the same direction: our figures understate the value of conservation.

The exercise generalizes, and the places where it would matter most are identifiable in advance. The European Union has committed to peatland restoration through the Nature Restoration Regulation and finances it largely through the Common Agricultural Policy. Among developing countries Indonesia stands out: its tropical peat is the most carbon-dense and most rapidly degrading in the world (Dommain et al., 2012), it is already the object of substantial international climate finance, and the sub-national data required to build a comparable supply curve are increasingly available. In both settings the binding question is the one we pose here—not whether peatland conservation is cheap in aggregate, but which parcels to buy and on what basis to price them—and in both, the answer will depend on parcel-level costs and benefits that national estimates cannot show.

Two extensions rank highest. Restoration costs remain the widest assumption in the calibration, and location-specific estimates tied to hydrological setting and prior degradation would narrow it considerably. And the valuation itself invites completion: pricing the services we have left unpriced, parcel by parcel, is the natural continuation of the exercise.

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Appendix

A. Data sources and construction

Table A.1 lists the spatial layers entering the analysis; the paragraphs below give construction detail and access information for each.

Table A.1: Spatial data layers

Layer	Source	Resolution	Units	Role in eq. (1)
Peatland extent and CO_2 reduction potential	USDA Forest Service (Lilleskov, 2025)	30 m	tCO_2/ha/yr	Q^j; defines sample
Fair market land value	Nolte (2020)	480 m	USD/ha	P^j_{land}
Wetland flood-mitigation benefit	Taylor and Druckenmiller (2022)	480 m	USD/ha/yr	B^j_{flood}
Land cover	USGS NLCD 2019	30 m	class	composition; wetland subset
Crop identity	USDA Cropland Data Layer 2020	30 m	class	crop composition
County corn yields	USDA NASS (2022)	county	t/ha	displacement calculation
County boundaries	Census TIGER/Line 2021	vector	—	aggregation unit

Notes. All raster layers are reprojected to a common Albers Equal-Area grid at 30 m; the two 480 m layers are assigned to 30 m cells by parent-pixel containment without smoothing or interpolation. Monetary values are deflated to 2024 USD with the BEA implicit PCE deflator.

Peatland extent and CO_2 reduction potential. The peatland layer is a preliminary 30 m raster for the conterminous United States produced by the USDA Forest Service (Lilleskov, 2025). It records, for each cell classified as peat (histosol) soil, the annual CO_2 reduction potential of restoration: the difference between estimated emissions under current drained conditions and emissions after rewetting. Cell-level values are derived from soil survey maps, land-cover overlays, and emission-factor models in the tradition of Couwenberg et al. (2008) and Wilson et al. (2016), in which the emission rate of organic soil is governed primarily by mean water-table depth, climate, and land use. Values enter our extract as integers in tCO_2/ha/year. The layer is unpublished and was obtained directly from the authors (version dated April 28, 2025). Its emission-factor uncertainty is the principal unquantified source of error in our estimates (Section 5).

Land values. Per-hectare fair market values come from Nolte (2020), who trains a machine-learning model on parcel sales from the Zillow Transaction and Assessment Dataset (ZTRAX) covering 2000–2019 and publishes predicted values on a 480 m grid for private land in the conterminous United States. The estimand is the expected sale price of a vacant parcel, which is the acquisition cost relevant to a conservation buyer, as distinct from an assessed value or an agricultural-use appraisal. We deflate the published values to 2024 USD using the BEA implicit PCE deflator (factor 1.2523). As noted in footnote 1, the layer enters our raster overlay with $\ln P_{\text{land}}$ recorded as integers, an artifact of the integer-raster overlay step; aggregate results are insensitive to this. Replication data for Nolte (2020) are available from the journal's repository.

Wetland flood-mitigation benefits. Flood-mitigation values come from Taylor and Druckenmiller (2022), who identify the marginal reduction in flood damages attributable to an additional upstream wetland hectare from parcel-level National Flood Insurance Program claims, and publish the result as a gridded surface of annual benefits in dollars per hectare at 480 m. We deflate to 2024 USD (factor 1.2044) and set the benefit to zero for peatland cells that do not overlap the wetland layer; approximately 40 % of peatland cells carry a positive value. Because the underlying estimate is a marginal value within the authors' estimation sample, aggregating it over the full wetland-overlapping stock is an extrapolation, and Section 4 discusses the direction of the resulting bias.

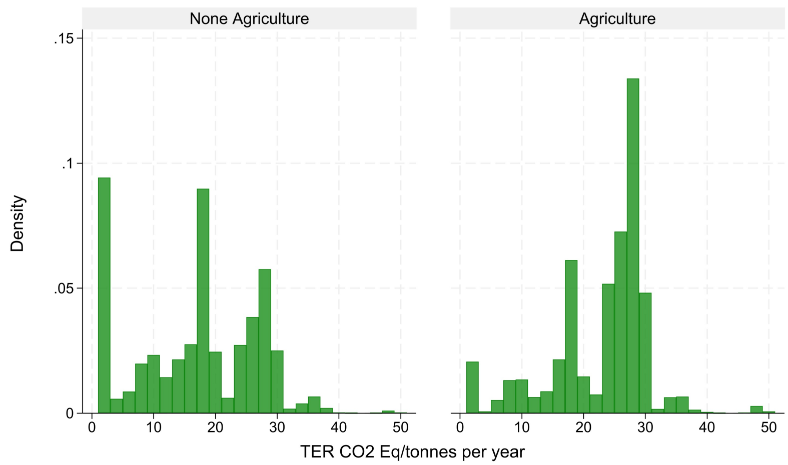
Land cover and crops. Each peatland cell is assigned a land-use class from the 2019 USGS National Land Cover Database at native 30 m resolution; we group classes into wetland, cultivated cropland, pasture/hay, forest, and other. Cropland cells are further assigned a principal crop from the 2020 USDA Cropland Data Layer. County-average corn yields, used in the output-displacement calculation of Section 4, are from USDA NASS (2022) and are applied uniformly to converted cropland cells within each county.

Boundaries, projection, and overlay. County boundaries are Census TIGER/Line (2021 vintage). All layers are reprojected to a common Albers Equal-Area projection on the 30 m peatland grid. The two 480 m layers are assigned to each 30 m cell by parent-pixel containment, with no smoothing or interpolation, so measurement error from the resolution mismatch is common within each parent pixel. Cells without a valid land value—water, urban, federal or tribal land, approximately 1.2 % of peatland area—receive the county-mean land price, and results are robust to dropping them.

Calibrated parameters. Restoration costs are not observed at the parcel and are calibrated from the restoration literature: \$3,300/ha initial and \$100/ha/year maintenance at baseline, \$6,100 and \$200 in the high-cost scenario, spanning the range reported by IPCC (2022), Taillardat et al. (2020), and Andersen et al. (2017). The contract horizon ($t = 25$ years) and discount rate ($i = 4\,\%$) are policy parameters varied in Section 5.

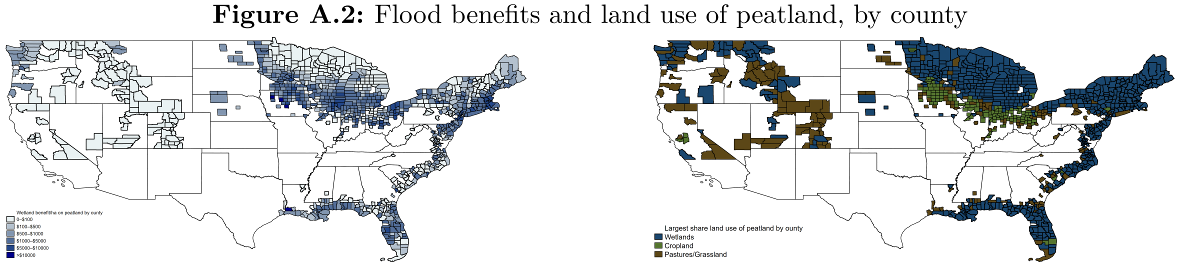
B. Additional descriptive evidence

Figure A.1: Distribution of CO_2 reduction potential by agricultural use



Notes. Distribution of cell-level annual CO_2 reduction potential, separately for agriculturally used and non-agricultural peatland. Agricultural cells exhibit systematically higher emissions, but within-group spread exceeds the between-group difference.

Figure A.2: Flood benefits and land use of peatland, by county

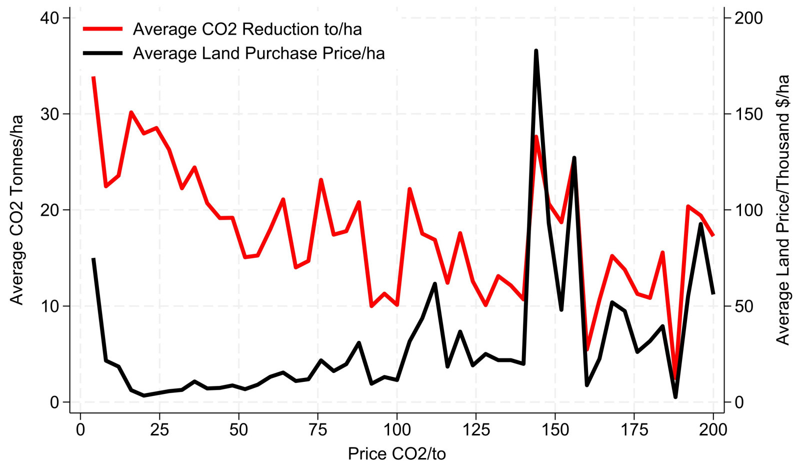


(a) Flood-mitigation benefits

(b) Dominant land use

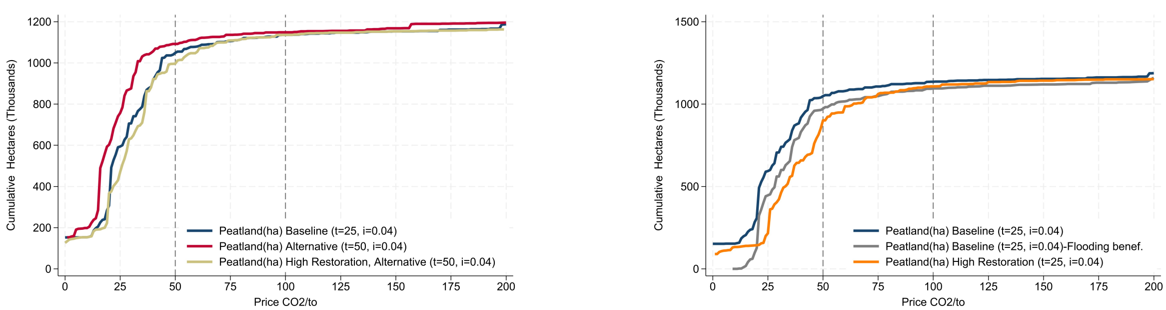
Notes. Panel (a): county means of annual flood-mitigation benefits (2024 USD per hectare per year) for wetland cells overlapping peatland; source Taylor and Druckenmiller (2022). Panel (b): modal NLCD land-use class among peatland cells in each county.

Figure A.3: Emission intensity and land price along the supply curve



Notes. Within-bin means of per-hectare annual CO_2 reduction potential (left axis) and per-hectare land price (right axis), by \$5/tCO_2 bin of the abatement cost distribution. Emission intensity declines across the steep segment while land price rises only in the far tail; the step pattern in the land-price series reflects the binned land-value data (footnote 1).

Figure A.4: Sensitivity of the supply curve to calibration



(a) Contract horizon

(b) Restoration cost and flood benefits

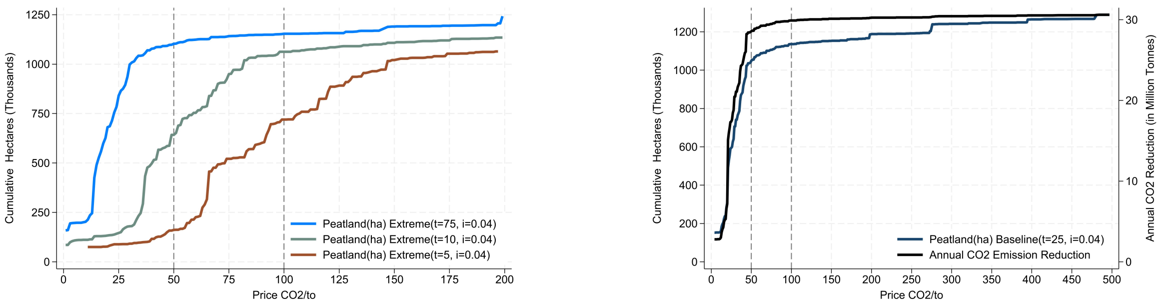
Notes. Panel (a): baseline ($t = 25$), longer horizon ($t = 50$), and high-cost restoration at $t = 50$. Panel (b): baseline, baseline excluding flood-mitigation benefits, and high-cost restoration ($C_{\text{rest},0} =$ \$6,100/ha, $C_{\text{rest}} =$ \$200/ha/year) at the baseline horizon. All hold $i = 4\,\%$.

C. Additional robustness

D. Implementation

The pipeline—raster preprocessing, cell-level cost computation, aggregation, and figure generation—runs in Stata 18 with the `spmap`, `geo2xy`, and `rangestat` packages, supplemented by Python (GDAL, `rasterio`) for the initial reprojection. Replication code and documentation will be deposited at openICPSR upon publication.

Figure A.5: Supply curves under extreme horizons and extended prices

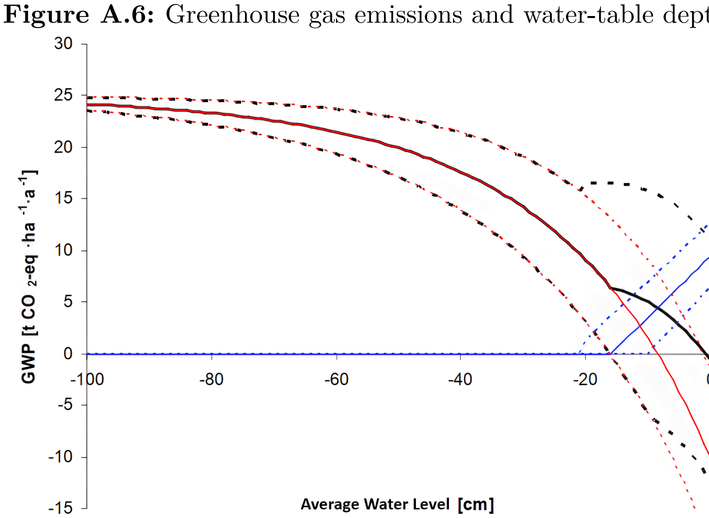


(a) Extreme horizons

(b) Extended price range

Notes. Panel (a): cumulative conservable area for horizons of 75, 10, and 5 years. Panel (b): cumulative area and abatement extended beyond the $200 range of Figure 3; the curve saturates by approximately $200/tCO_2$.

Figure A.6: Greenhouse gas emissions and water-table depth



Notes. Estimated annual greenhouse gas emissions (tCO_2-equivalent/ha/year) as a function of mean annual water-table depth, reproduced from Couwenberg et al. (2008). The monotonicity of this relationship is what makes water-table depth a workable compliance metric for peatland conservation contracts.