Evaluation of Wetland Area Gains and Losses under the US Clean Water Act

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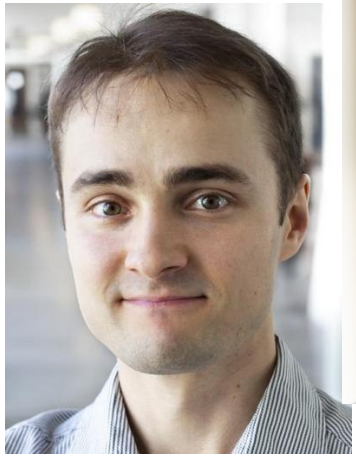

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DRAGON CAPITAL

Summary

Summary

This paper evaluates environmental outcomes at wetland conservation sites in the US.

These sites were established to **offset** impacts to wetlands in other locations and the offsetting is funded through a **market**.

Little empirical evidence on the environmental performance of offset markets despite increasing popularity across various domains (carbon, biodiversity).

Summary

Contribution		Finding
Methodological contribution in measuring environmental outcomes	$\Longrightarrow$	Plausible causal effect on environmental outcomes
Evaluation of how the market mechanism drives outcomes	$\Longrightarrow$	The opportunity cost of land use explains outcome patterns
Program-wide evaluation of statutory policy goals	$\Longrightarrow$	Large regional variation in achieving statutory objectives

Policy Background

The Observer

Thousands march in London to urge leaders to tackle wildlife crisis

Protest features 350 environmental groups demanding more robust action on UK wildlife loss

The Guardian

Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows

Investigation into Verra carbon standard finds most are 'phantom credits' and may worsen global heating

Public demand for nature conservation is increasing.

Offsetting, and market-based offsetting in particular, has a bad reputation.

Wetlands provide critical environmental and economic services

Some important functions of wetlands:

- Habitat for animals and plants
- Absorbing pollutants and improving water quality
- Protecting land areas from erosion
- Reducing the impacts of floods (Taylor and Druckenmiller, AER 2022)

Wetland mitigation banking

The 1972 US Clean Water Act mandates that impacts to wetlands must be compensated by an equivalent environmental gain.

Housing development in Naples, Florida. Image source: Joel Sartore

Wetland mitigation banking

Wetland mitigation banking = A for-profit firm undertakes wetland restoration projects, receives compensation credits and sells them to a CWA permittee.

This industry collects annual revenues in excess of 3.5 billion USD

Mitigation bank in Placer County, California. Image source: US EPA

Wetland mitigation banking

Credit demand (Developers)

Credit supply (Mitigation banks)

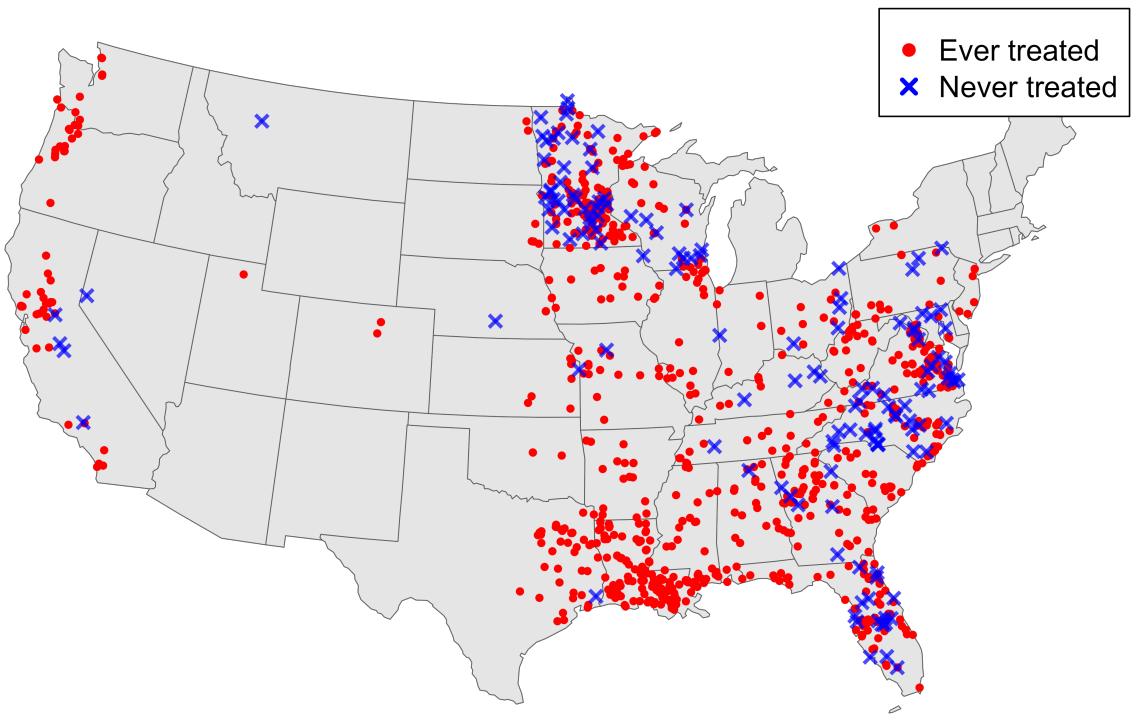
Regulator (US Army Corps of Engineers)

Data

Data

Collected data on wetland area for

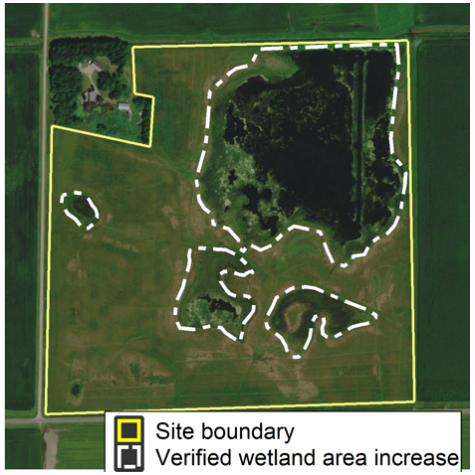
- 400 wetland mitigation banks participating in the federal scheme (ever treated)
- 141 planned mitigation banks that applied for participation but were denied (never treated)



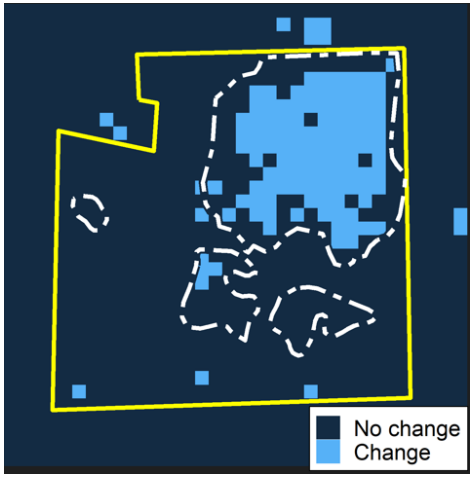
Data

Two complementary data sources to measure the magnitude and timing of wetland area gains:

Visual interpretation of satellite imagery



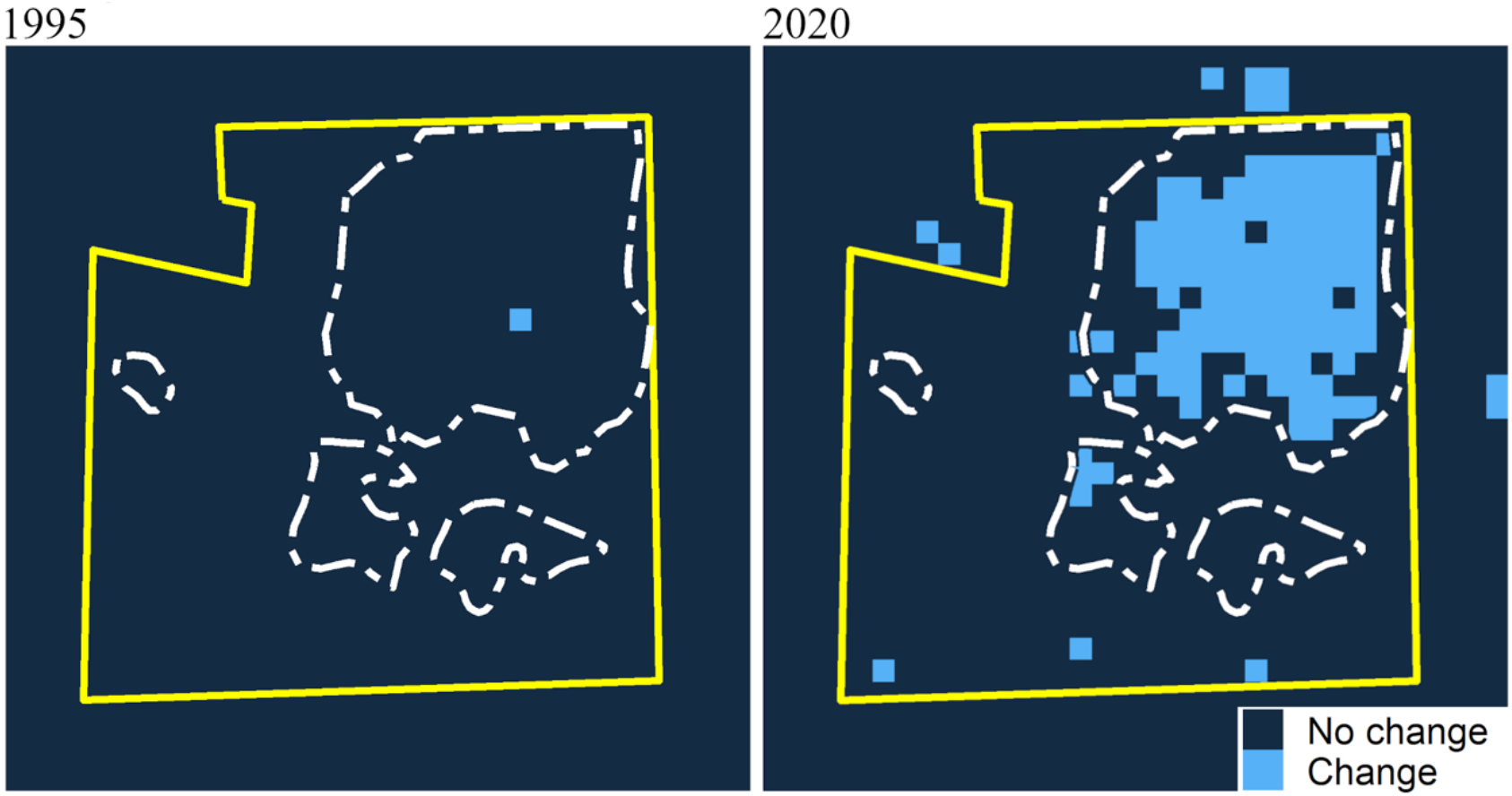
Land cover change detection data



Visual interpretation

The site is situated in rural Minnesota and was established in 2013.

Land cover change detection (SCTIME)

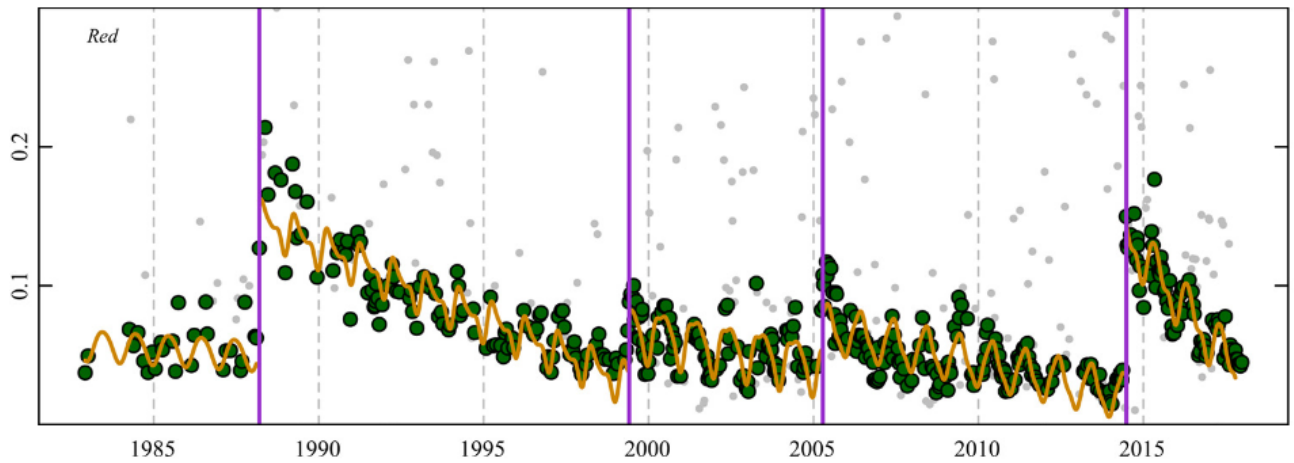


Data source: LCMAP / SCTIME (USGS)

Land cover change detection (SCTIME)

The algorithm fits a time series model for each pixel in Landsat imagery.

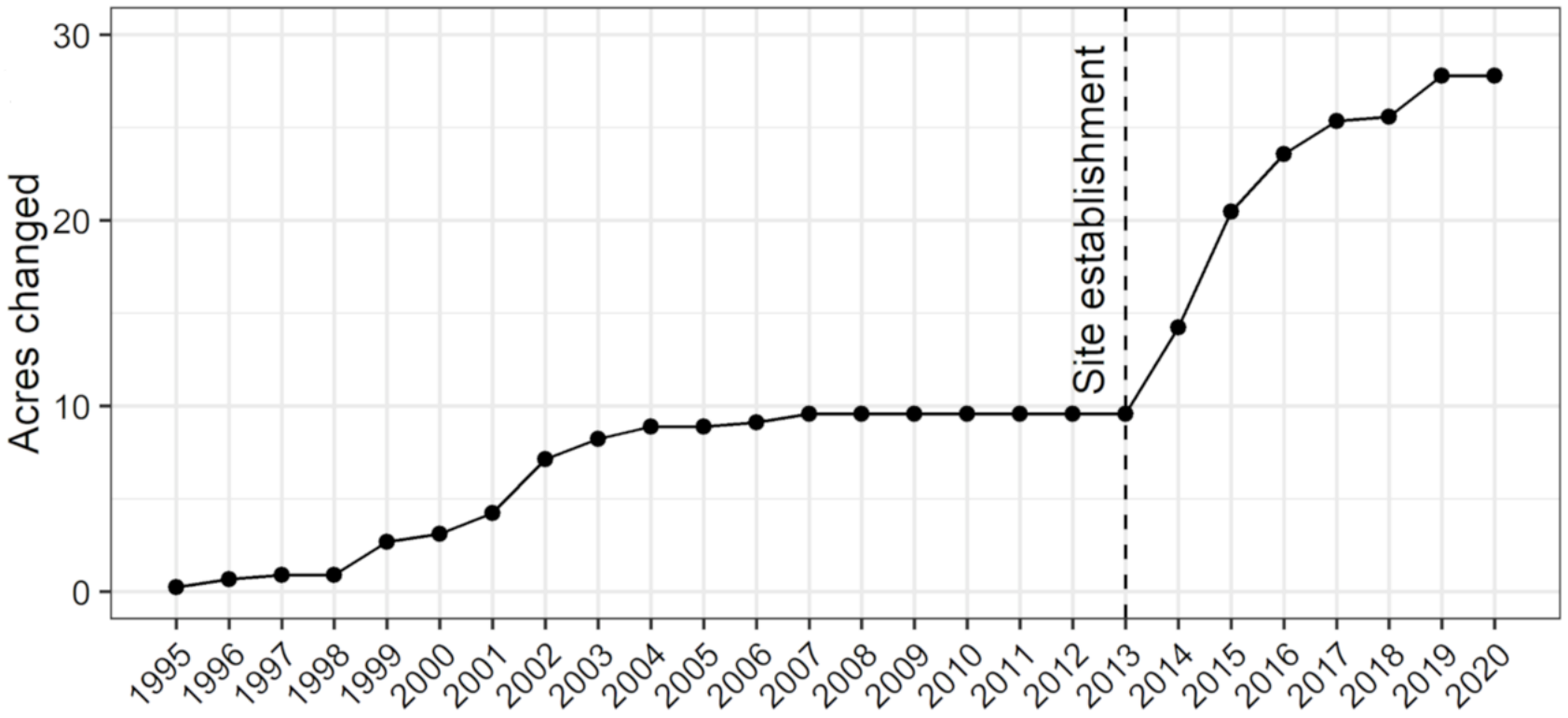
- Green dots: Surface reflectance of a single pixel (red band).
- Yellow: Fitted model
- Purple lines: Model breaks = identified land cover change



Source: Brown et al. (2020)

Agricultural land cover produces a stable surface reflectance time series. Conversion to wetland will be identified as a model break.

Land cover change detection (SCTIME)



Data source: LCMAP / SCTIME (USGS)

Empirical strategy

Long differences

$$\Delta y_i = \tau D_i + \Delta X_i \beta + \varepsilon_i$$

Dynamic difference-in-differences

$$y_{it} = \sum_{s \in \mathcal{S}} \tau_s D_{its} + X_{it}\beta + \alpha_i + \gamma_t + \varepsilon_{it}$$

where

y_{it}	Wetland area at site i in year t
D_{its}	Treatment indicators
X_{it}	Precipitation, GDP, population, agricultural land value
α_i, γ_t	Site and year fixed effects

Empirical strategy

Control units

(i) Not-yet-treated sites	Using sites established since 2016 as a control group and restricting the estimation sample to 1995–2015
(ii) Candidate sites	Entered the crediting process but were withdrawn e.g. due to the opposition of local authorities or neighbouring properties

Results

Long differences estimates

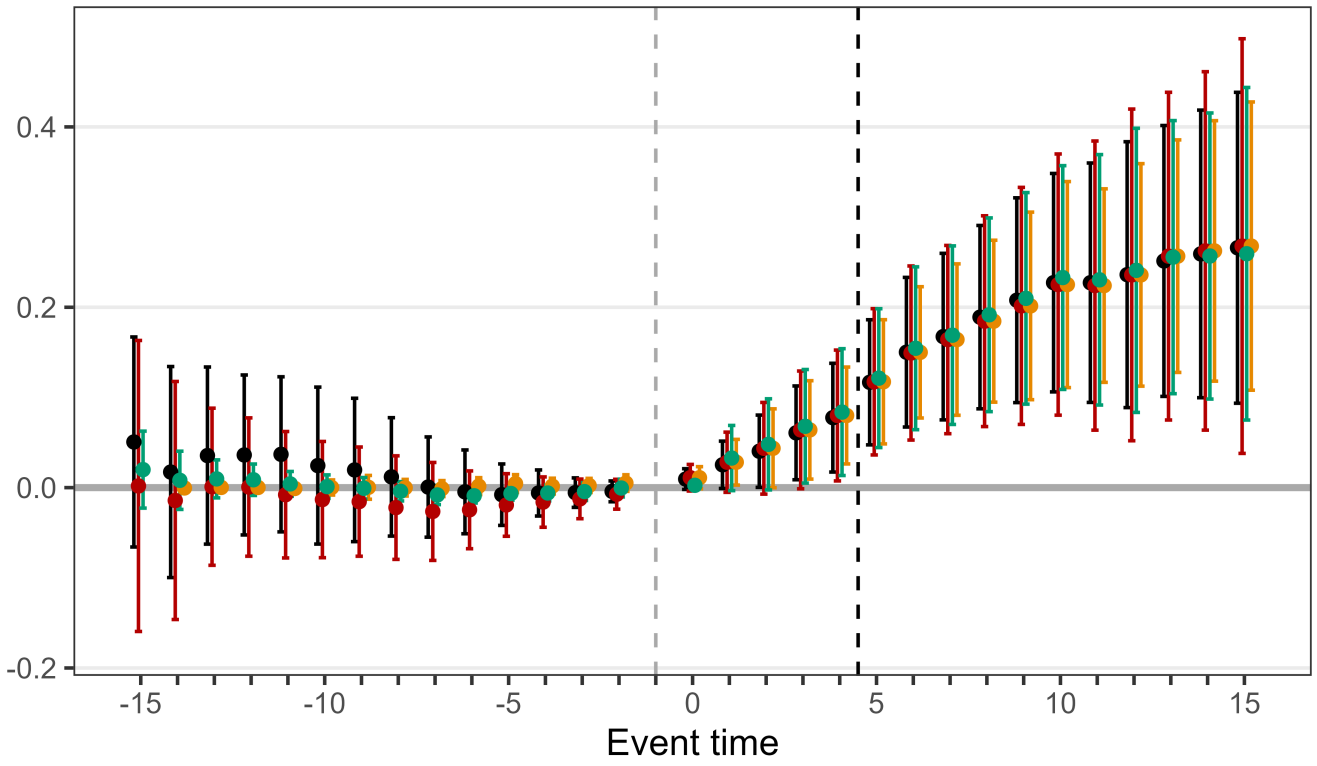
Outcome: % wetland area
Control group: not yet treated

	(1)	(2)	(3)	(4)
Treated	0.23	0.23	0.20	0.22
	(0.04)	(0.04)	(0.05)	(0.04)
Precipitation		0.00		0.00
		(0.00)		(0.00)
Population density		0.04		0.05
		(0.01)		(0.01)
GDP		−0.05		0.01
		(0.03)		(0.03)
Land value		−0.04		−0.04
		(0.04)		(0.04)
State FEs			✓	✓
N	400	400	400	400

Standard errors in parentheses. Clustered by state.

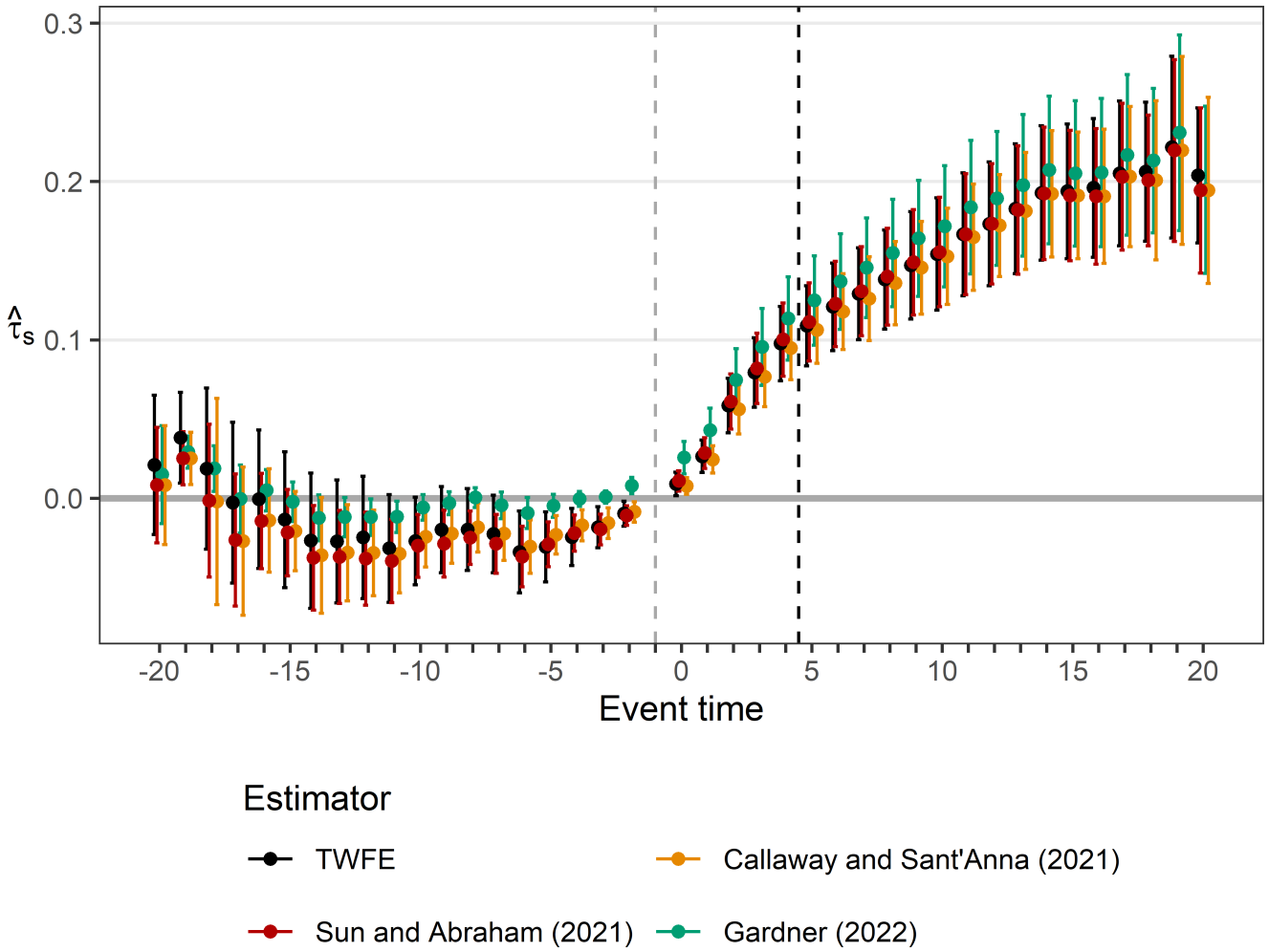
Dynamic estimates

Outcome: % wetland area
Control group: not-yet-treated sites



Dynamic estimates

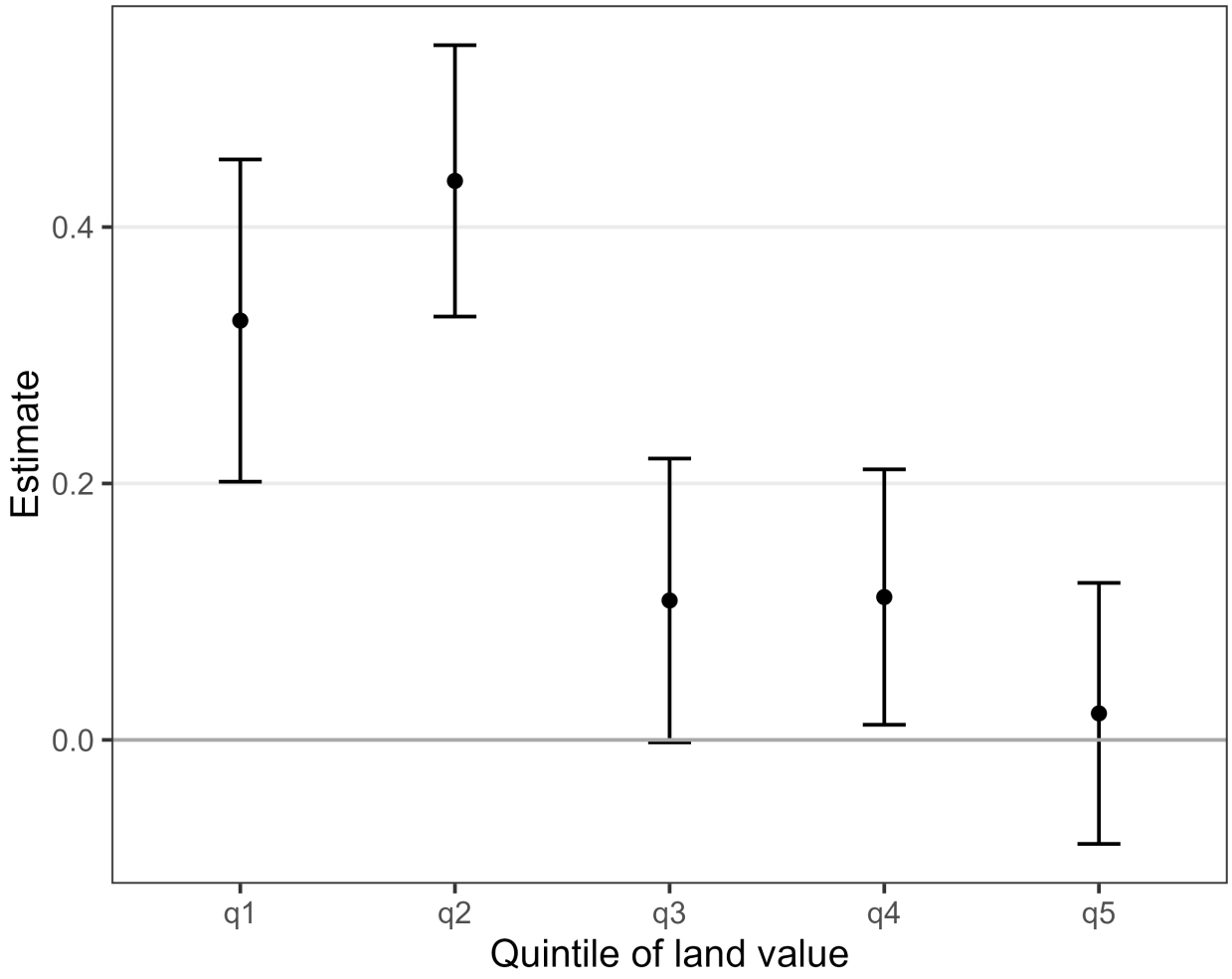
Outcome: % wetland area
Control group: candidate sites



Heterogeneity

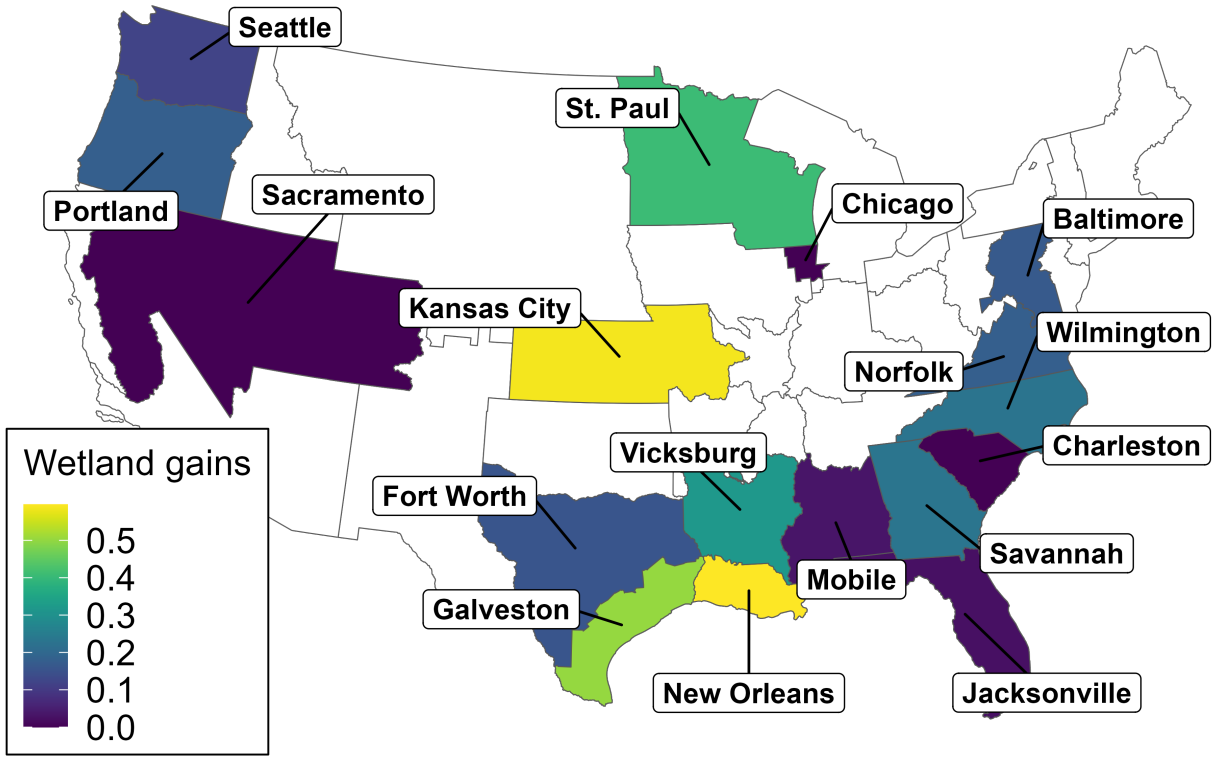
Long differences estimates over land value at treatment year.

High opportunity cost $\Longrightarrow$ less environmental good provision.



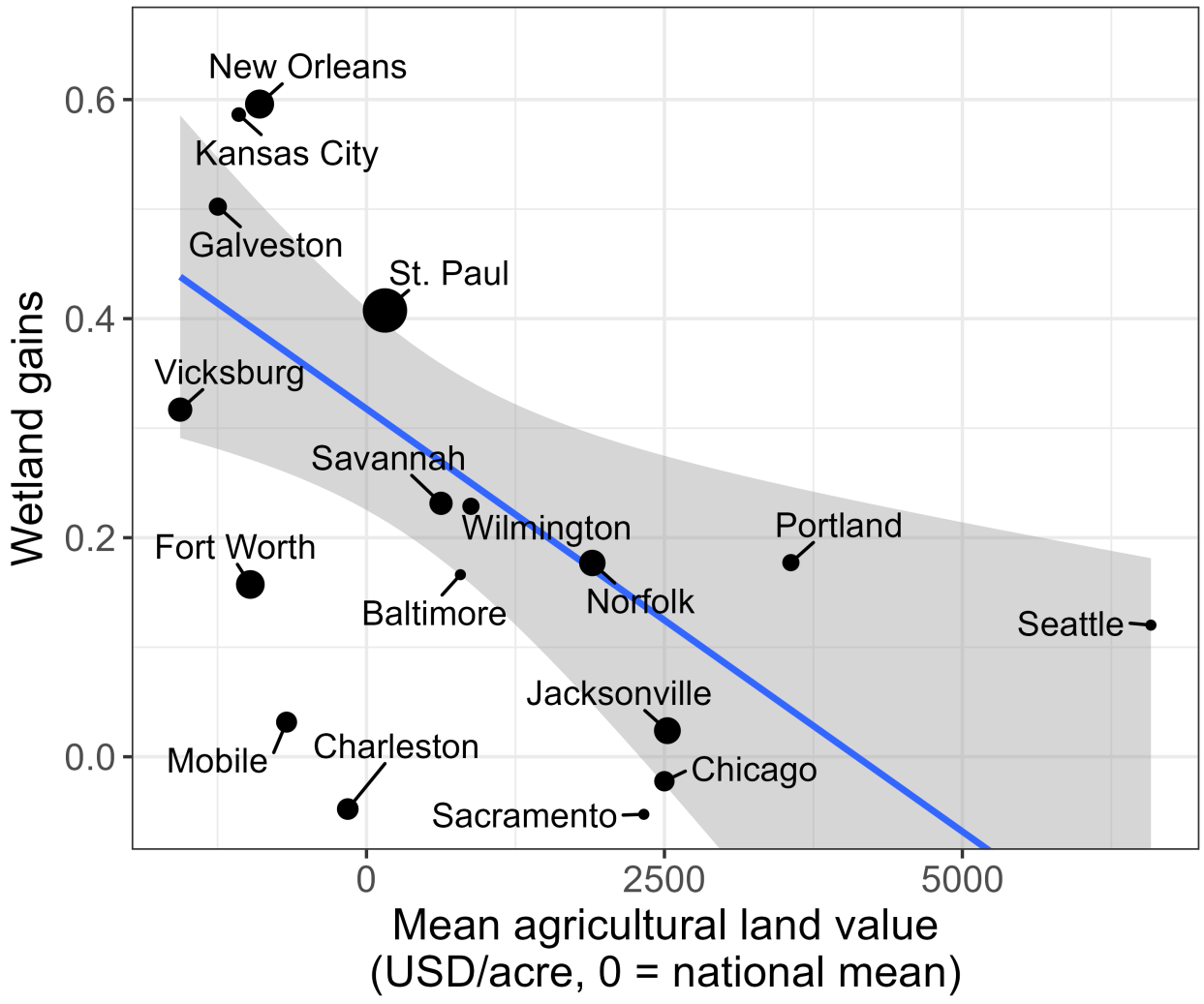
Heterogeneity

Long differences estimates across administrative districts



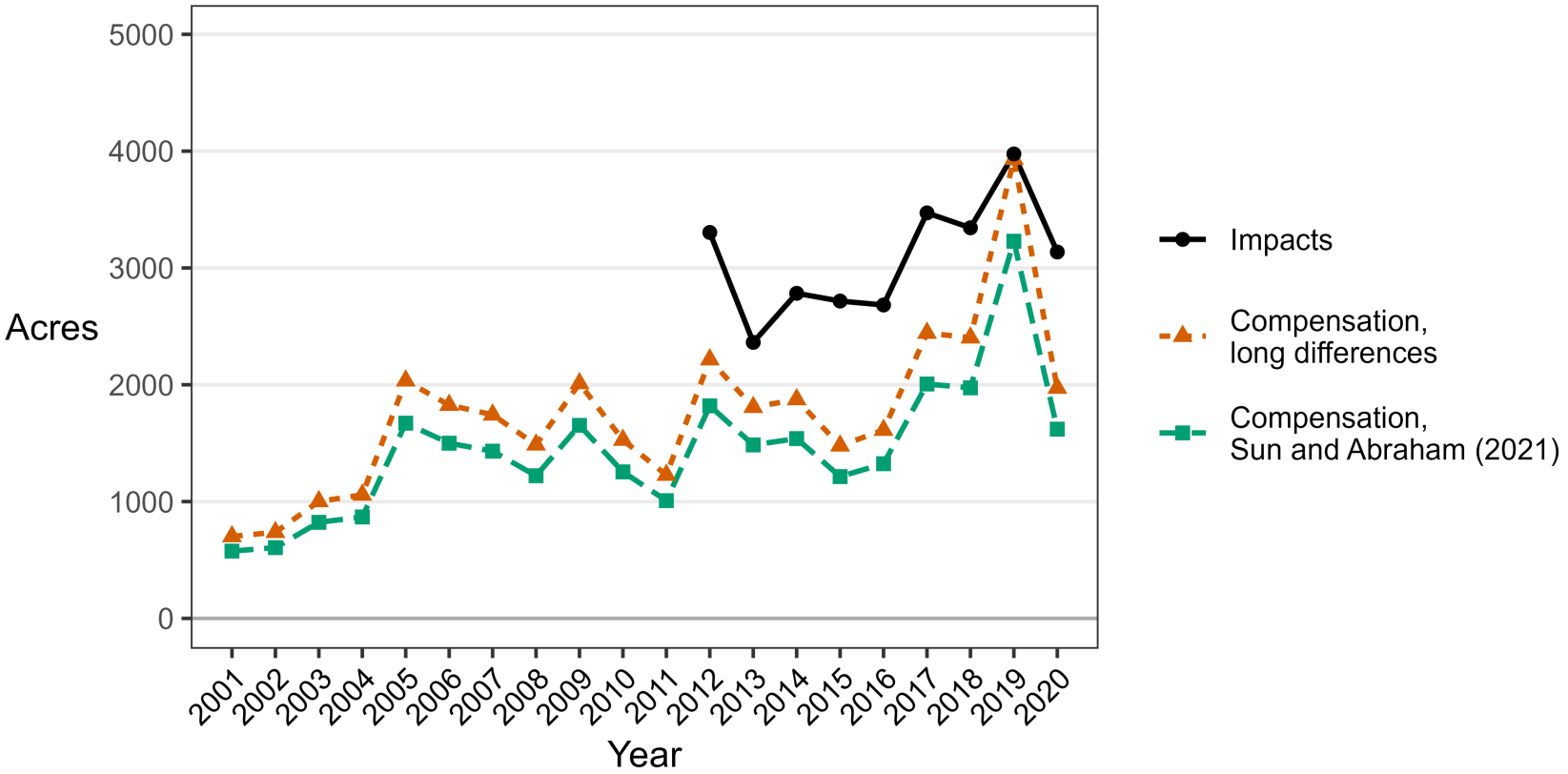
Heterogeneity

Long differences estimates across administrative districts (size = N)



Discussion

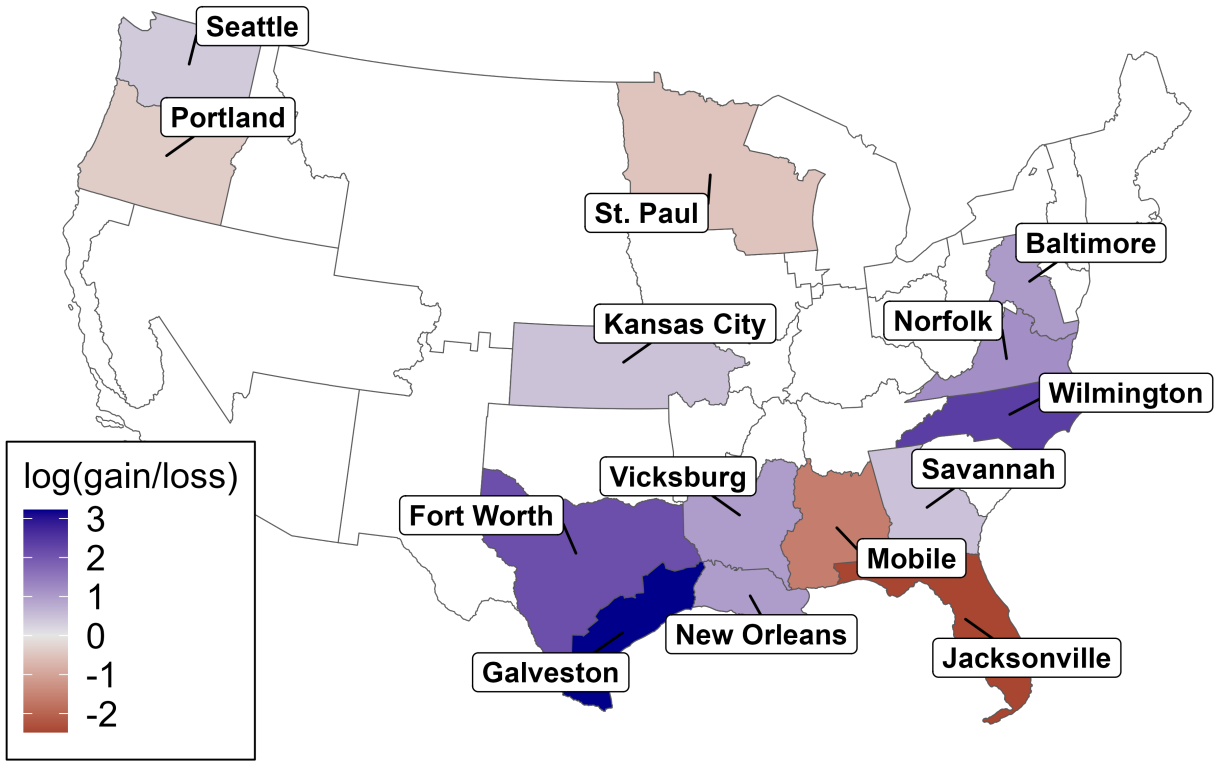
Policy implications



Quality gap: The statutory **no net loss** goal is not met – unless furhter offset by qualitative improvements.

The net loss estimates are conservative!

Policy implications

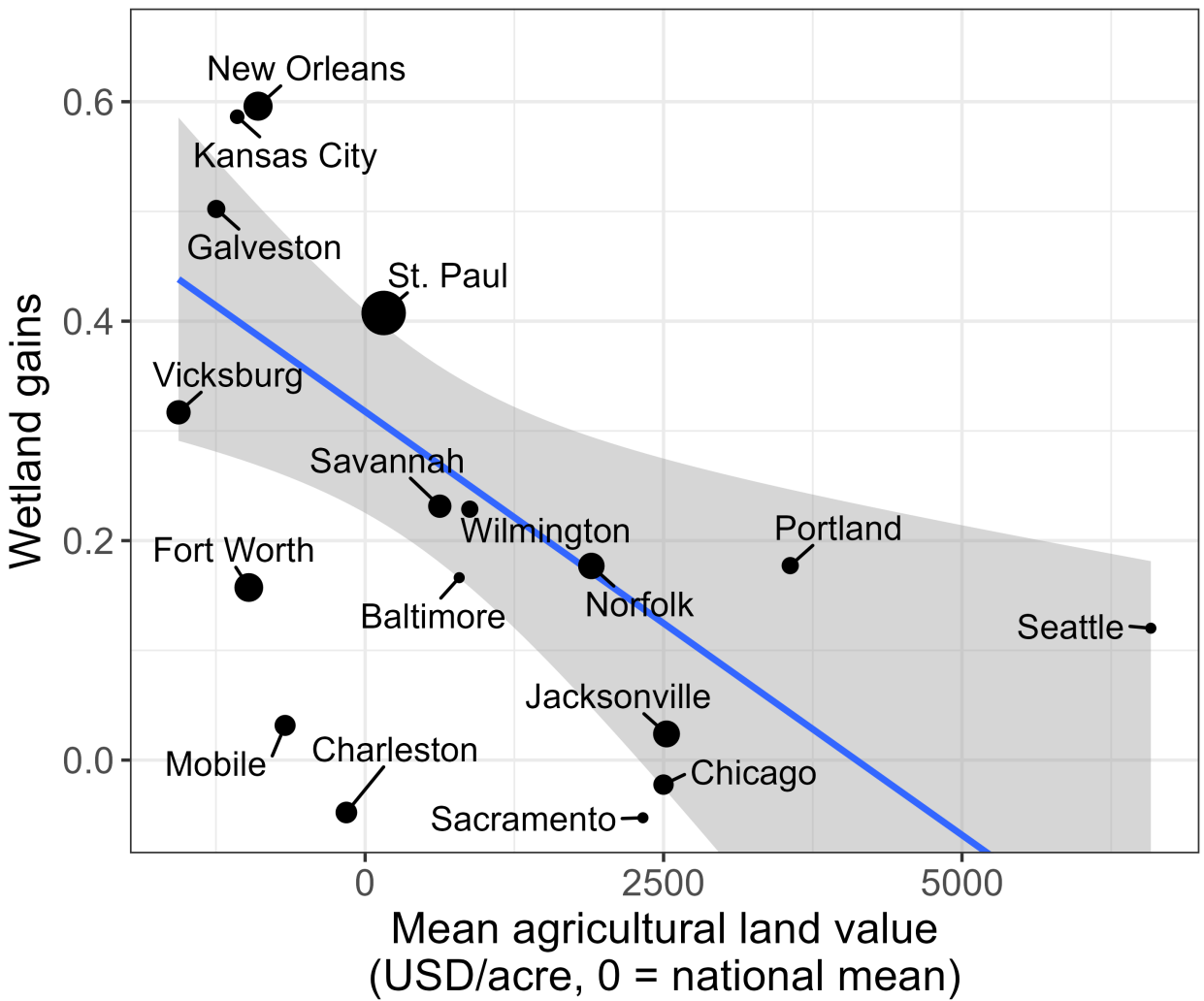


Aggregate net losses driven by four regions.

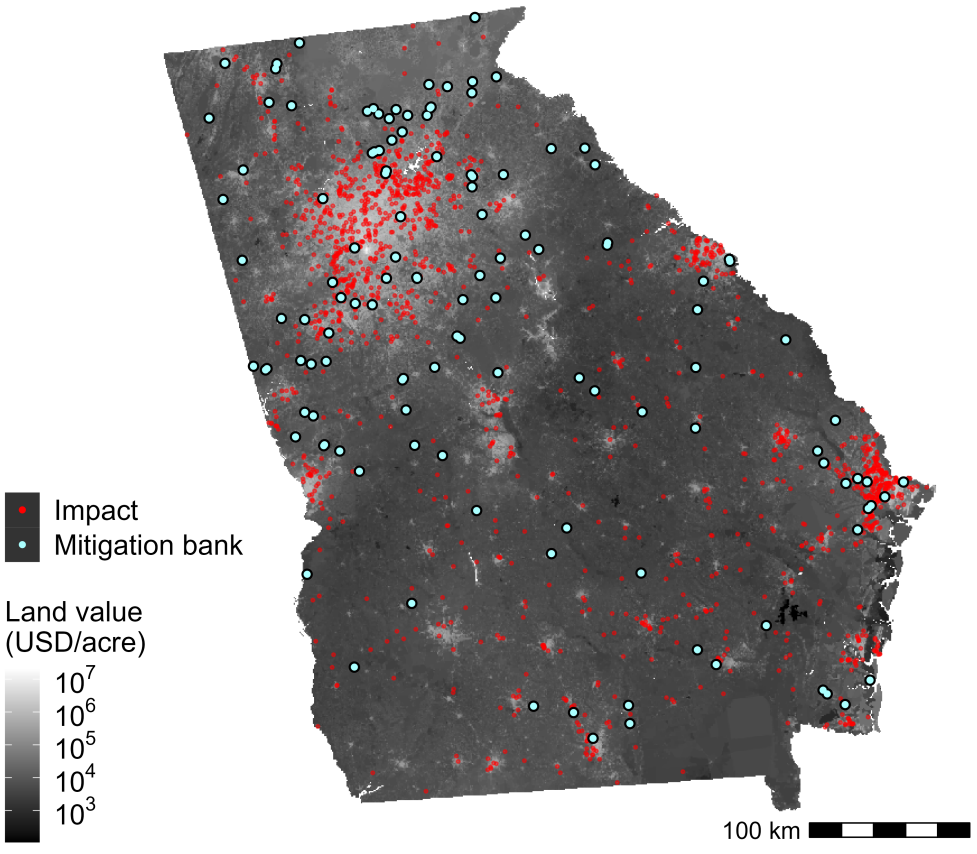
What about welfare?

Welfare

If the benefits from wetland restoration were uniform across regions, this depicted correlation would be unproblematic.



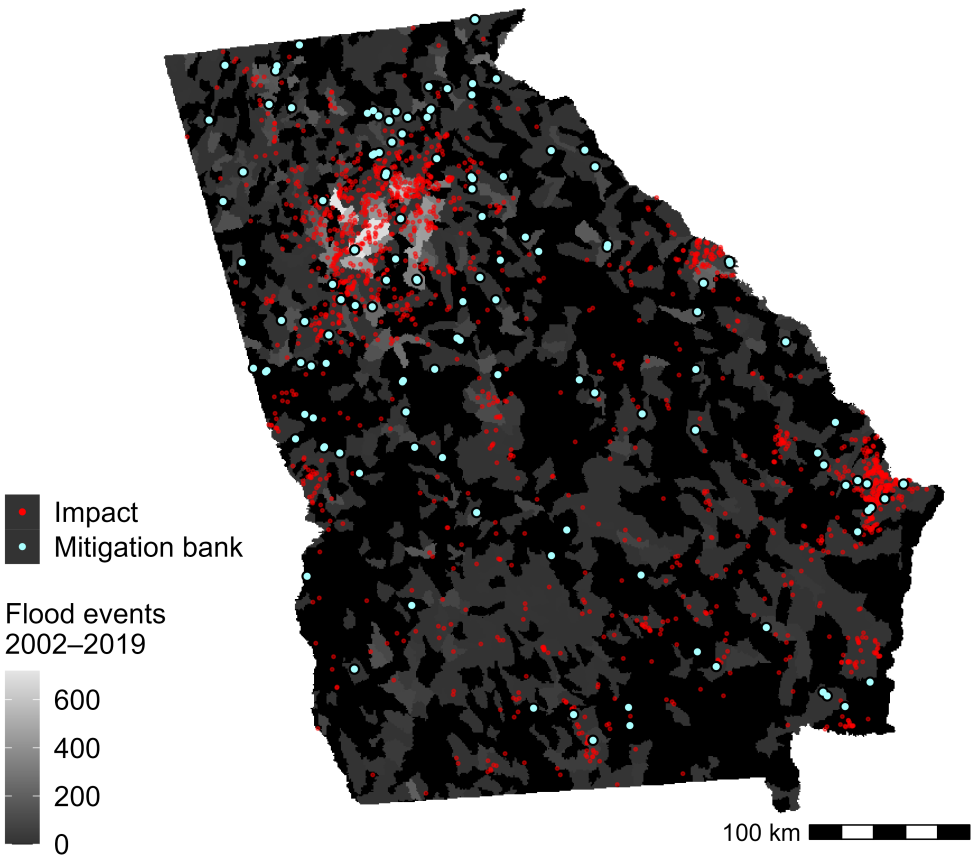
Welfare



The cost savings from relocating wetlands through offset markets are evident.

Data source: Nolte (2020)

Welfare



Data source: US Flood Database, Li et al. (2021)

At the same time, an acre of wetland provides more services close to urban areas than in rural areas.

Does the pricing of wetland restoration benefits in the offset market reflect this positive correlation between the benefit and the opportunity cost?