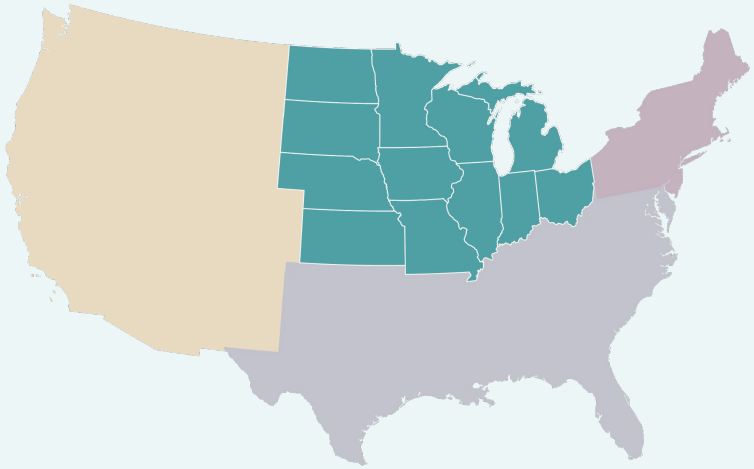
GIBBS LAND USE & ENVIRONMENT LAB
GLUE

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON
Nelson Institute For Environmental Studies
Department of Geography
COLLEGE OF LETTERS & SCIENCE

Spatial Data Science for **Land Conservation** in the **United States**



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Advised by **Holly Gibbs**

November 2025

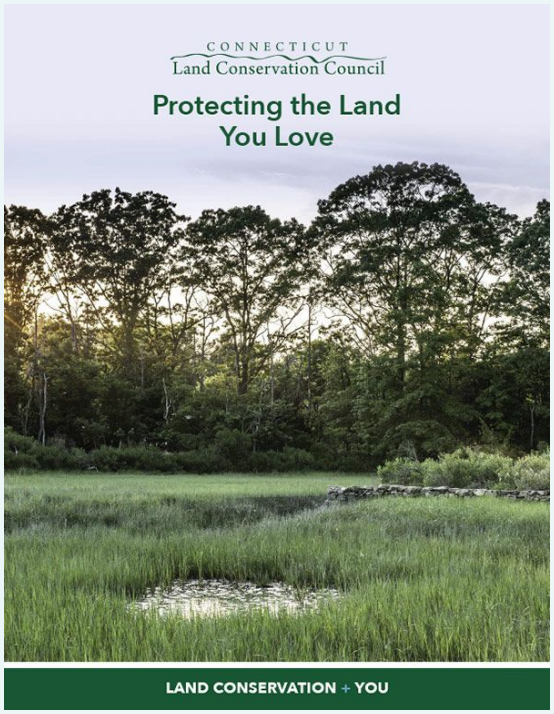
Outline

1. Research Context
2. Chapter 1: **Data** Creation
3. Chapter 2: Midwest **Land Conservation**
4. **Future** Plans!

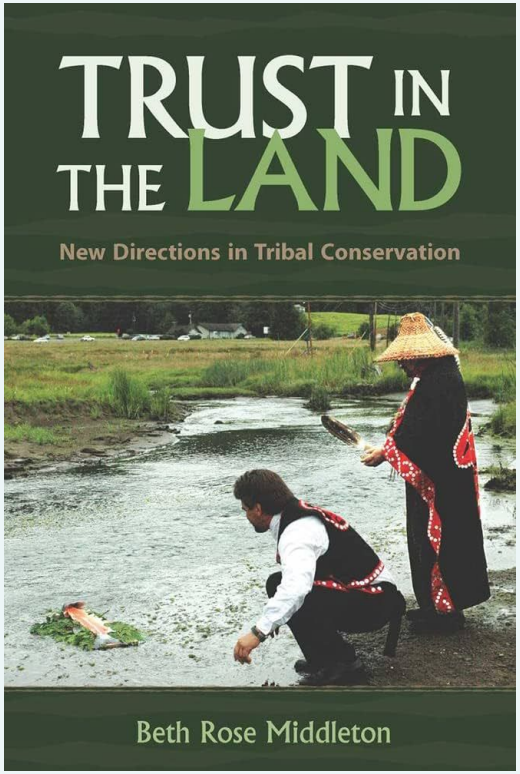
Thesis text word cloud

Students!

- **Raines:**
  - Grassland conversion at the property level
- **Sam:**
  - Mapping US organic farms
- **Lucas:**
  - Mapping US Farm payments

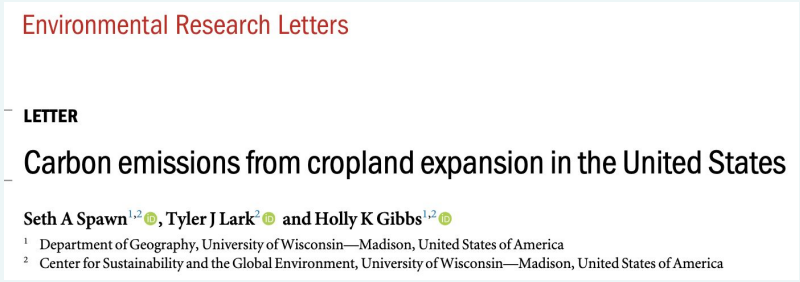

CONNECTICUT
Land Conservation Council
Protecting the Land
You Love
LAND CONSERVATION + YOU


LAND CONSERVATION
IS CLIMATE ACTION
NATURE KNOWS BEST
when we work for nature, nature works for us.
LET THE
TREES GROW
Trees are carbon-absorbing superheroes, and Wisconsin has billions of them. Healthy, well-managed forests can support the forest products industry and store carbon better than any technology.
CONNECT
WILDLIFE CORRIDORS
Too many vital wildlife habitats are isolated from one another, islands of conservation. Land trusts protect habitat corridors that support wildlife migrations and allow plant and animal populations to shift as the climate changes.
FARM FOR TOMORROW
Regenerative agriculture restores the land and provides food for the dinner table. Wisconsin has more than 15 million acres of farmland. Rotational grazing, cover crops, and less frequent tilling all help to make farming a climate solution.
CARE FOR WETLANDS
Wetlands protect our communities from floods. And they act as a filter and a sponge, cleaning water as it passes through and soaking up pollution. Land trusts work to protect intact wetlands and restore those that have been harmed.
KEEP IT WILD
Our wild places can be a powerful defense against the effects of climate change. Undisturbed land absorbs more carbon from the atmosphere, supports a wider array of plants and wildlife, and offers natural protection from threats like flooding, erosion, and pollution.
RESTORE GRASSLANDS
98% of our native prairies have been lost. Lands trusts work to protect what's left and to restore grasslands where we can. The deep roots of prairie grasses store tremendous amounts of carbon and support impressive populations of wildlife.
GATHERINGWATERS.ORG
gathering waters
wisconsin's alliance for land trusts
@GATHERINGWATERS


TRUST IN
THE LAND
New Directions in Tribal Conservation
Beth Rose Middleton

Land Conservation

- **Habitat loss** threatens **biodiversity** and ecosystem **function**
- Natural areas provide clean water, carbon storage, and pollination
- **Conversion** continues: 1M+ acres/year of grassland lost in the Great Plains
- Most remaining natural areas exist as **fragmented** patches across **working** landscapes



Environmental Research Letters

LETTER

Carbon emissions from cropland expansion in the United States

Seth A Spawn[1,2], Tyler J Lark[2] and Holly K Gibbs[1,2]

[1] Department of Geography, University of Wisconsin—Madison, United States of America
[2] Center for Sustainability and the Global Environment, University of Wisconsin—Madison, United States of America

ELSEVIER

Land Use Policy

Volume 97, September 2020, 104727

Protecting our prairies: Research and policy actions for conserving America's grasslands

Tyler J. Lark [a b]

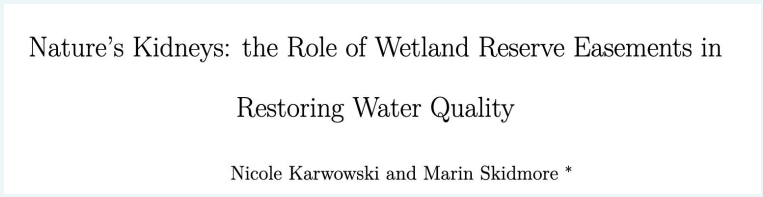
RESEARCH ARTICLE | SUSTAINABILITY SCIENCE

Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s

H. K. Gibbs, A. S. Ruesch, F. Achard, +3, and J. A. Foley Authors Info & Affiliations

Edited by B. L. Turner, Arizona State University, Tempe, AZ, and approved July 30, 2010 (received for review September 22, 2009)

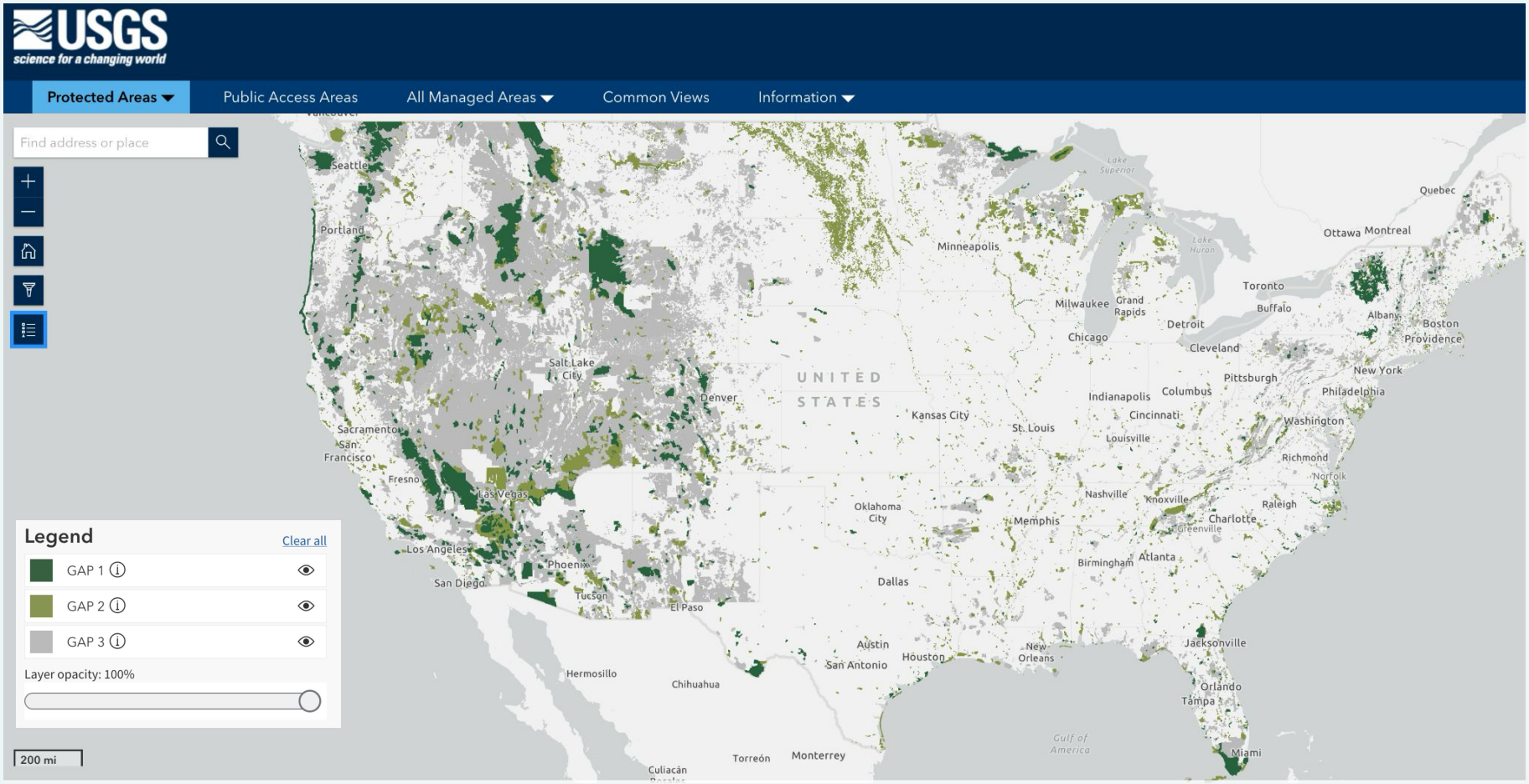
August 31, 2010 | 107 (38) 16732-16737 | https://doi.org/10.1073/pnas.0910275107



Nature's Kidneys: the Role of Wetland Reserve Easements in Restoring Water Quality

Nicole Karwowski and Marin Skidmore *

Protected Areas in the United States



USGS Protected Area Database 4.0

Private Land Dominance

- **~60%** of US land (1.4 billion acres) is **privately** owned
- Private landowners manage:
  - 90% of U.S. cropland
  - 70% of forest-use land
  - 66% of grassland/pasture

Guerin, 2015; Driftless Area

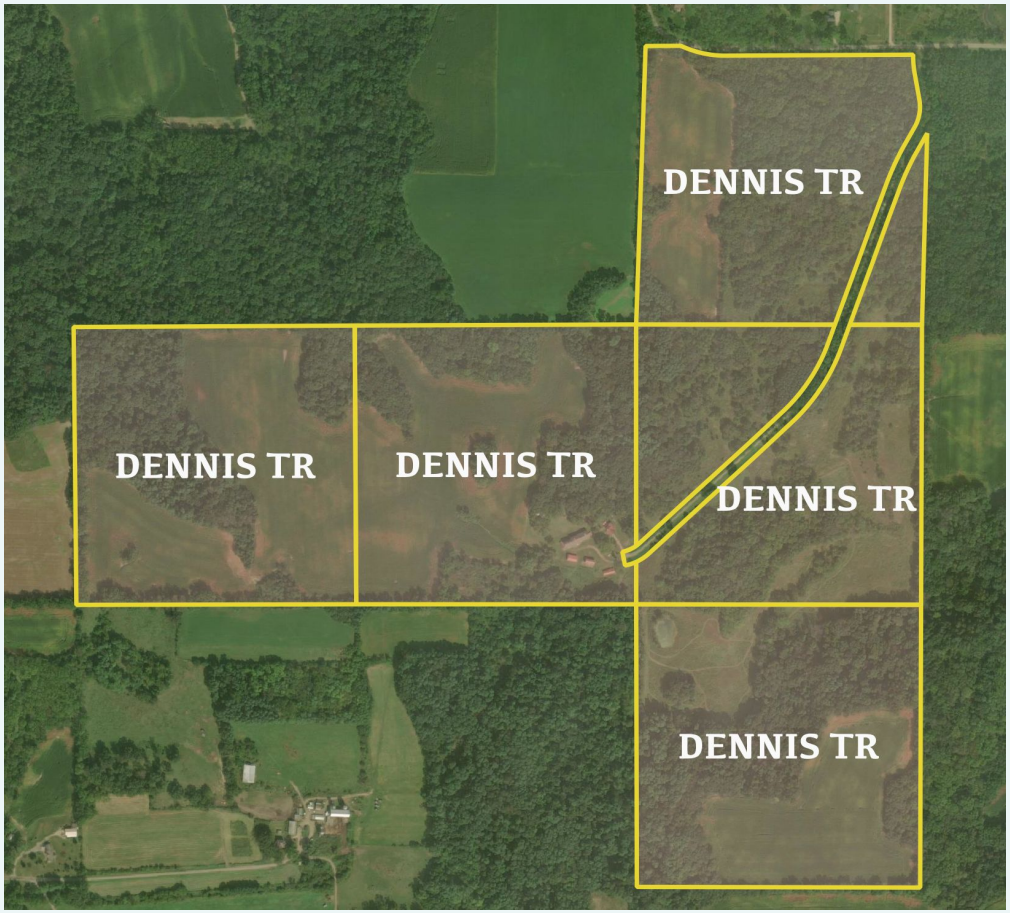
Land Conservation: **trade-offs**

- **System bias**: Policy and markets **favor production** over habitat.
- Core **trade-off**: Food and income vs. biodiversity and ecosystem health.

Source: KSJB AM 2022

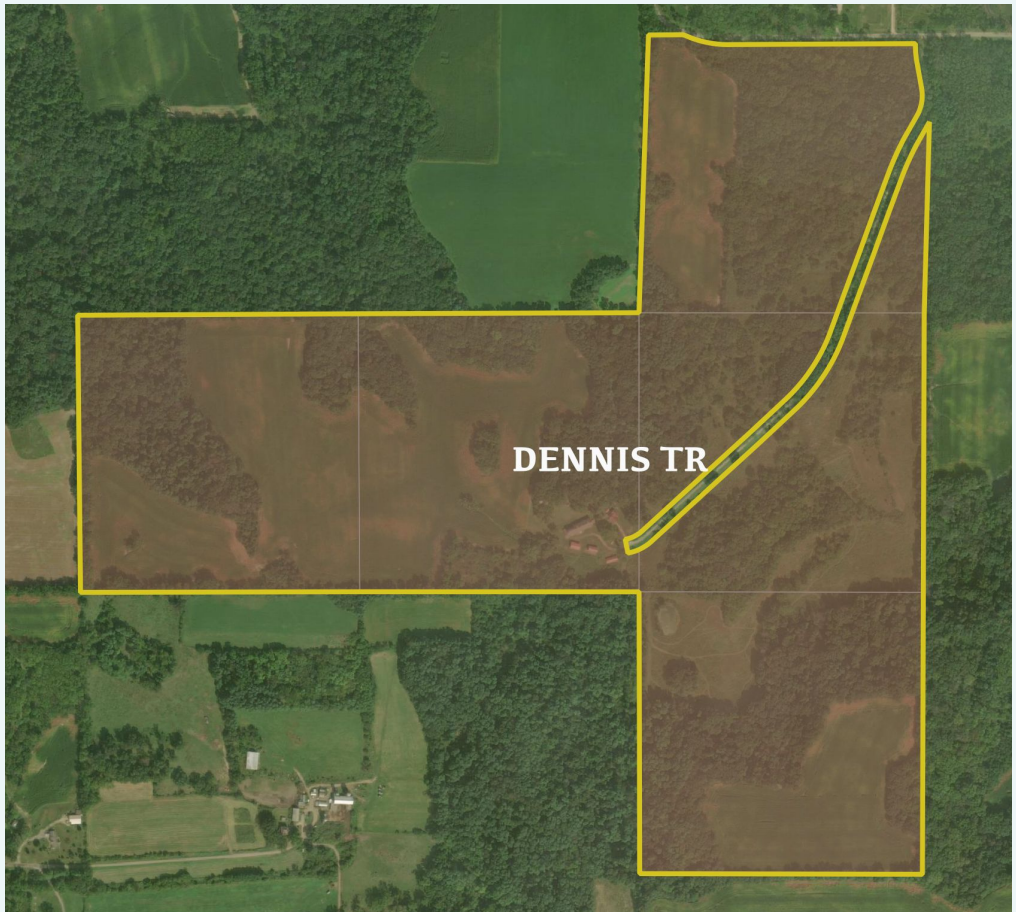
Parcels are **individual** records of land **ownership**

Five Parcels,
All owned
by the
Dennis Trust



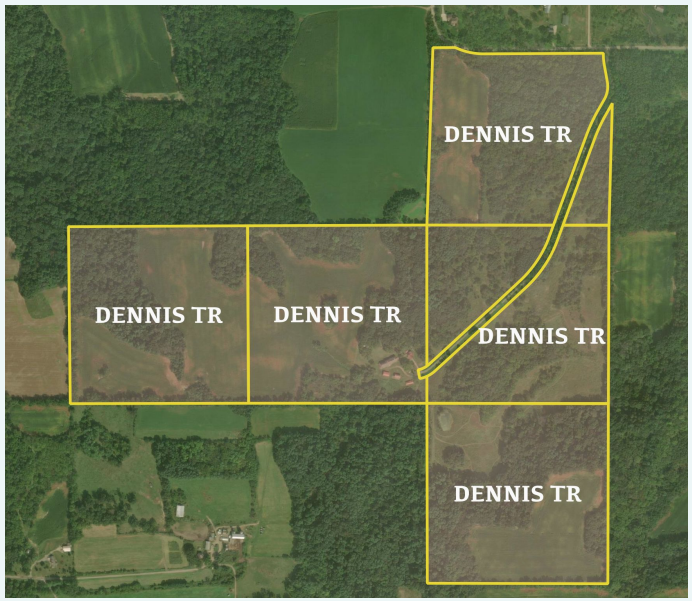
Together, all parcels owned by the same landowner become a **Property**

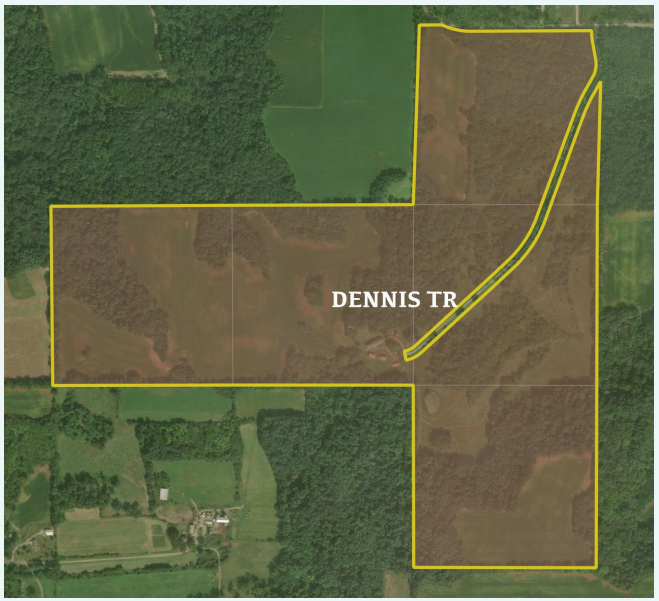
Five Parcels,
One Property
Owned
by the
Dennis Trust



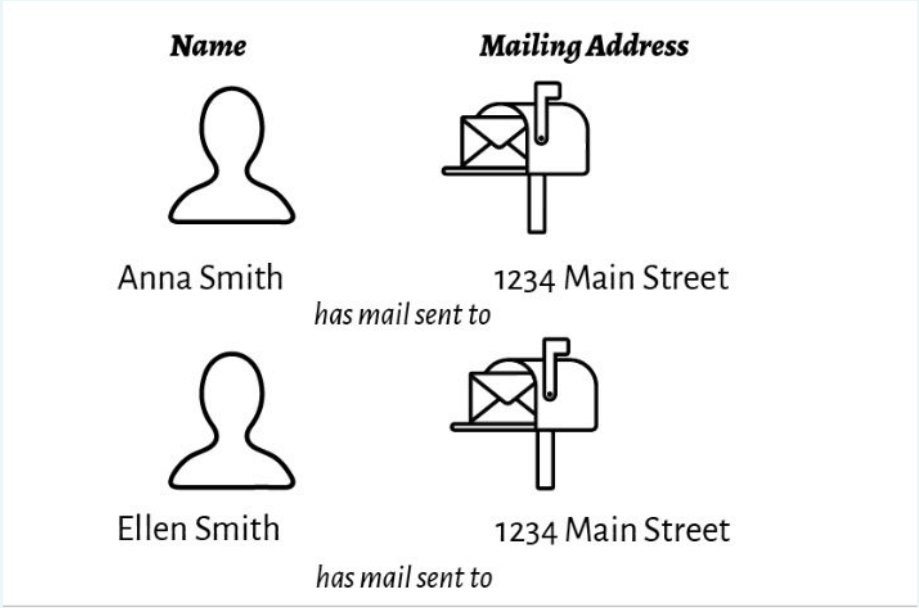
Chapter 1: From parcels to properties
Matching attributes and boundaries of tax records across the United States

In Review at
Nature
Scientific Data!!!!

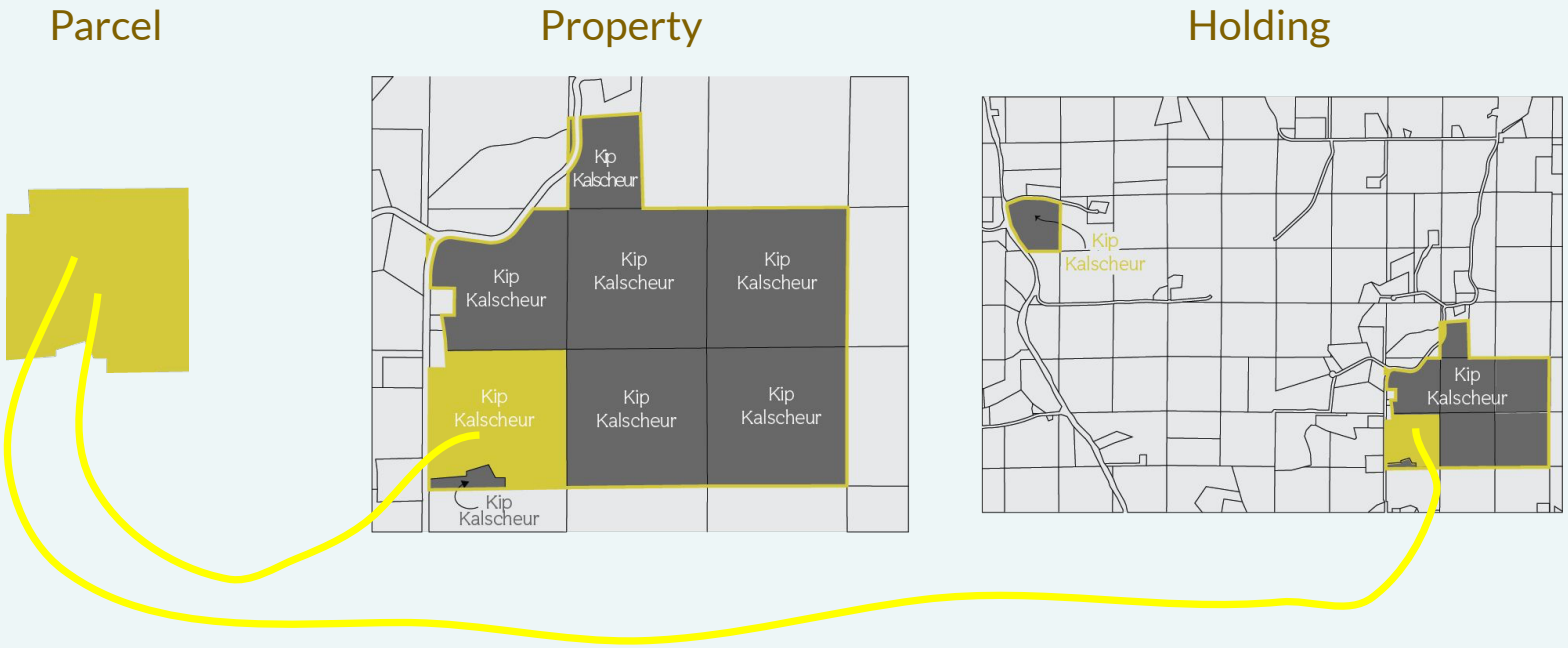




Using owner **name** and **mailing address** To create **entities**



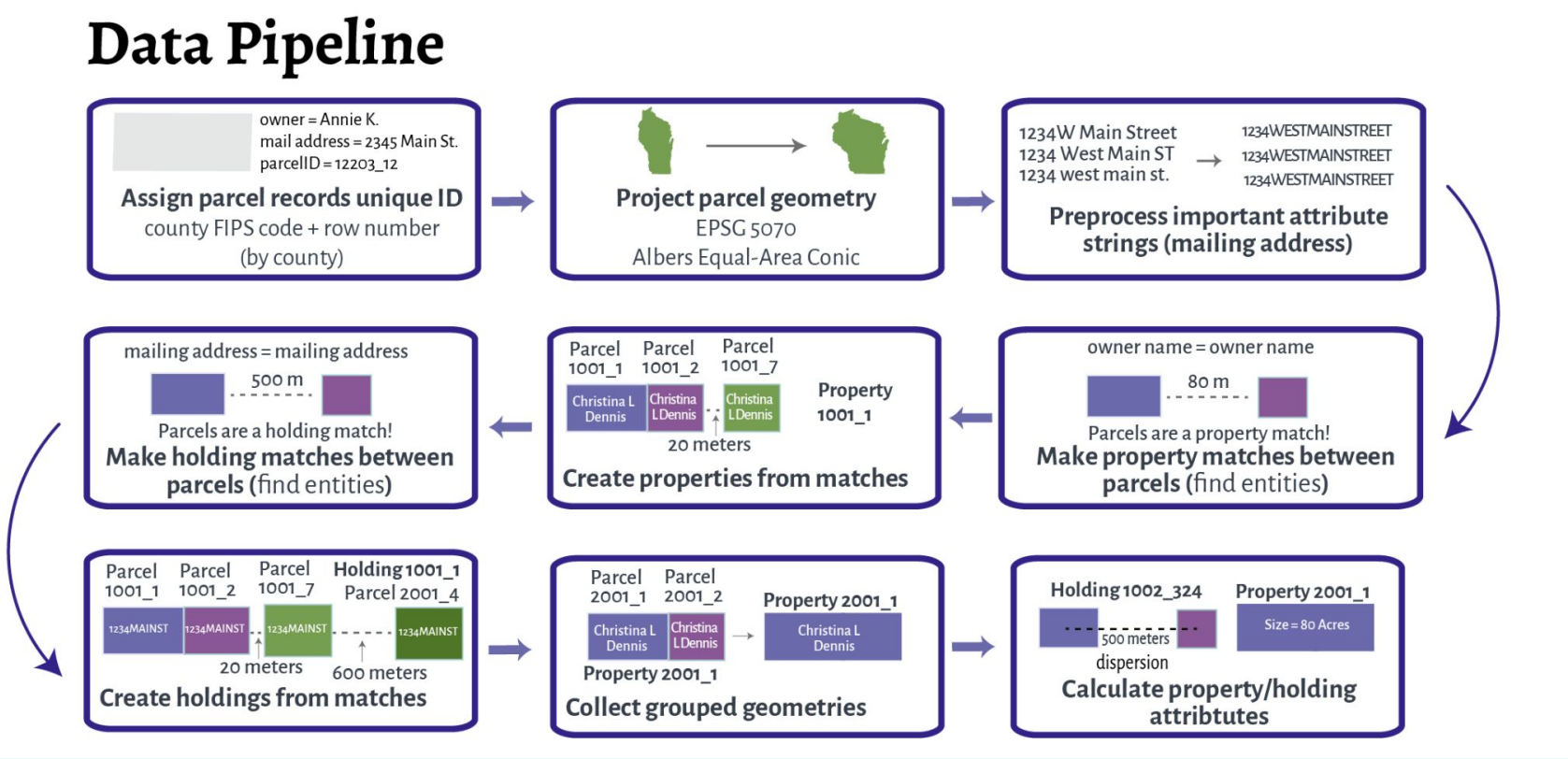
Parcels & **Properties** & **Holdings** (locations may be different)



Parcels to Properties Pipeline

Parcel Source – **Regrid.com**

- **150 million+** parcels in the US
- Entity Matching ← Data science



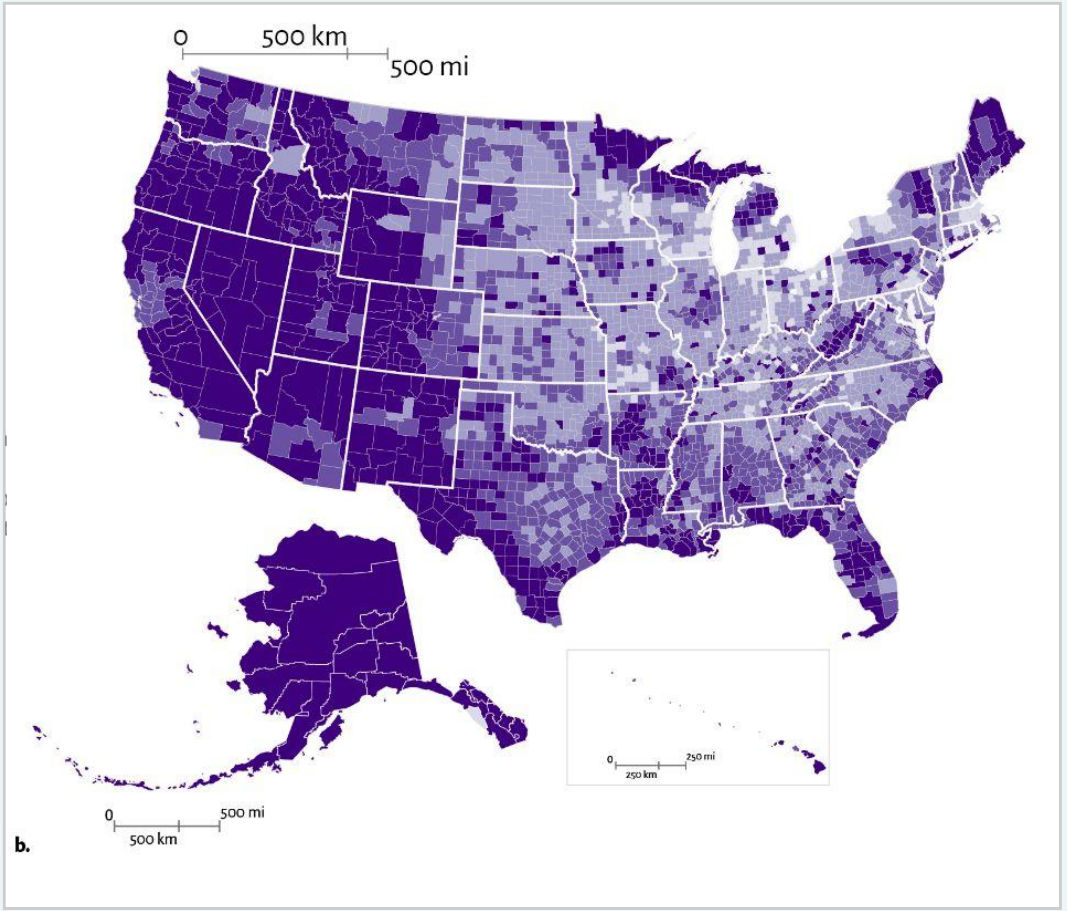
Results from paper summaries of #s

(a.)

Region	#of Parcels	#of Properties	Avg Area	Median Area	Avg (AW) Localness	Avg (AW) Urban	% Land Local > 0.5	% Land Local > 0.0
W	1	24,129,731	12.37	0.2	0.1	0.04	9.86	9.86
W	2-5	1,899,201	70.59	1.43	0.25	0.02	25.34	29.18
W	6+	185,256	3895.29	23.03	0.09	0	6.78	31.3
MW	1	23,538,654	6.11	0.29	0.41	0.09	40.95	40.95
MW	2-5	3,767,539	49.66	2.87	0.46	0.02	46.55	49.38
MW	6+	381,372	418.15	123.31	0.38	0.03	38.36	49.46
S	1	42,846,733	4.56	0.32	0.36	0.14	36.34	36.34
S	2-5	5,411,213	35.25	2.6	0.4	0.05	39.52	42.16
S	6+	435,833	488.53	20.03	0.2	0.04	19.62	28.61
NE	1	18,615,164	3.34	0.27	0.44	0.23	43.88	43.88
NE	2-5	1,579,050	22.4	1.13	0.44	0.09	43.68	47.8
NE	6+	97,859	305.62	11.72	0.21	0.1	20.56	36.88

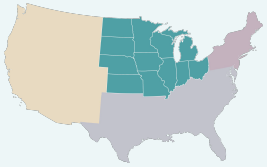
Example: Are property owners **local** or **absentee**?

- **Light** Purple = Most Property owners are LOCAL
- **Dark** Purple = Most Property owners are ABSENTEE



Why such **rectangle?**

Private property rights are strong with this one



John Locke 1632-1704, UK

The right to **land** and resources gained through one's labor — were a **natural right** of all men.

Thomas Jefferson 1743-1826, VA

<u>Public Land Survey System</u>

- Document land taken
- Sell land & **raise money** for war debt
- Collect taxes $$$$$

Land Surveyor

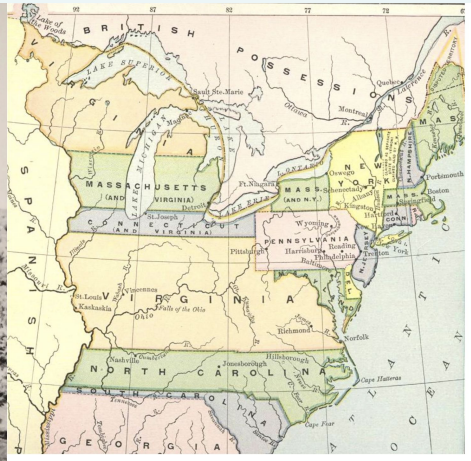
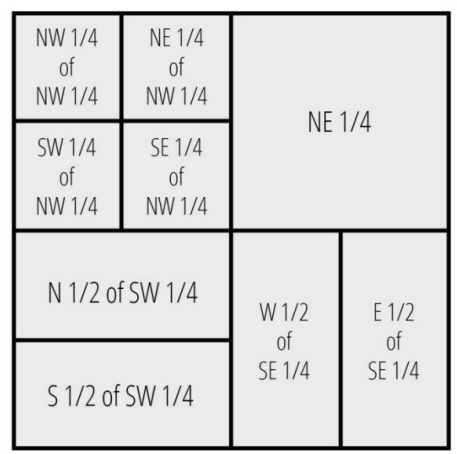


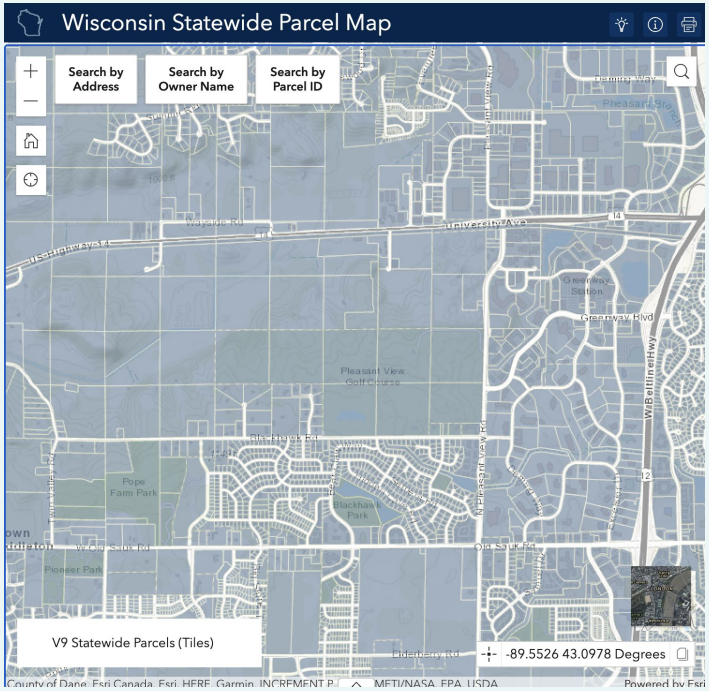
Figure 1: Land holdings of colonies in 1781. (*VirginiaPlaces.org*)

PLSS Grid —> Parcel Data



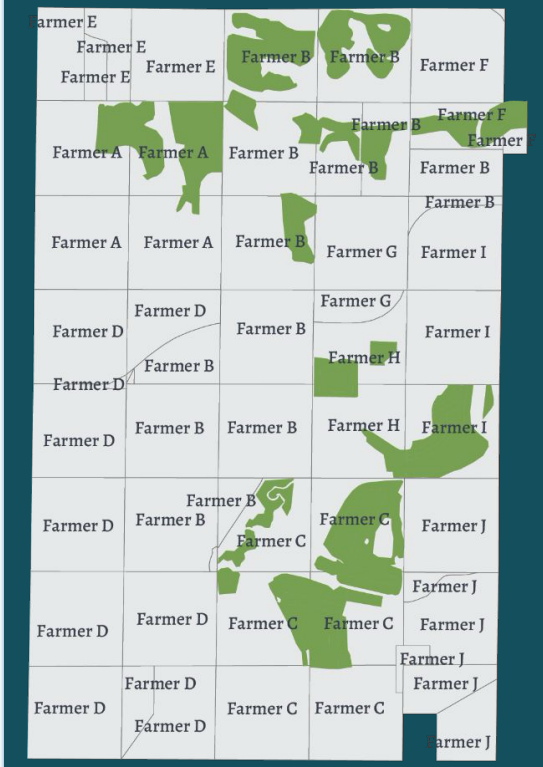
Public Land Survey System grid layout

1800's surveyor map



Present-day parcel data (Wisconsin, State cartographer's office)

From individual parcels:



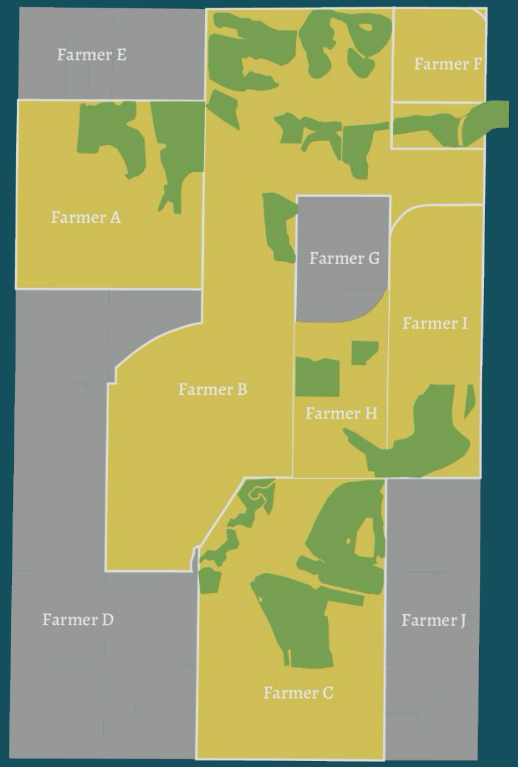
Conserved Land

Property with CRP

Property without CRP

Original Parcels

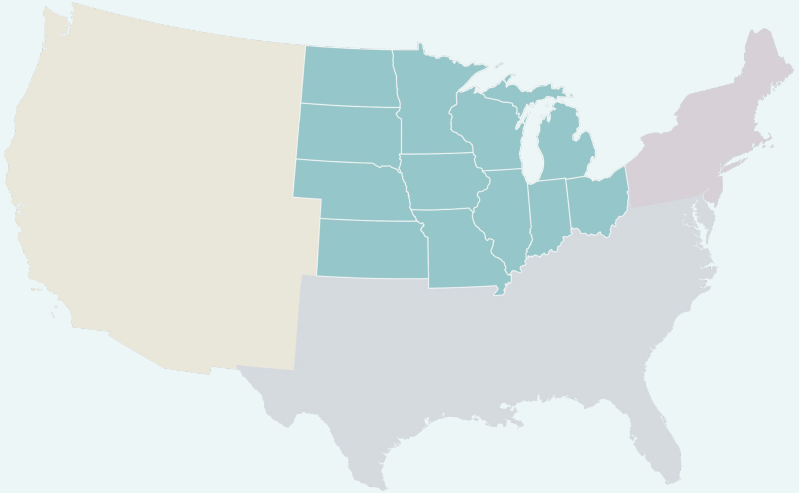
To cohesive properties:



Chapter 2: Property-Level Conservation

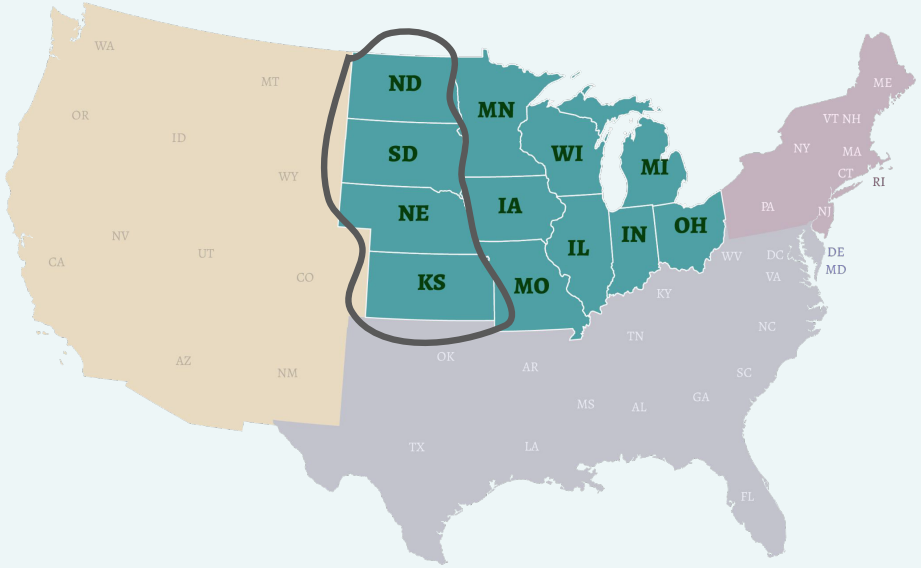
Natural Land Protection on Private Lands in the Rural Midwest

- What property traits are associated with the presence and extent of conserved natural land on rural private properties in the Midwest?



Why the **Midwest**?

- **Diverse** agroecological systems:
  - Northern Plains: 51% cropland, 41% pasture



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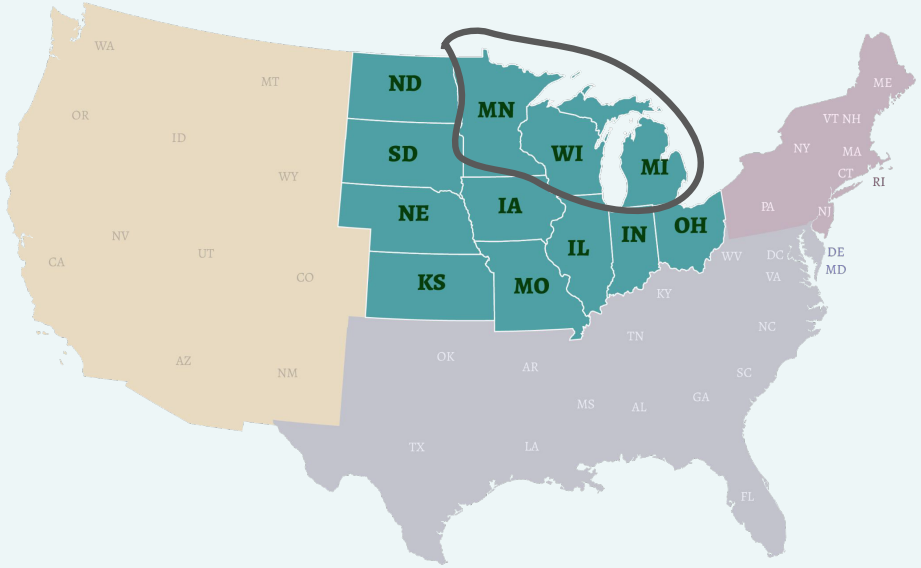
  - Lake States: 42% forest-use land



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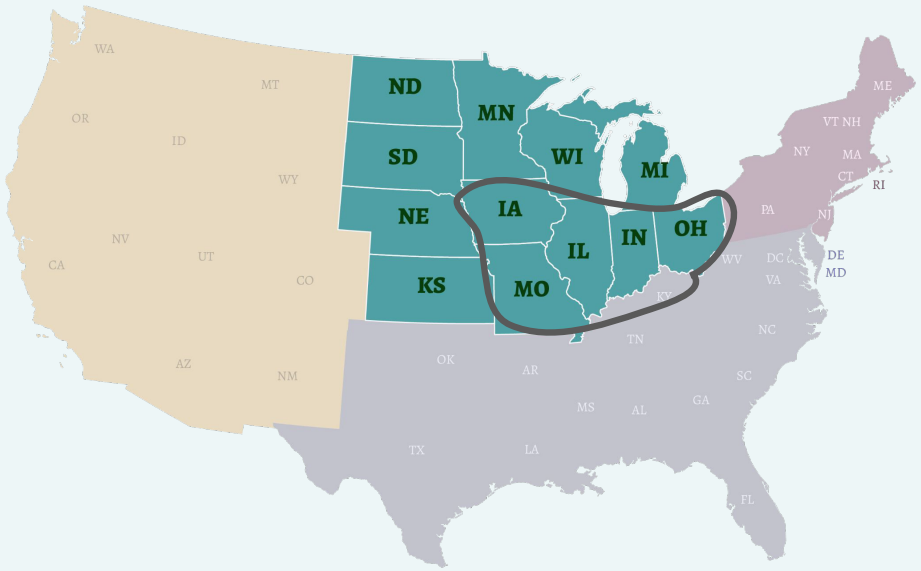
  - Corn Belt: 54% cropland



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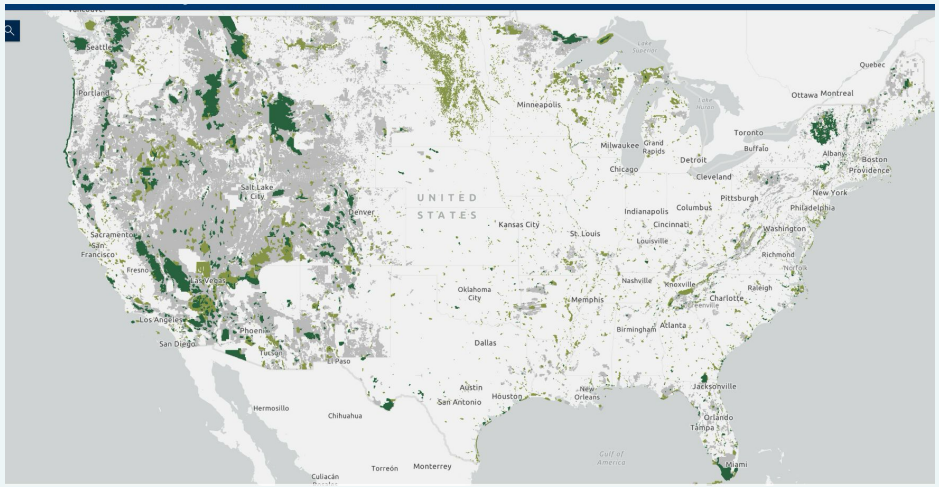


- Overwhelmingly **privately** owned (<5% federal lands)
- Ideal setting to examine conservation across **ownership** types and **land uses**

Conservation Pathway # 1: **Formal**

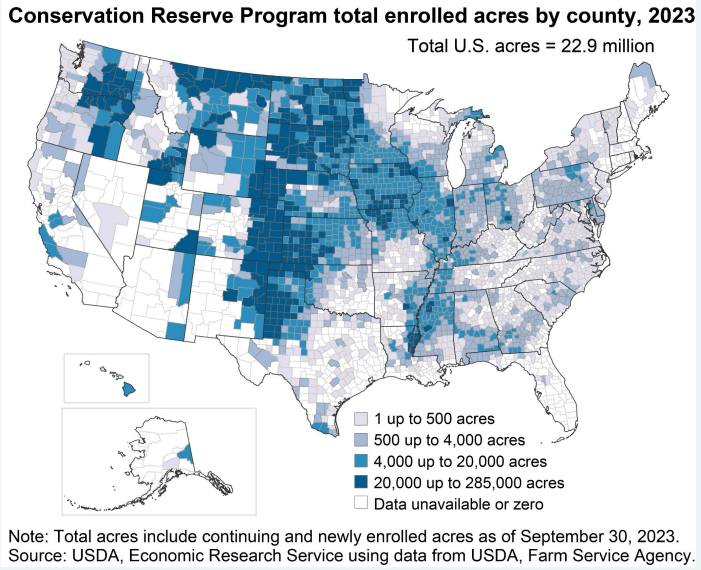
- Formally **enrolled** land
  - **Voluntary** programs
    - balancing private property **rights** & **conservation** goals

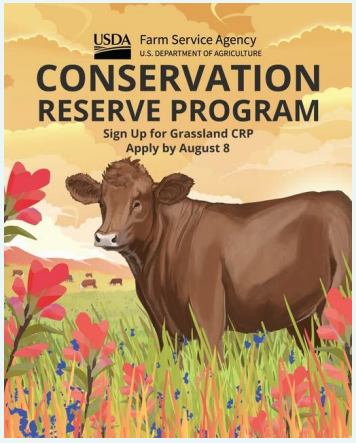
Conservation Pathway # 1: **Formal**

- Formally **enrolled** land

The Conservation Reserve Program: USDA Working Lands Conservation

- Formally **enrolled** land
  - Conservation Reserve Program **(CRP)**
    - Working lands program
    - **Convert** sensitive land **out** of **cropland** and into **vegetative** cover
    - 10-15 year **contracts**
      - Annual rental **payments**



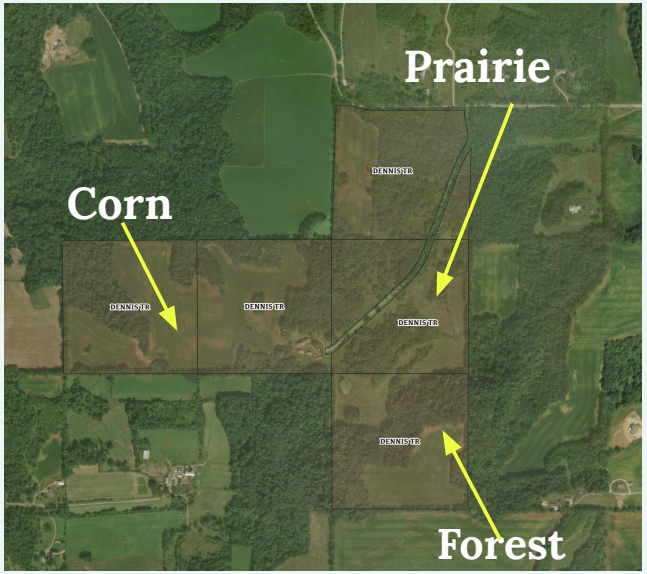


Conservation Easements

- Formally **enrolled** land
  - Conservation **Easements**
    - Permanent legal restrictions
    - One-time compensation or tax benefits
    - Landowners work with groups like the Nature Conservancy, NRCS

Conservation Pathway #2: **Informal**

- Informal (conserved?) natural land cover
  - **Stewardship** decisions, intentional or incidental
  - Remnant vegetation, field edges, shelterbelts, riparian buffers, grasslands, grazing land, wetlands, woodlots
  - Also referred to as:
    - Semi-natural
    - Land-sparing
    - Marginal
    - Unused
    - Non-crop



Research **Gap**

- Existing research focuses on **individual** programs or small **case** studies
- Unit of analysis:
  - **Isolated** parcel data **obscures** decision making
  - **Census** tracts, **county** level are coarse
  - **Pixel** data lacks socioeconomic context
- With property data >> **full portfolio** of cultivated land, formally conserved, informally conserved

Sample: Rural, Private Midwest

- First regional analysis integrating formal + informal conservation
  - Excludes urban areas
  - Excludes Gap 1-3 Protected Areas besides conservation easements

- 7.5 million **rural private** properties
  - 414 million acres in the **Midwest**

Data Sources

- Outcome Unit: **Property boundaries** I created from Regrid parcel data (2024)
- **CRP** enrollment **polygons**: USDA FSA (2023) *via Tyler Lark!
- Conservation **easements polygons**: USGS PAD-US 4.0
- Land **cover**: USDA Cropland Data Layer (10m resolution)

- **Informal** natural land = natural land not in a formally enrolled program (spatially explicit subtraction)

What is **correlated** with **Informal Natural Land? Economic, Biophysical, Geographic, Ownership** predictors

- 17 property **characteristics**

1. **Economic**: Trade-offs, incentives, pressures
2. **Land** Characteristics: Biophysical constraints
3. **Geography**: Landscape context
4. **Ownership**: Structure

Variables (1/4): **Economics**

Variable	**Description**
Land Value	Estimated fair market **value** of the land
Subsidies	Does the property receive any disaster relief or commodity **subsidies** from the FSA?
CRP Rental Rate	Maximum **rate** receive if property has CRP otherwise county average
Formal Conservation	Is there any **formally** conserved land on the property (CRP or CEs)
Organic Farm	Is there an **organic** farm on the property

Variables (2/4): **Land**

Variable	**Description**
Corn/Soy Share	Amount of property that is **corn** or **soy**
Crop Diversity	The number of **distinct crops (not just row crops)** cultivated within the property
Mean Slope	The mean **slope** of the property
Irrigated Share	Amount of property that is **irrigated**
Soil Productivity (NCCPI)	Inherent capacity of soils to produce dryland commodity crops



Variables (3/4): **Geographic**

Variable	**Description**
Distance to closest formal practice	Distance from property centroid to closest formal conservation practice centroid not on the same property.
Distance to closest urban area or place	Distance to closest census-designated urban area/place.

Variables (4/4): **Ownership**

Variable	**Description**
Property Size	**Size** of the property
Holding Dispersion	**Longest distance** between vertices of all parcels within holding property belongs to
Localness (0=absentee, 1 = local)	Average **localness** of the owner mailing addresses within the property (weighted by parcel area)
Owner is an Organization	Likely owner **type** is an **organization** (LLC, Inc, Farm)

Methods: Summaries & Regressions

- Normalized differences (compare properties)
- **Presence** models (binary logit)
- **Extent** models (OLS, beta regression)
  - For the **Midwest**
  - *Heterogeneity Analyses*:
    - By **State**
    - By **forest**, **grassland**, **wetland**

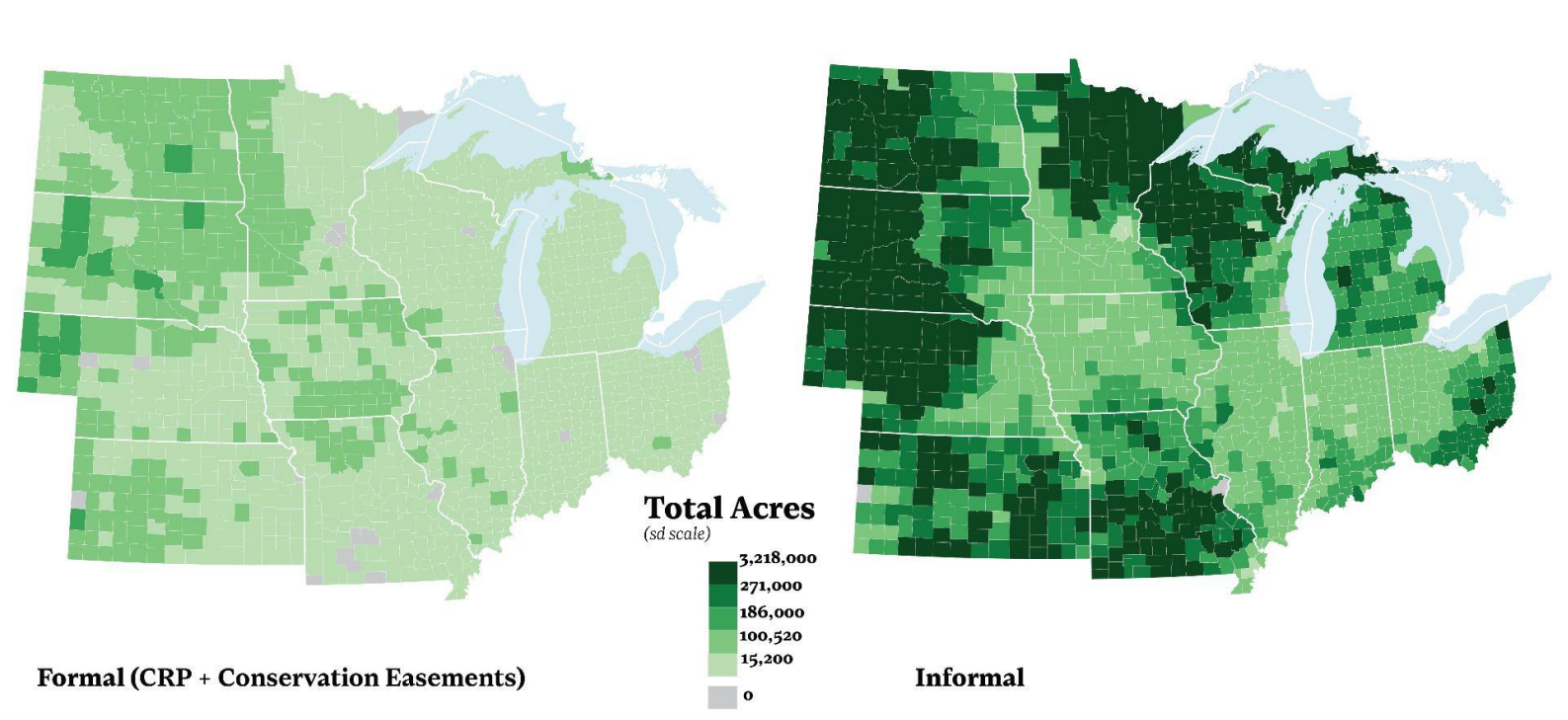
Scale of Informal Natural Land

- **Informal Natural Land:** 195.5M acres (48% of all rural MW)
  - 4.9M properties **contain** at least 1 acre of informal natural land
  - **Grassland**: 113M acres (58% of informal)
  - **Forest**: 59.6M acres (31%)
  - **Wetland**: 19.5M acres (10%)

- **Formal** Conservation: 13.6M acres (3.3%)
  - 4% of properties **enrolled** in formal programs
    - **CRP**: 10.7M acres
    - **Easements**: 3.1M acres

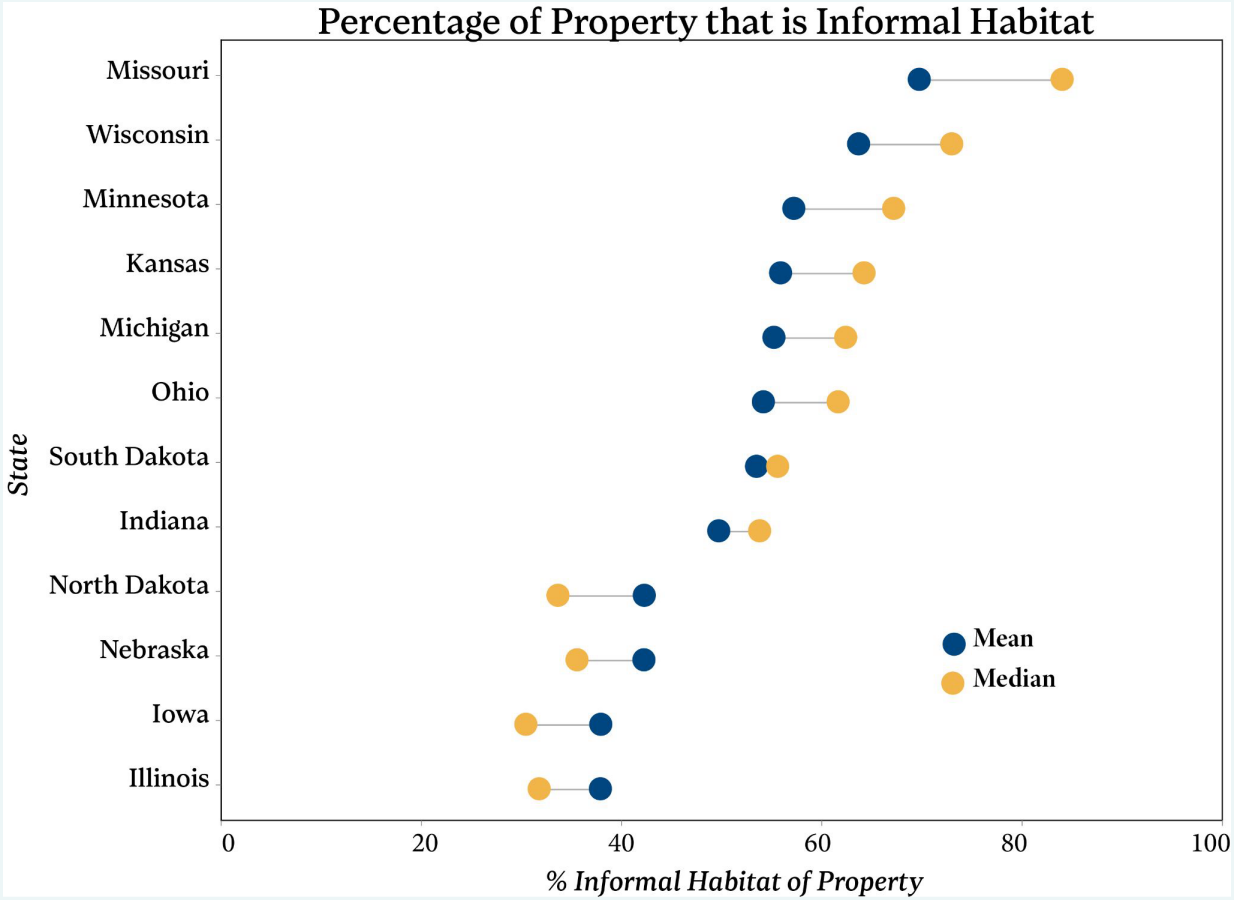
Conservation Land by **Acreage**

- **Informal Natural Land:** 195.5M acres (48% of all rural MW)
- **Formal** Conservation: 13.6M acres (3.3%)



Private Rural MW Properties are on **average** 66% informal natural land

- Variation by State



- I did a lot
- I will **highlight** the results I'm discussing
- Will be focusing in **informal** natural land, not formal (see paper if interested)

Properties **with** and **without** at least **1 acre** of informal natural land

Land Value (ln($/ha))
Crop Diversity (# of crops)
Distance to urban area (km)
CRP rental rate ($/acre/yr)
Has formal conservation
Mean slope
Soil Productivity
Property area (ac)
Subsidies Received ($/prop)
Owner is Organization
Absenteeism
Has organic farm
Irrigated Area (%)
Holding area (ac)
Distance to closest enrolled practice (km)
Holding dispersion (km)
Share of Corn/Soy cover

Comparing **variables** with
Normalized Differences

Positive normalized diff = attribute is **HIGHER** in properties **with** informal natural land

Variable	No Informal Mean (N=2,472,115)	SD	Has Informal Mean (N=4,949,561)	SD	Norm. Diff
Land Value (ln($/ha))	9.950	1.004	9.363	0.886	-0.621**
Crop Diversity (# of crops)	0.465	0.886	1.144	1.764	+0.486**
Distance to urban area (km)	3.627	3.755	4.620	4.202	+0.249**
CRP rental rate ($/acre/yr)	152.895	80.854	134.335	78.430	-0.233**
Has formal conservation	0.013	0.114	0.054	0.226	+0.229**
Mean slope	2.842	2.945	3.521	3.164	+0.222**
Soil Productivity	575.501	191.306	535.195	177.982	-0.218**
Property area (ac)	13.624	46.646	75.695	434.562	+0.201**
Subsidies Received ($/prop)	330.401	5995.340	778.159	7730.782	+0.065*
Owner is Organization	0.056	0.230	0.071	0.257	+0.062*
Absenteeism	0.573	0.494	0.599	0.487	+0.053*
Has organic farm	0.000	0.013	0.001	0.037	+0.044
Irrigated Area (%)	0.026	0.147	0.030	0.144	+0.026
Holding area (ac)	106035.417	1422441.474	88078.723	1290649.195	-0.013
Distance to closest enrolled practice (km)	380.352	421.083	375.206	413.292	-0.012
Holding dispersion (km)	52.942	233.891	53.643	219.210	+0.003
Share of Corn/Soy cover	0.156	0.565	0.155	0.296	-0.001

Normalized diff. $= (\bar{X}_{with} - \bar{X}_{without})/\sqrt{(s^2_{with} + s^2_{without})/2}$.
**|Norm. Diff.| > 0.1; *|Norm. Diff.| > 0.05.

Variables that are **substantially** different (diff > 0.1)

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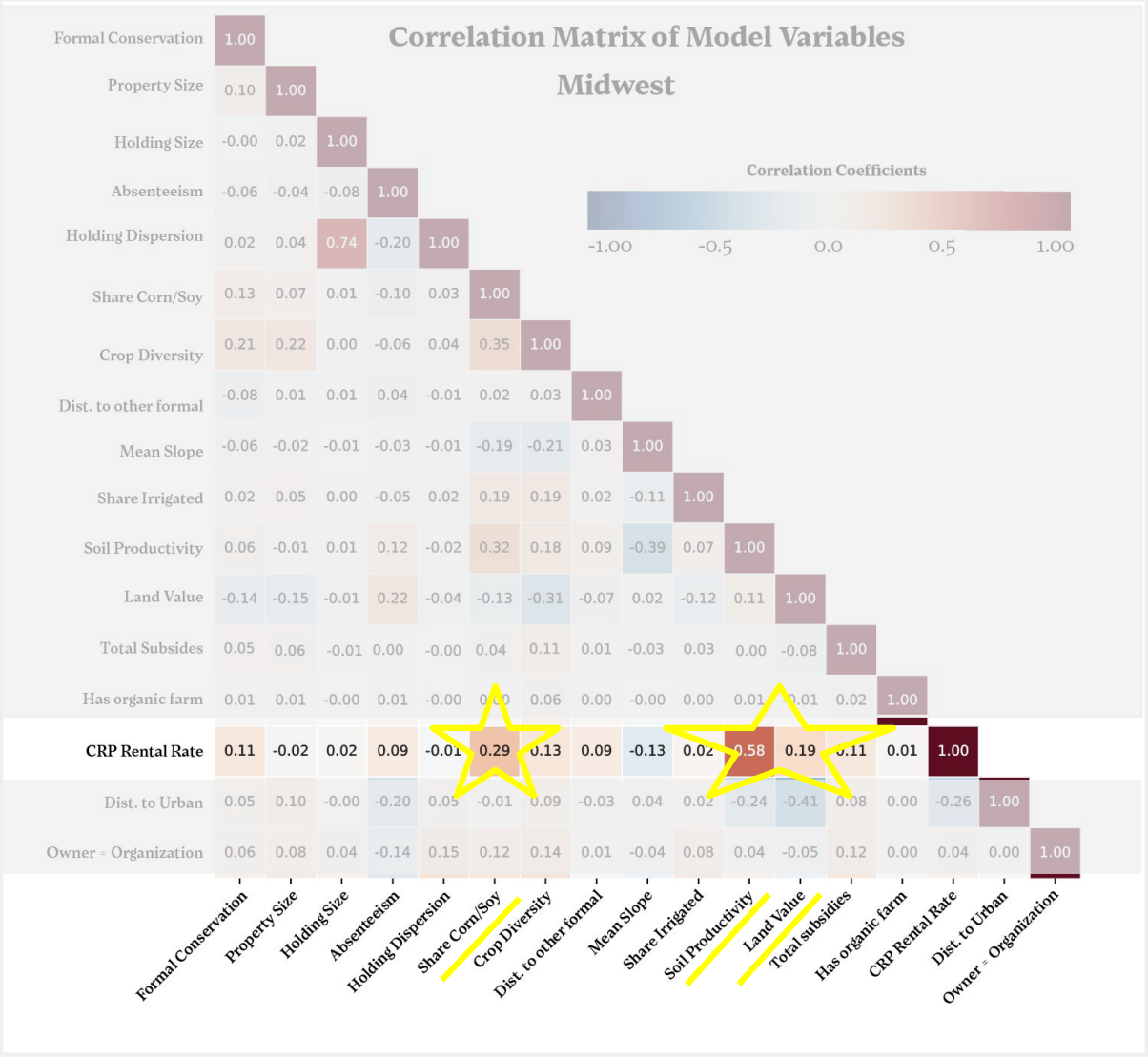
Negative = is *higher* in properties **without** informal natural land


Correlation Matrix of Model Variables
Midwest
Correlation Coefficients
-1.00
-0.5
0.0
0.5
1.00
Formal Conservation
Property Size
Holding Size
Absenteeism
Holding Dispersion
Share Corn/Soy
Crop Diversity
Dist. to other formal
Mean Slope
Share Irrigated
Soil Productivity
Land Value
Total subsidies
Has organic farm
CRP Rental Rate
Dist. to Urban
Owner = Organization

Variables that are **substantially** different (diff > 0.1)

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Positive = is *higher* in properties **with** informal natural land

Methods: Summaries & **Regressions**

- Normalized differences (compare properties)
- Regression: Put those variables in conversation with each other
- **Presence**: Does property have conservation?
- **Extent**: How much land is conserved?
    - **Percentage** of Property

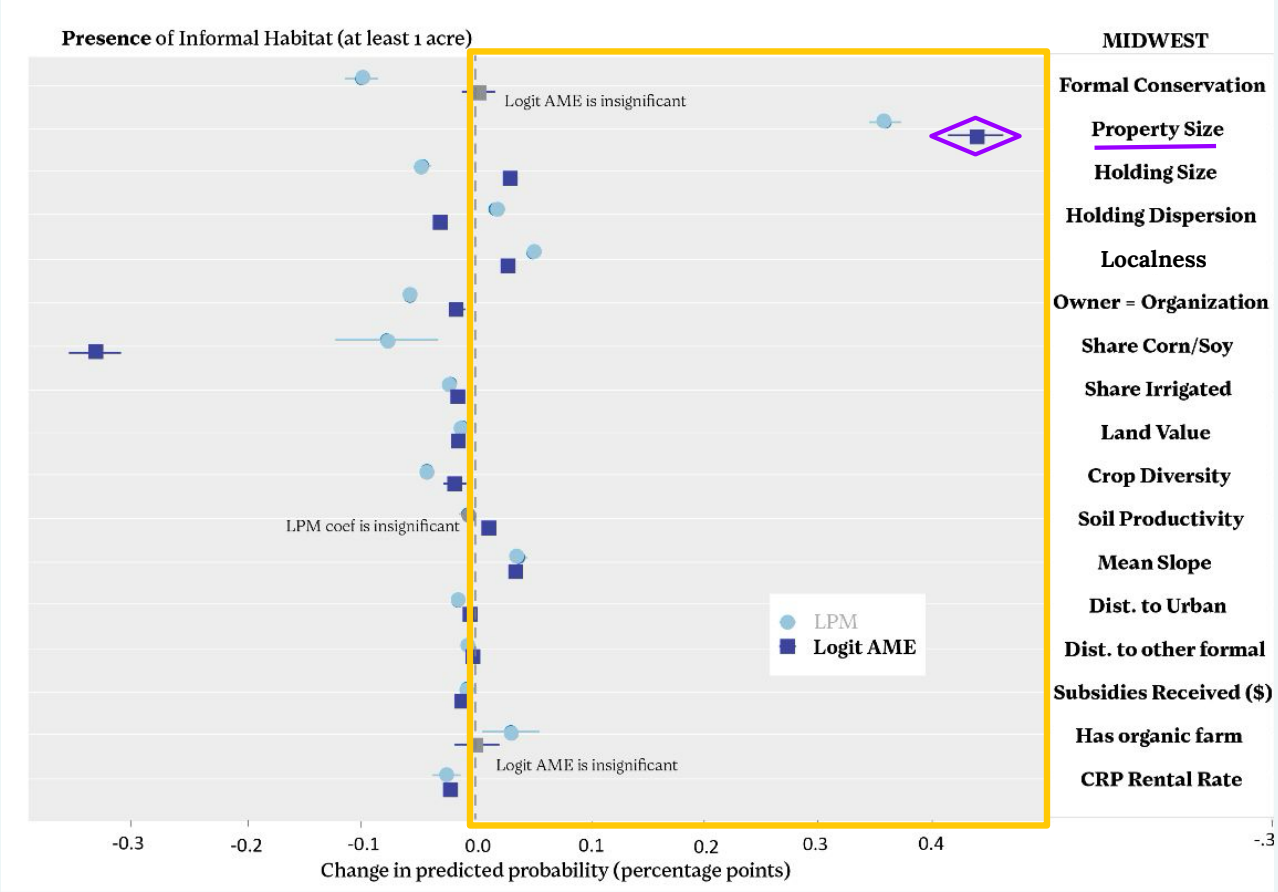
For **regressions**, variables **standardized** for comparability

- Variables have **different units** (acres, dollars, percentages etc)
  - Hard to compare
- Variables were standardized to be comparable
  - **Continuous** ~ mean 0, SD 1
    - Interpret coefficients as **one-SD** change
  - **Binary** stays 0/1
    - Interpret as a **0 to 1 change**

What is **correlated** with the **presence** and **extent** of at least one acre of informal natural land?

Starting with the **Presence** of at least **1 acre** of **informal natural land**

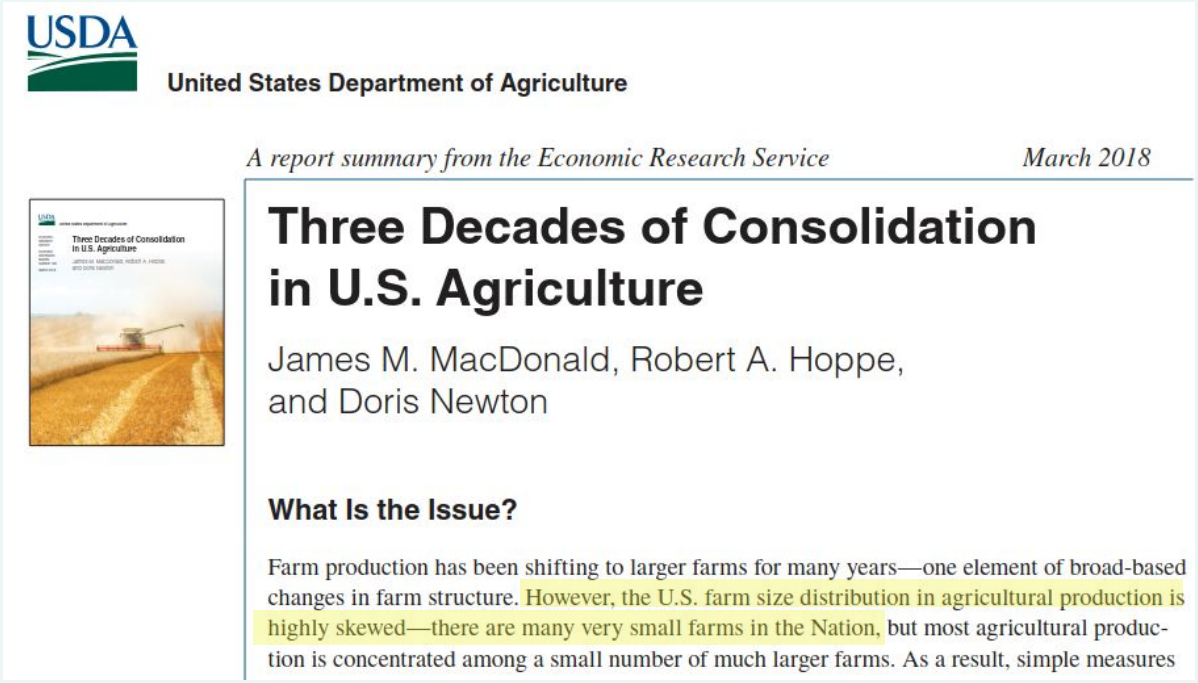
Property Size



Positively predicts presence

Property size is **skewed** (lots of small ones)

- Well documented that there are many many small *farms*
- Same is true for properties



USDA

United States Department of Agriculture

A report summary from the Economic Research Service *March 2018*

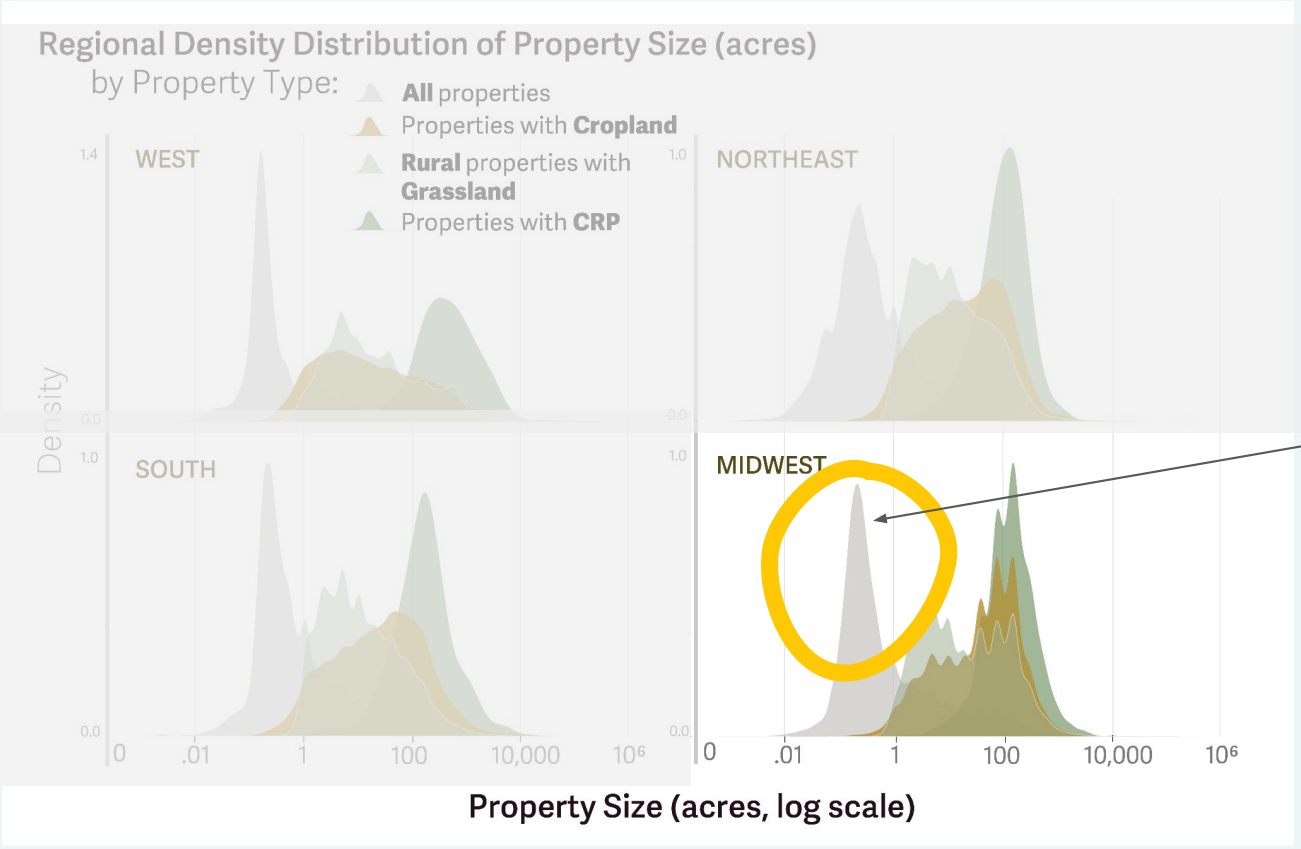
Three Decades of Consolidation in U.S. Agriculture

James M. MacDonald, Robert A. Hoppe, and Doris Newton

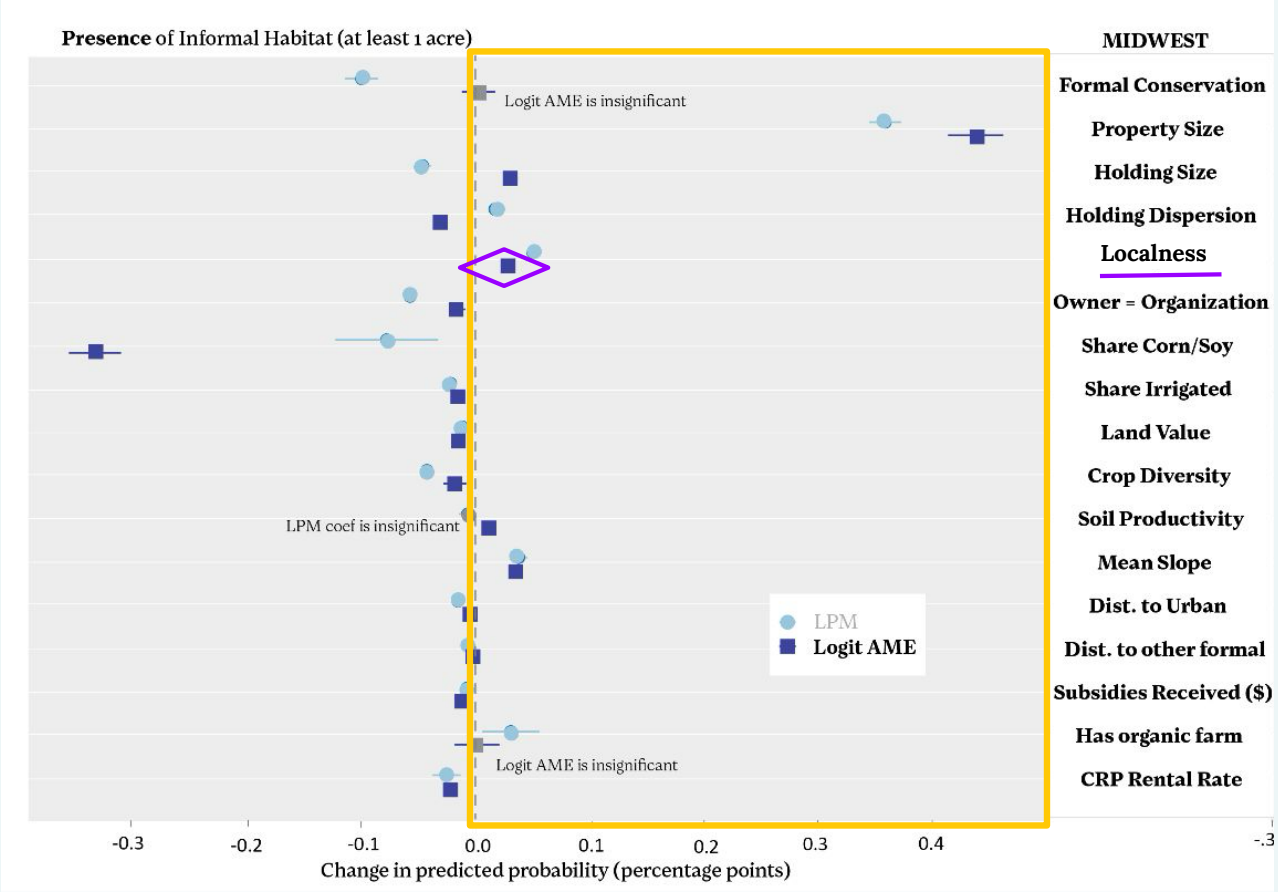
What Is the Issue?

Farm production has been shifting to larger farms for many years—one element of broad-based changes in farm structure. However, the U.S. farm size distribution in agricultural production is highly skewed—there are many very small farms in the Nation, but most agricultural production is concentrated among a small number of much larger farms. As a result, simple measures

Property size is skewed (lots of small ones) **so I log transform it in the models** (ln)



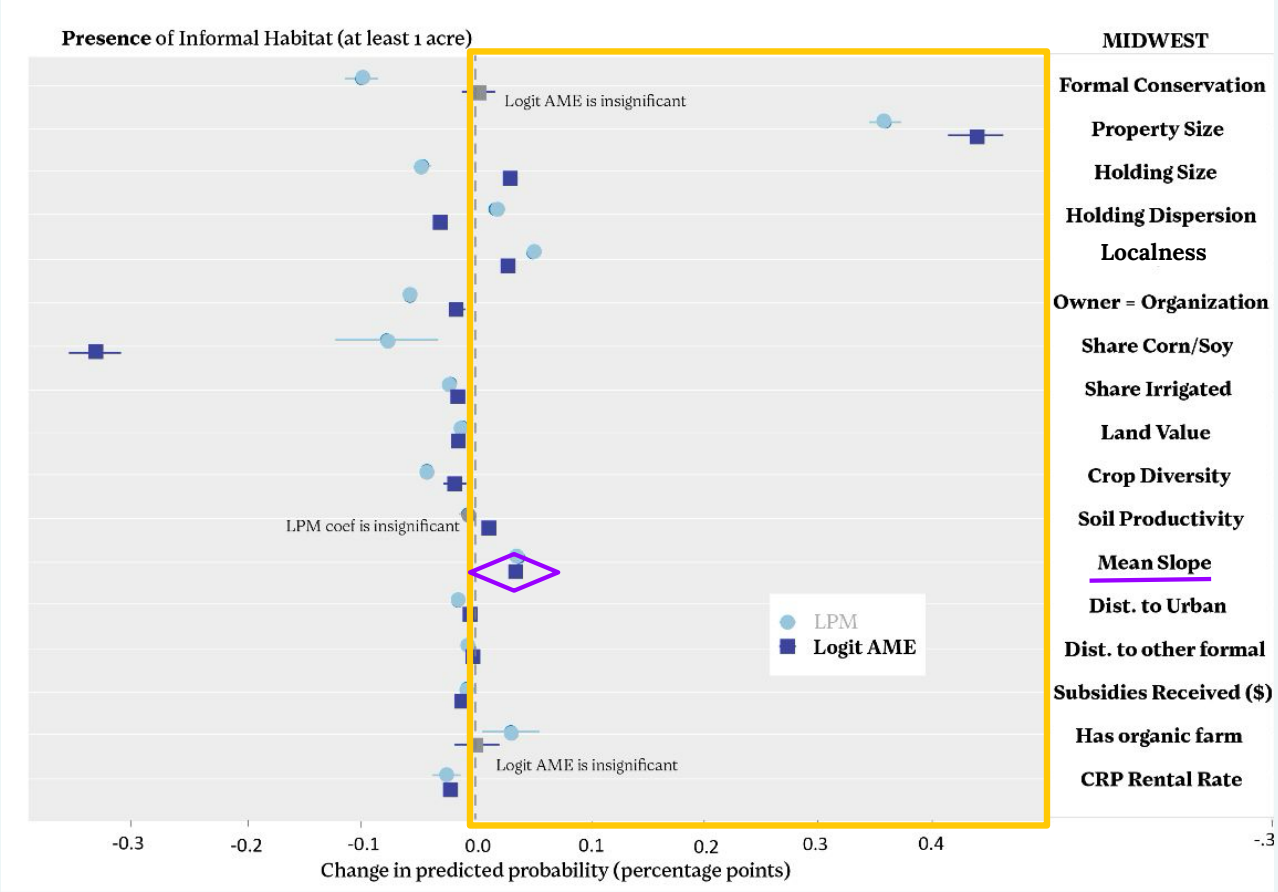
Small properties (urban, residential)



Localness
0=absentee, 1= local

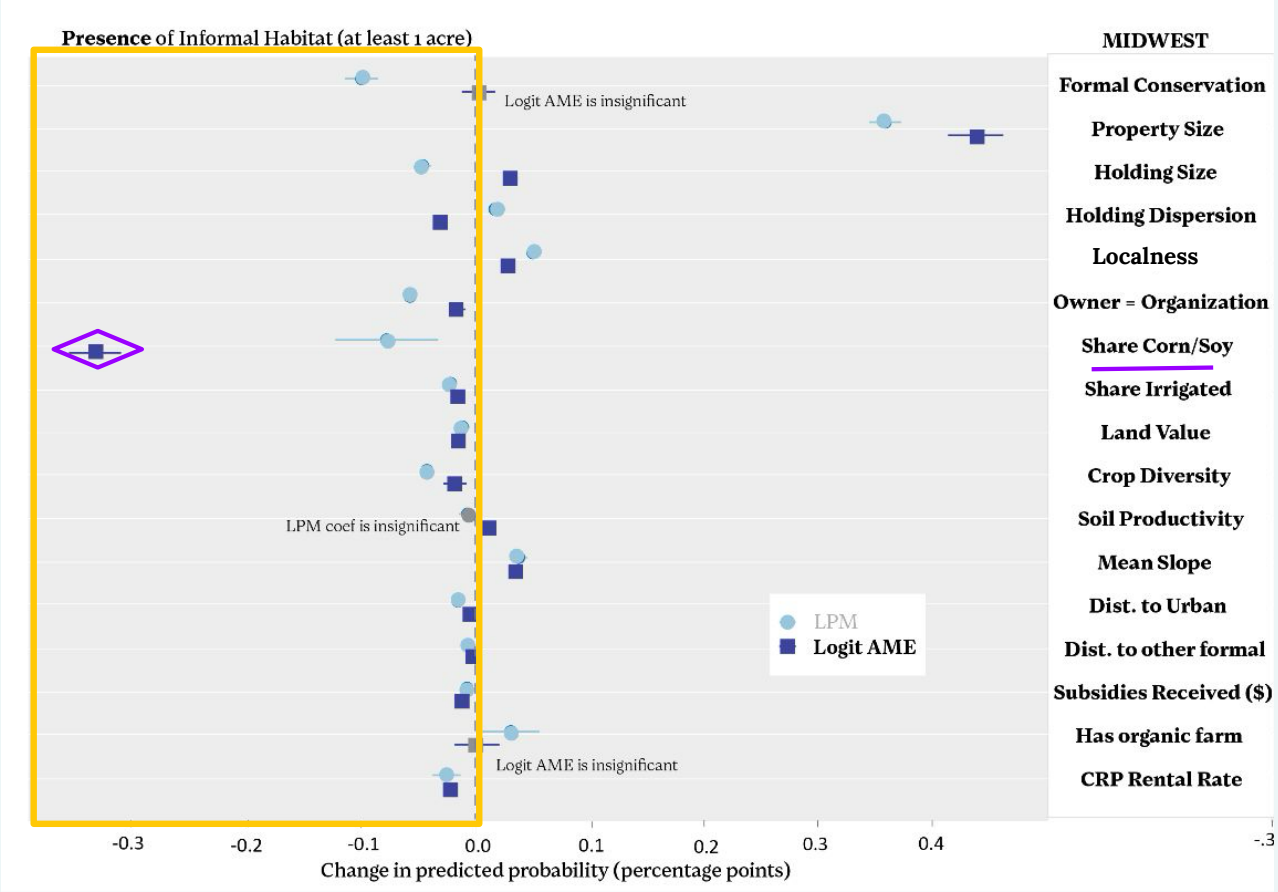
Positively
predicts
presence

Mean Slope



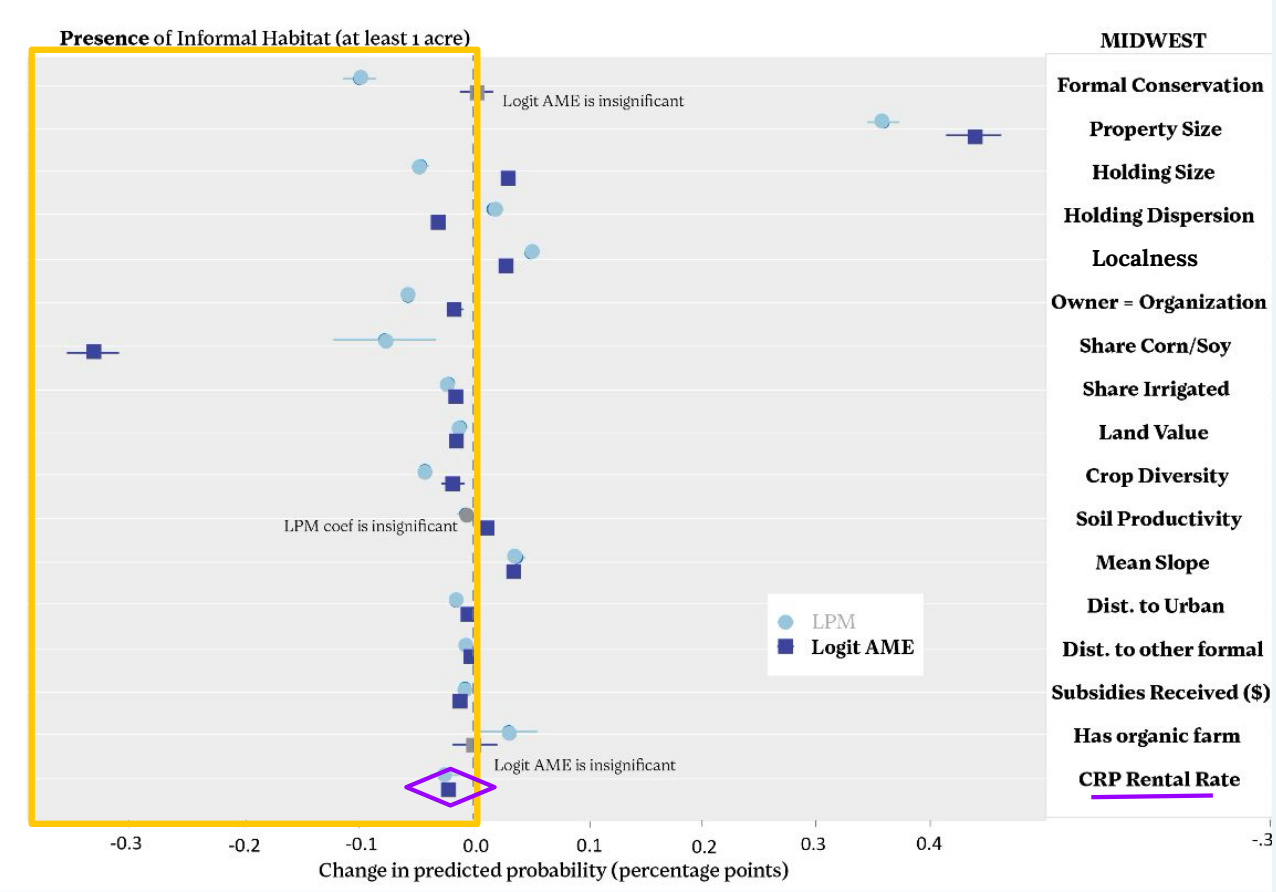
Positively predicts presence

Corn/Soy share

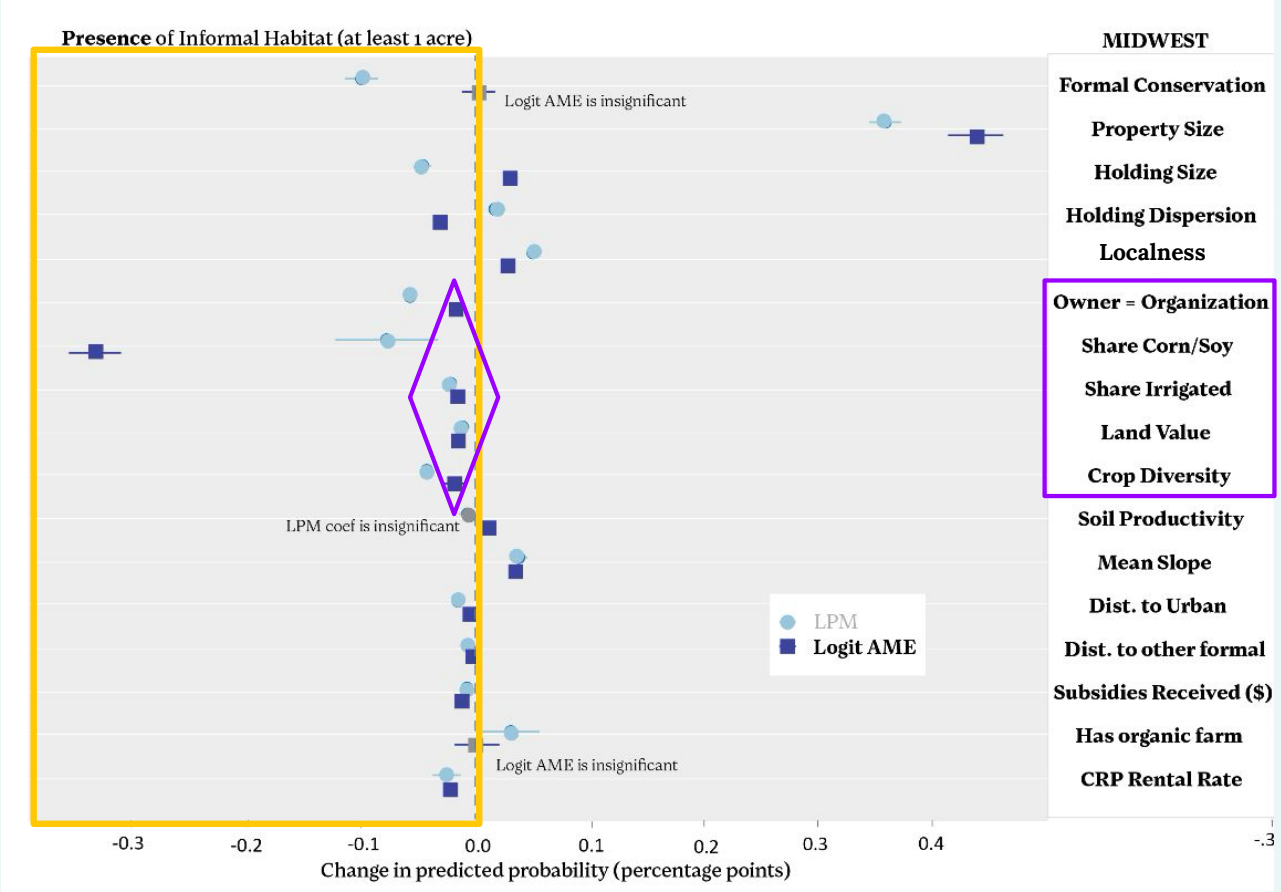


Negatively predicts presence

CRP Rental Rate



Negatively predicts presence

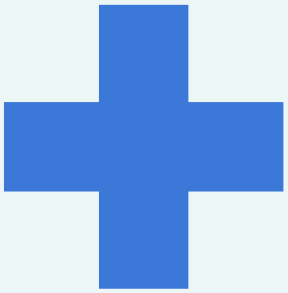


Organizations, irrigation, land value, # of crops

Negatively predicts presence

Predicting Presence

Property Size
Localness
Mean Slope

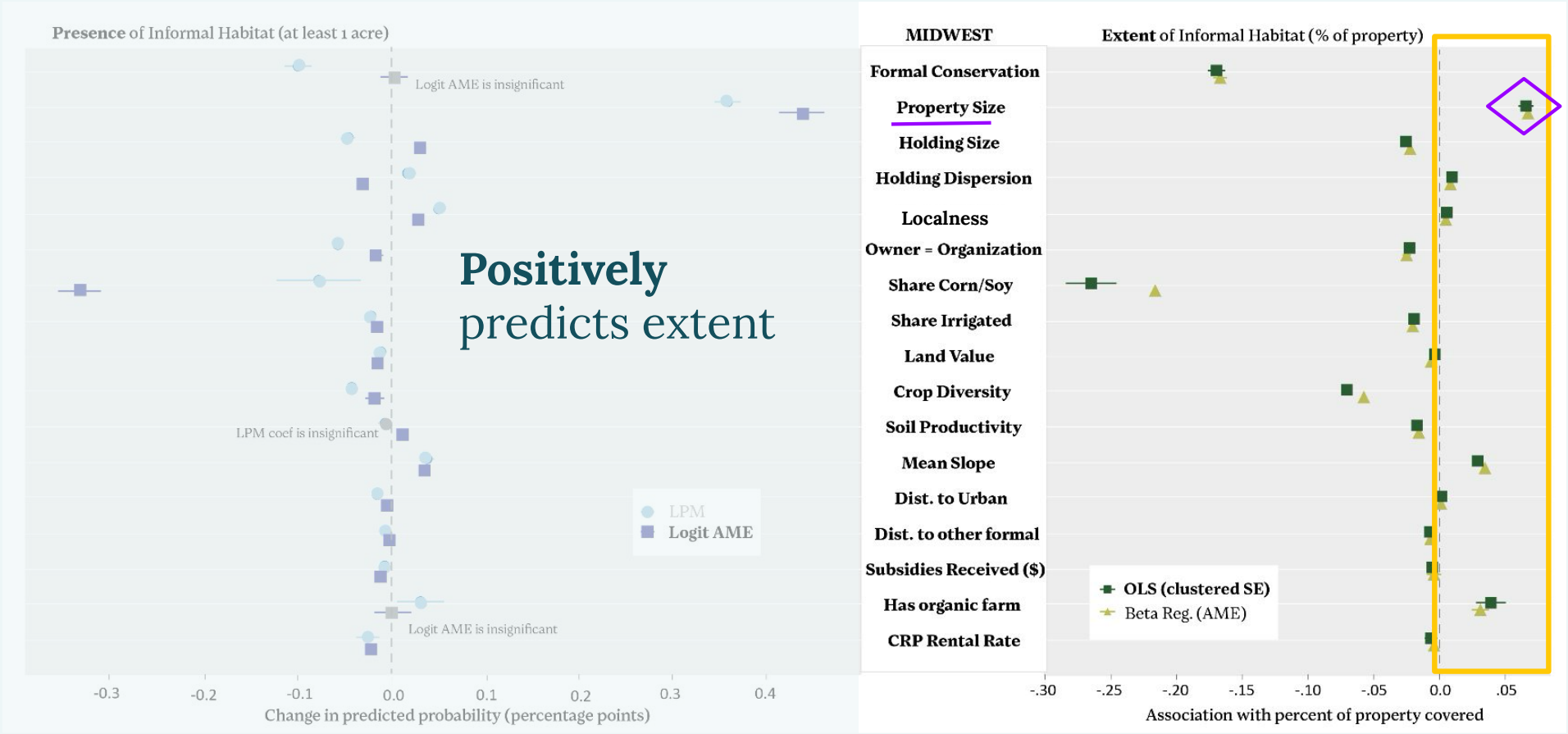


Share Corn/Soy
CRP Rental Rate
Irrigation
Land Value
 # Crops

Of properties with **at least 1 acre of natural land,** what predicts the **extent** of **that land?**

- Percentage of property
- Conditional on already having some

Property Size

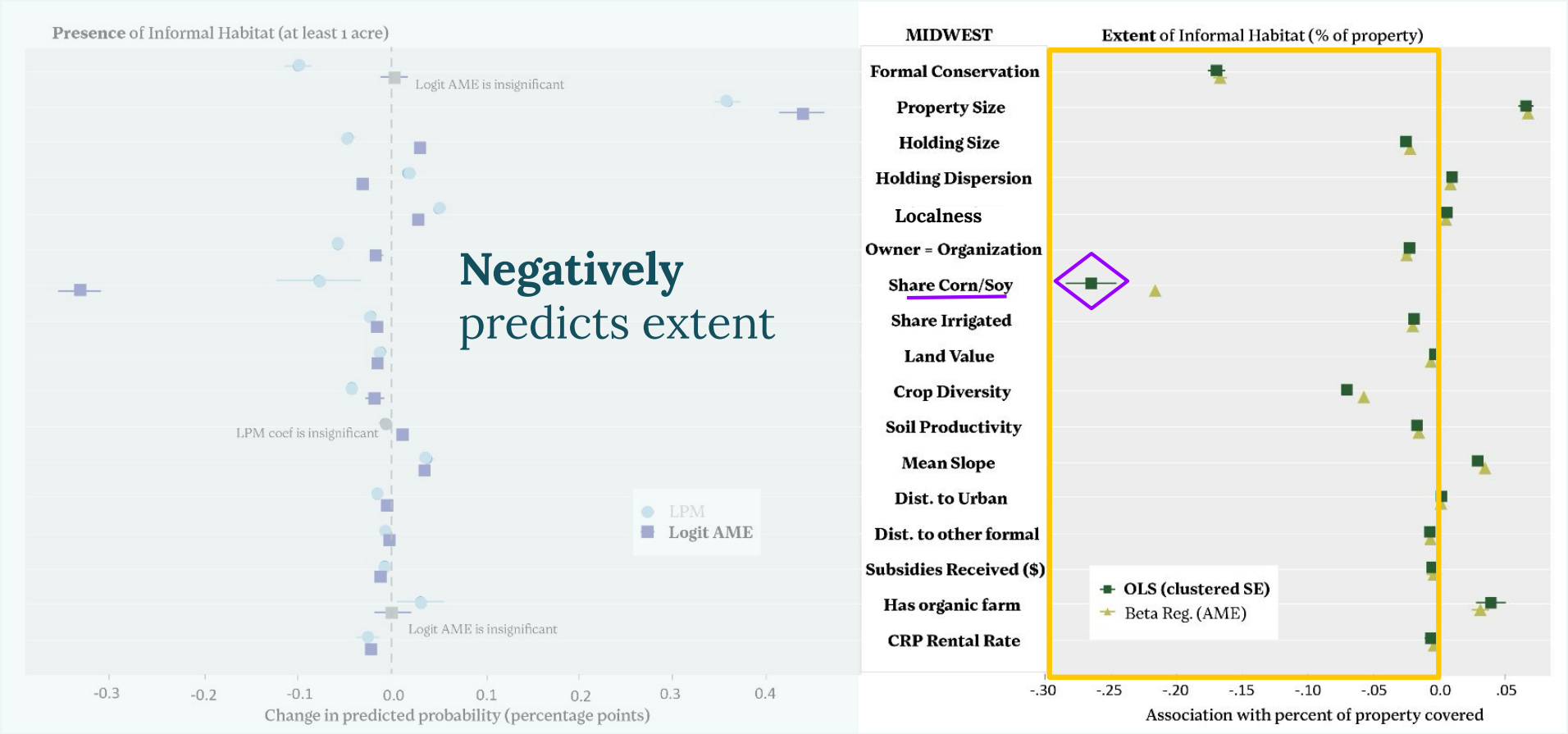


Organic Farm Presence

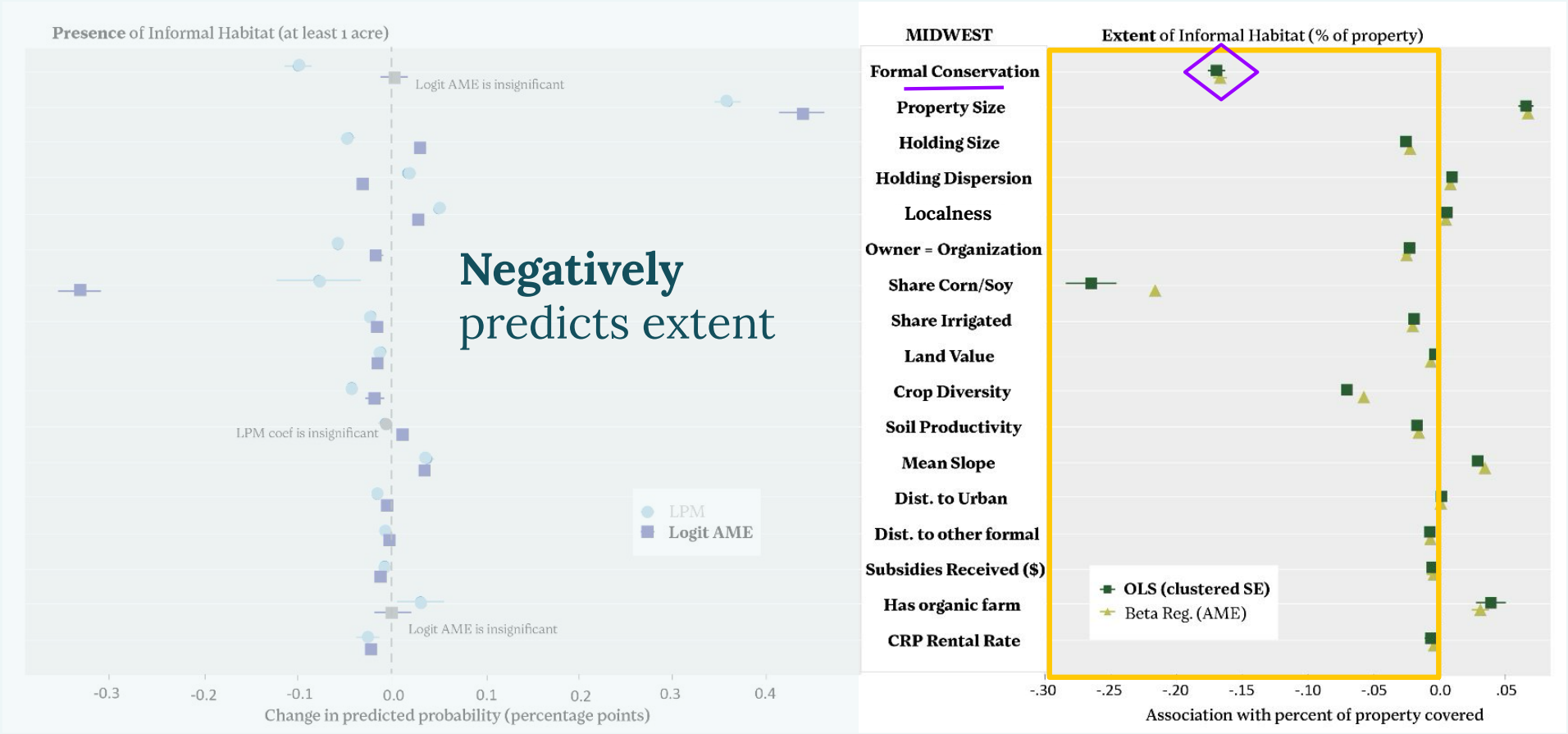
Mean Slope


Presence of Informal Habitat (at least 1 acre)
Logit AME is insignificant
LPM coef is insignificant
Logit AME is insignificant
LPM
Logit AME
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
Change in predicted probability (percentage points)
Positively
predicts extent
MIDWEST
Extent of Informal Habitat (% of property)
Formal Conservation
Property Size
Holding Size
Holding Dispersion
Localness
Owner = Organization
Share Corn/Soy
Share Irrigated
Land Value
Crop Diversity
Soil Productivity
Mean Slope
Dist. to Urban
Dist. to other formal
Subsidies Received ($)
Has organic farm
CRP Rental Rate
OLS (clustered SE)
Beta Reg. (AME)
-.30
-.25
-.20
-.15
-.10
-.05
0.0
.05
Association with percent of property covered

Corn/Soy Share

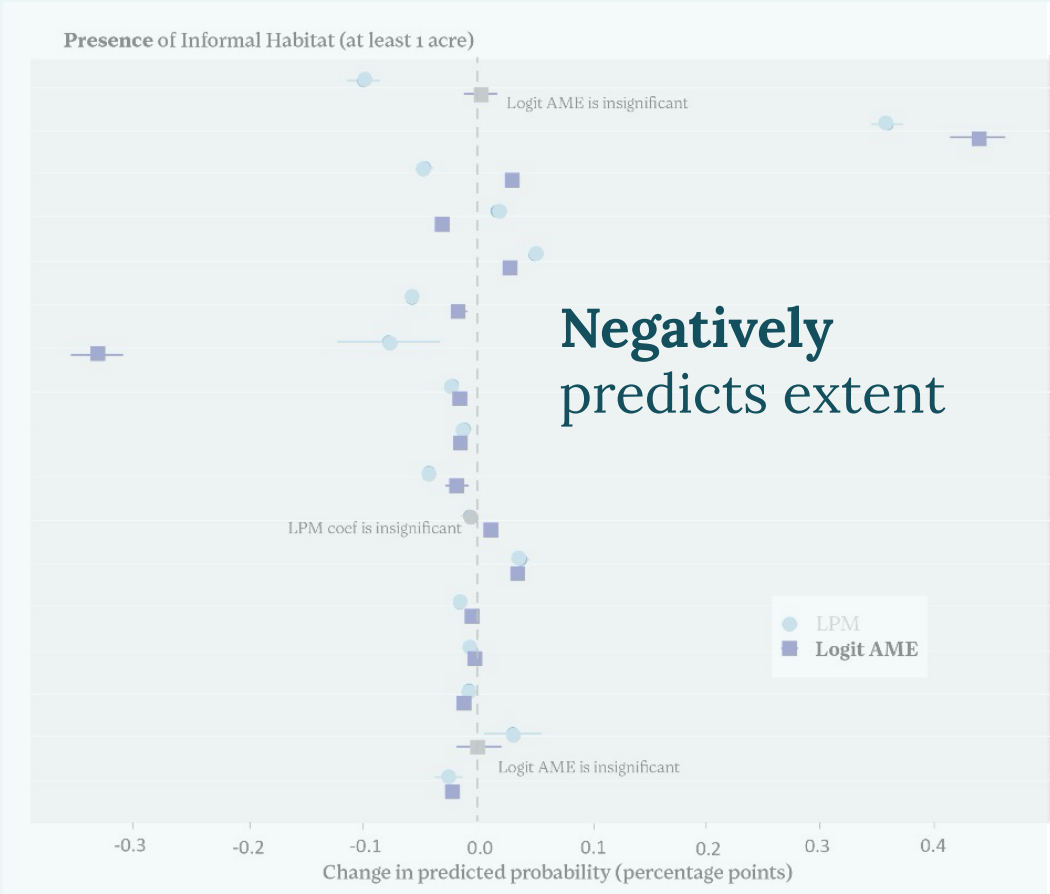


Presence of Formal Conservation

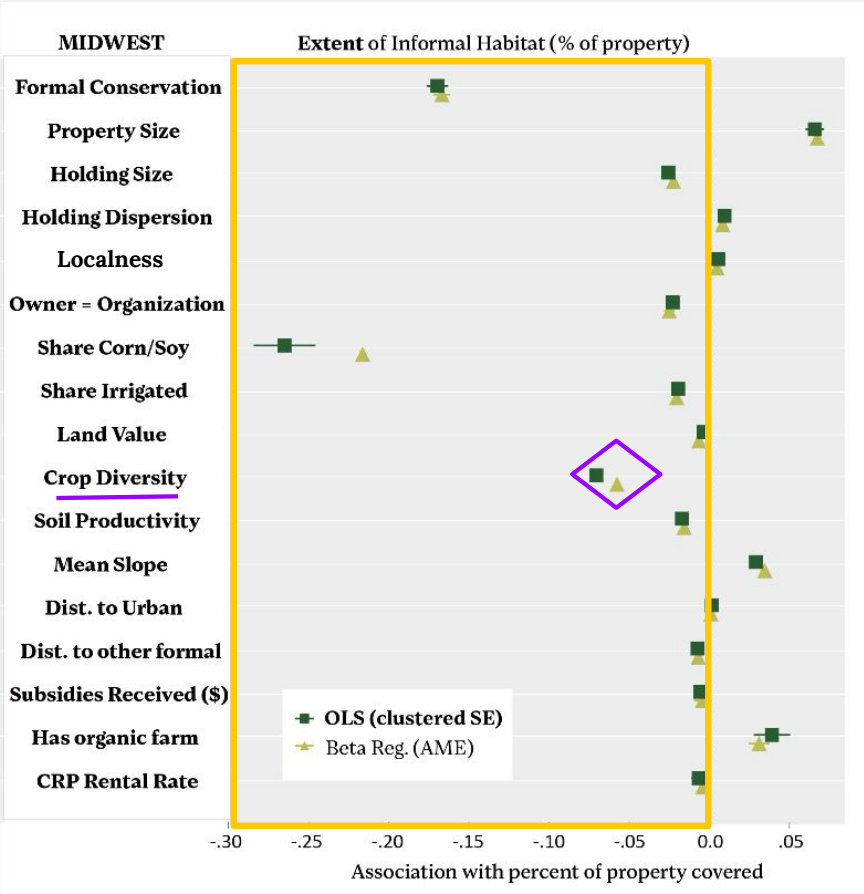


Negatively
predicts extent

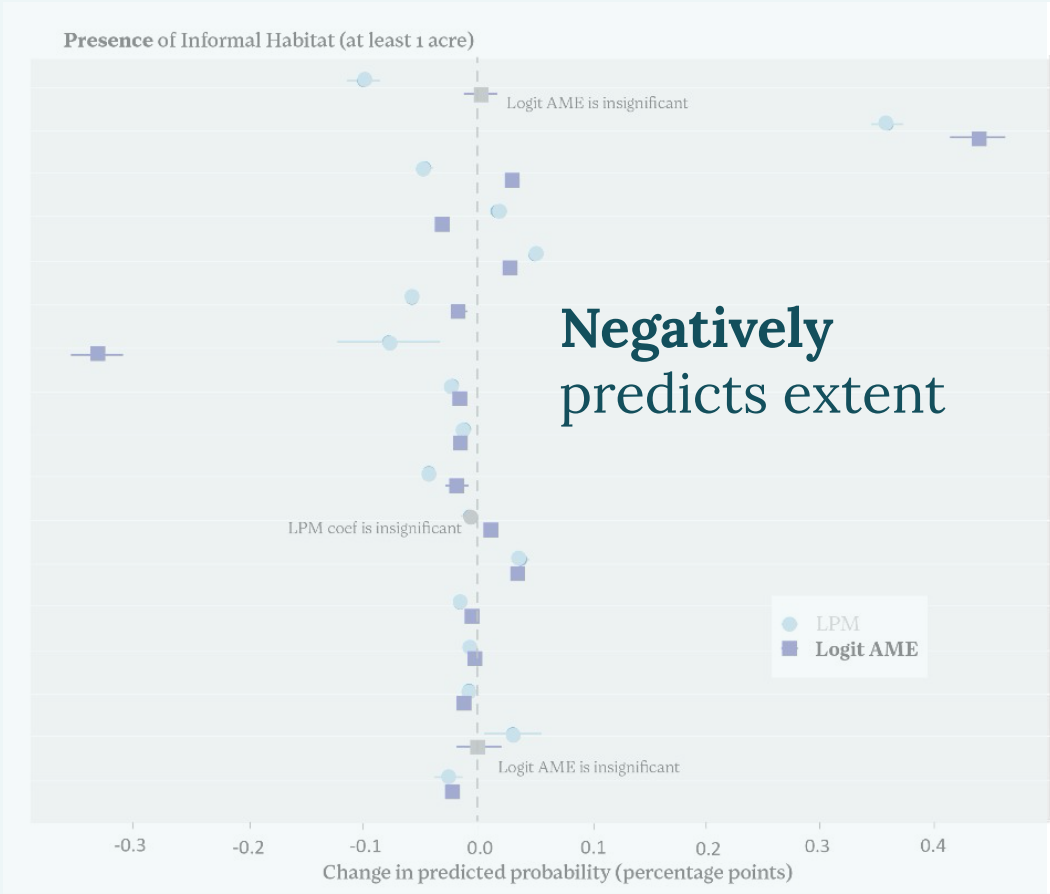
Number of Crops



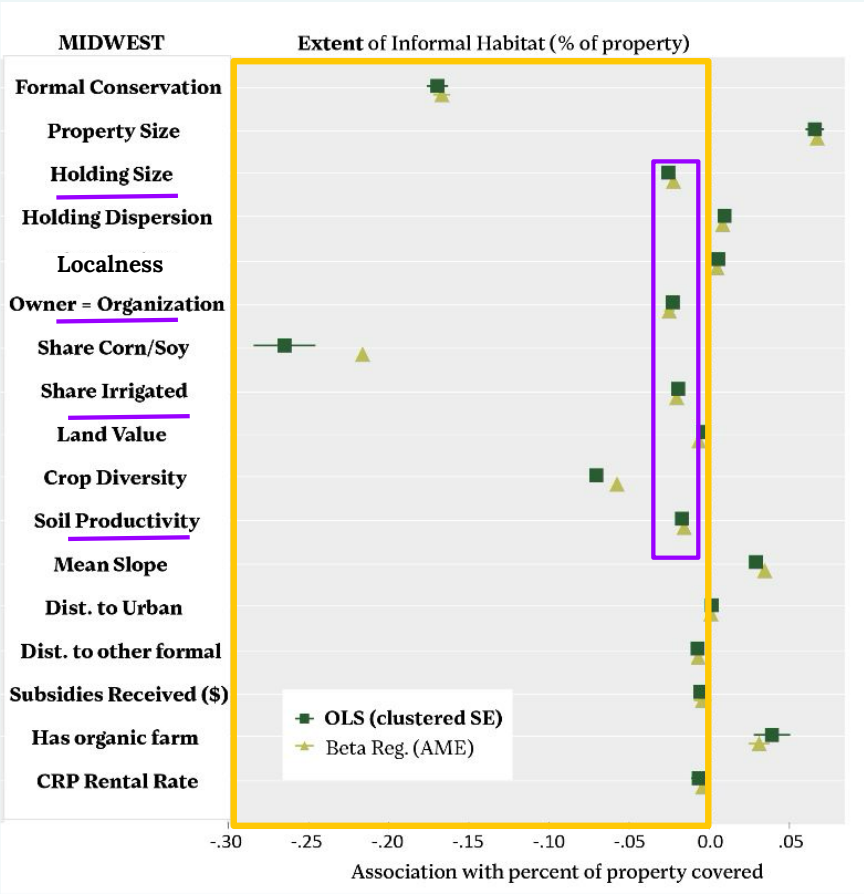
Negatively
predicts extent



Orgs, Irrigation, Soil Productivity, Holding Size



Negatively predicts extent



Predicting Extent

Property Size
Organic Farm present
Mean Slope

Share Corn/Soy
Formal Conservation
Irrigation
Land Value
 # Crops
Soil Productivity
Holding Size

Property size: **positive** relationship with informal natural land

Presence: +43.8 points (HUGE!)

Extent: +6.8 points (modest)

- **Having vs Dedicating**
  - **Larger** properties → **more likely** to have ≥1 acre of natural land
  - Among properties with natural land, size → only **modest** gains in natural land **share**
- **Scale**
  - Larger landholders can balance production and conservation
  - Smaller properties may have to prioritize one use.

Informally Protected Natural Land: Embedded in Land Constraints

Physical constraints (soil, slope, irrigation) associated with patterns **more** than economics

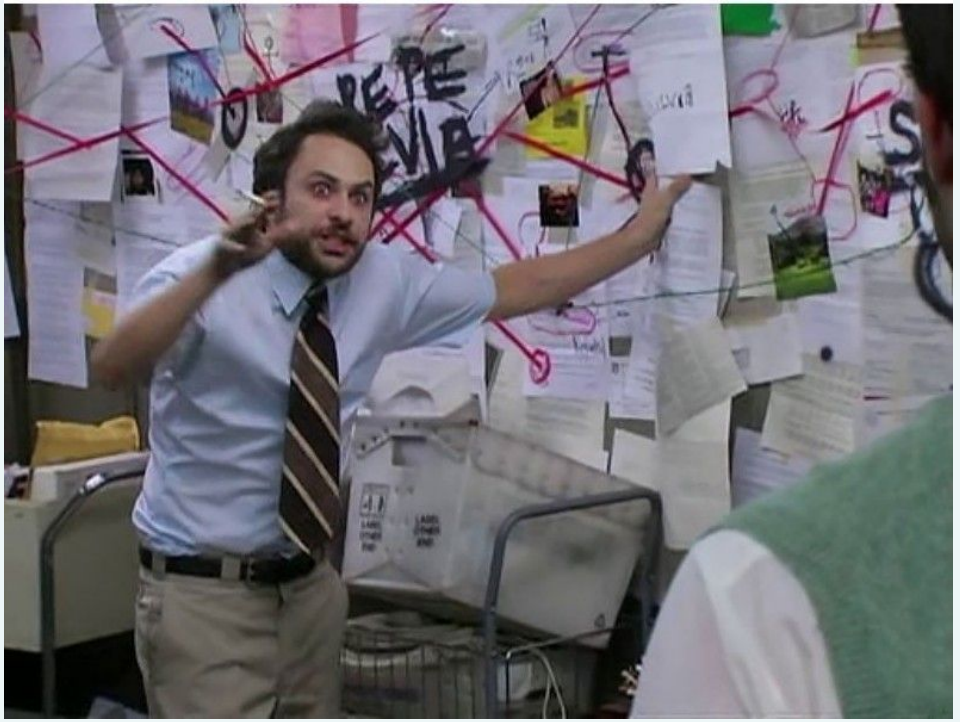
Productive soils → **small** patches; **marginal** soils → **large** shares

Corn/soy and irrigation strong negative predictor

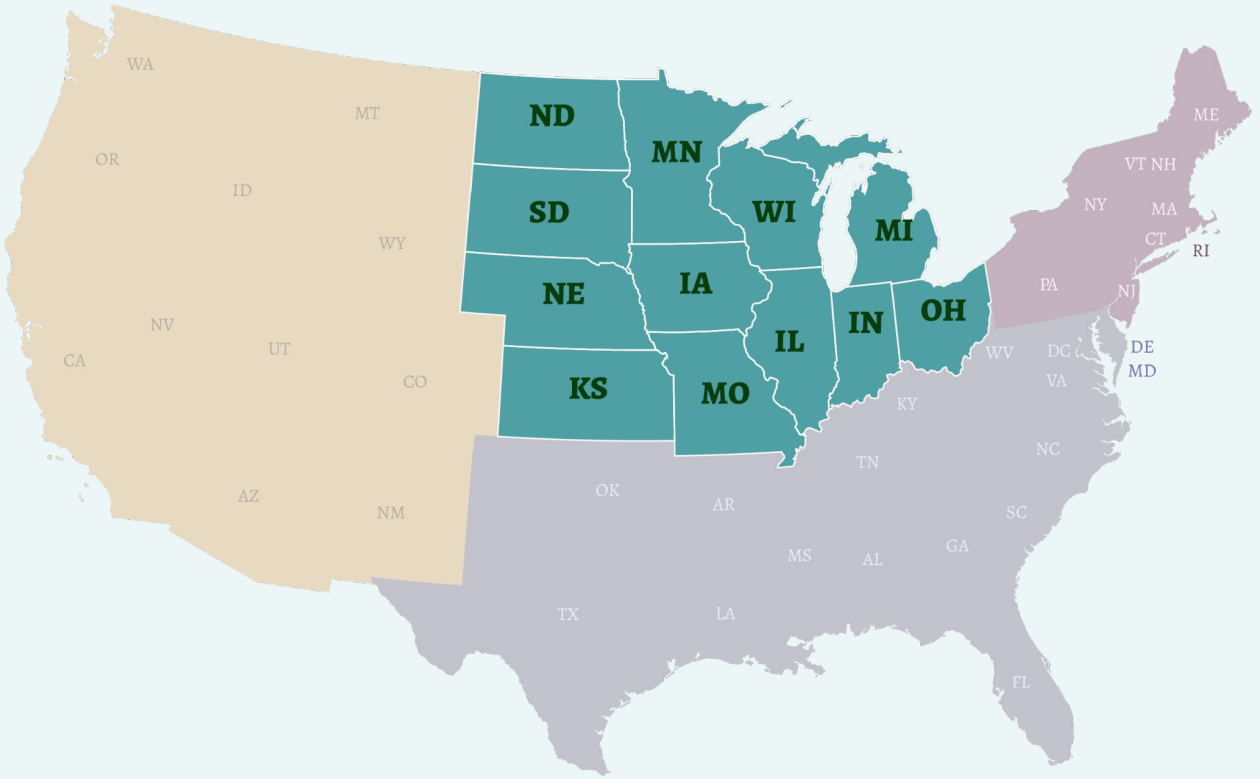
Organic farming shows minimal associations

Habitat concentrates where farming is *least viable*

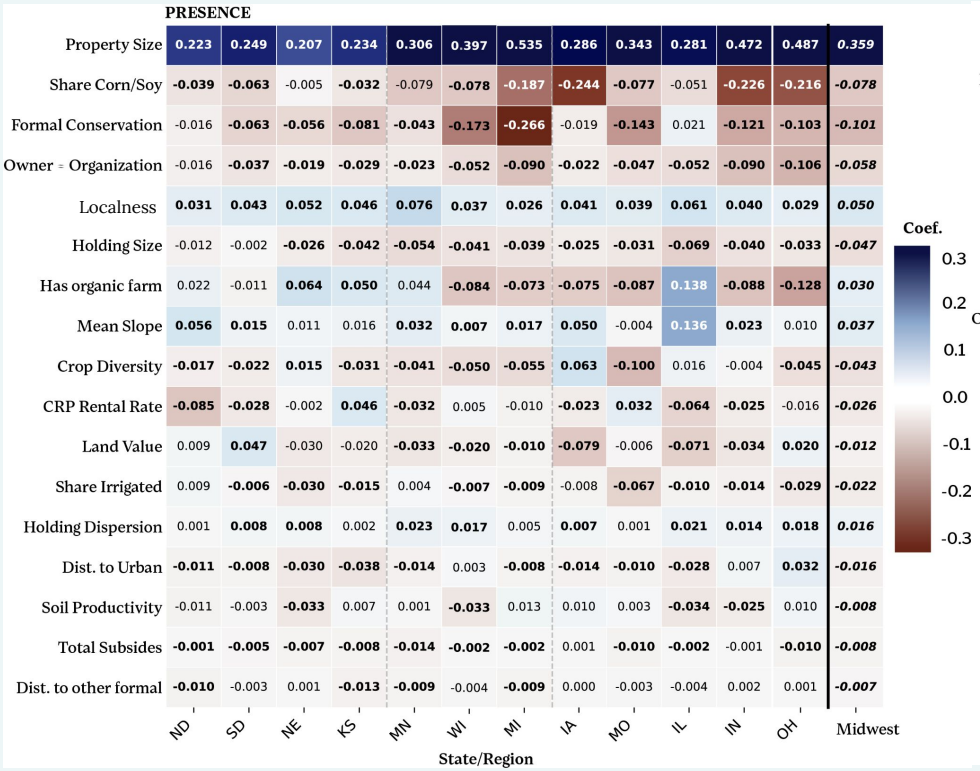

ROAD TO 270 WHAT IF

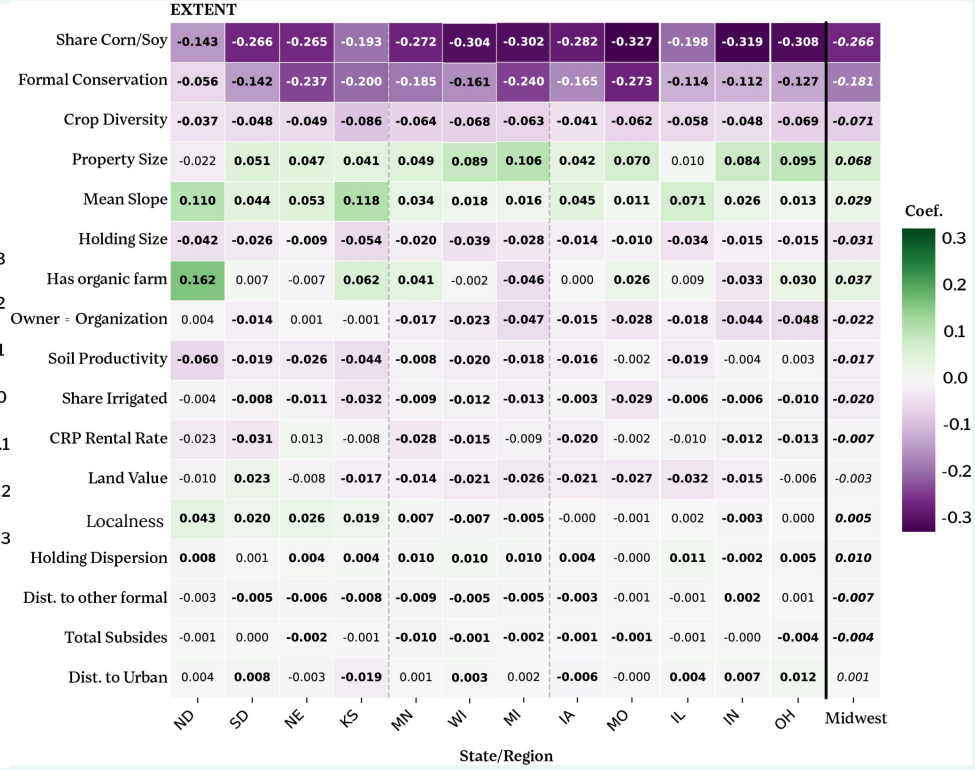


Heterogeneity by **State**



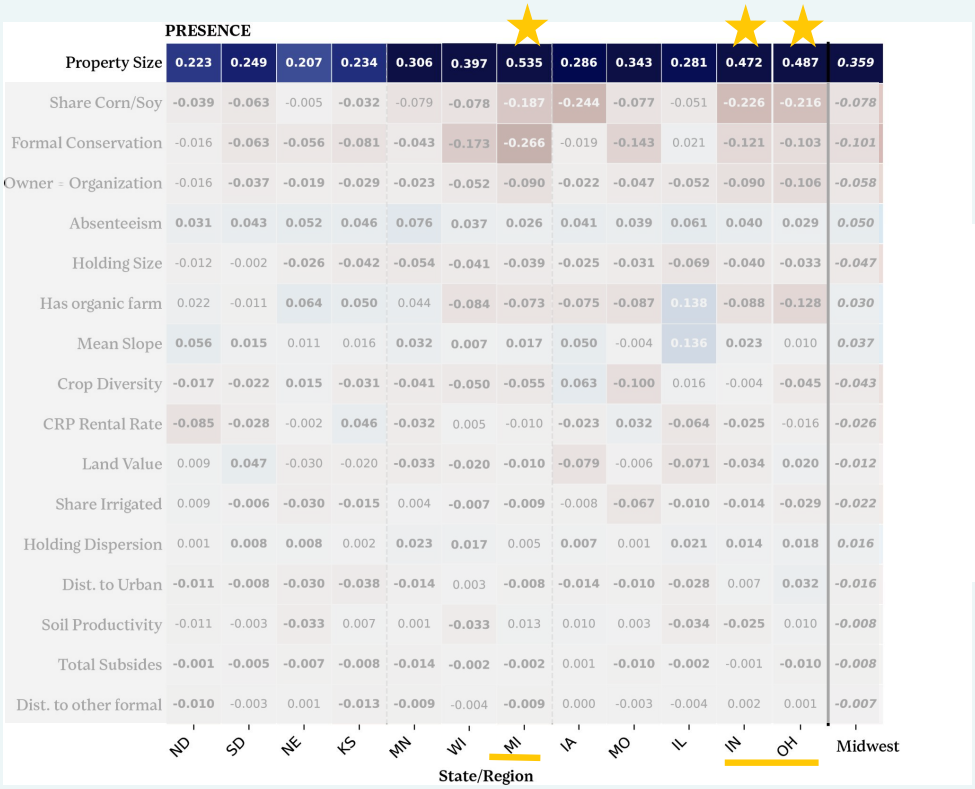
Heterogeneity by State





Property size – positive but depends on state

- **Property size**: **Strongest** predictor everywhere (β = 0.21-0.54 for **presence**)
  - Largest magnitudes: Michigan, Indiana, Ohio



PRESENCE

Property Size	ND	SD	NE	KS	MN	WI	MI	IA	MO	IL	IN	OH	Midwest
	0.223	**0.249**	**0.207**	**0.234**	**0.306**	**0.397**	**0.535**	**0.286**	**0.343**	**0.281**	**0.472**	**0.487**	***0.359***
Share Corn/Soy	**-0.039**	**-0.063**	-0.005	**-0.032**	-0.079	**-0.078**	**-0.187**	**-0.244**	**-0.077**	-0.051	**-0.226**	**-0.216**	***-0.078***
Formal Conservation	-0.016	**-0.063**	**-0.056**	**-0.081**	**-0.043**	**-0.173**	**-0.266**	-0.019	**-0.143**	0.021	**-0.121**	**-0.103**	***-0.101***
Owner = Organization	-0.016	**-0.037**	**-0.019**	**-0.029**	**-0.023**	**-0.052**	**-0.090**	**-0.022**	**-0.047**	**-0.052**	**-0.090**	**-0.106**	***-0.058***
Absenteeism	**0.031**	**0.043**	**0.052**	**0.046**	**0.076**	**0.037**	**0.026**	**0.041**	**0.039**	**0.061**	**0.040**	**0.029**	***0.050***
Holding Size	-0.012	-0.002	**-0.026**	**-0.042**	**-0.054**	**-0.041**	**-0.039**	**-0.025**	**-0.031**	**-0.069**	**-0.040**	**-0.033**	***-0.047***
Has organic farm	0.022	-0.011	**0.064**	**0.050**	0.044	**-0.084**	**-0.073**	**-0.075**	**-0.087**	**0.138**	**-0.088**	**-0.128**	***0.030***
Mean Slope	**0.056**	**0.015**	0.011	0.016	**0.032**	**0.007**	**0.017**	**0.050**	-0.004	**0.136**	**0.023**	0.010	***0.037***
Crop Diversity	**-0.017**	**-0.022**	**0.015**	**-0.031**	**-0.041**	**-0.050**	**-0.055**	**0.063**	**-0.100**	0.016	-0.004	**-0.045**	***-0.043***
CRP Rental Rate	**-0.085**	**-0.028**	-0.002	**0.046**	**-0.032**	0.005	-0.010	**-0.023**	**0.032**	**-0.064**	**-0.025**	-0.016	***-0.026***
Land Value	0.009	**0.047**	-0.030	-0.020	**-0.033**	**-0.020**	**-0.010**	**-0.079**	-0.006	**-0.071**	**-0.034**	**0.020**	***-0.012***
Share Irrigated	0.009	**-0.006**	**-0.030**	**-0.015**	0.004	**-0.007**	**-0.009**	-0.008	**-0.067**	**-0.010**	**-0.014**	**-0.029**	***-0.022***
Holding Dispersion	0.001	**0.008**	**0.008**	0.002	**0.023**	**0.017**	0.005	**0.007**	0.001	**0.021**	**0.014**	**0.018**	***0.016***
Dist. to Urban	**-0.011**	**-0.008**	**-0.030**	**-0.038**	**-0.014**	0.003	**-0.008**	**-0.014**	**-0.010**	**-0.028**	0.007	**0.032**	***-0.016***
Soil Productivity	-0.011	-0.003	**-0.033**	0.007	0.001	**-0.033**	0.013	0.010	0.003	**-0.034**	**-0.025**	0.010	***-0.008***
Total Subsides	**-0.001**	**-0.005**	**-0.007**	**-0.008**	**-0.014**	**-0.002**	**-0.002**	0.001	**-0.010**	**-0.002**	-0.001	**-0.010**	***-0.008***
Dist. to other formal	**-0.010**	-0.003	0.001	**-0.013**	**-0.009**	-0.004	**-0.009**	0.000	-0.003	-0.004	0.002	0.001	***-0.007***

State/Region

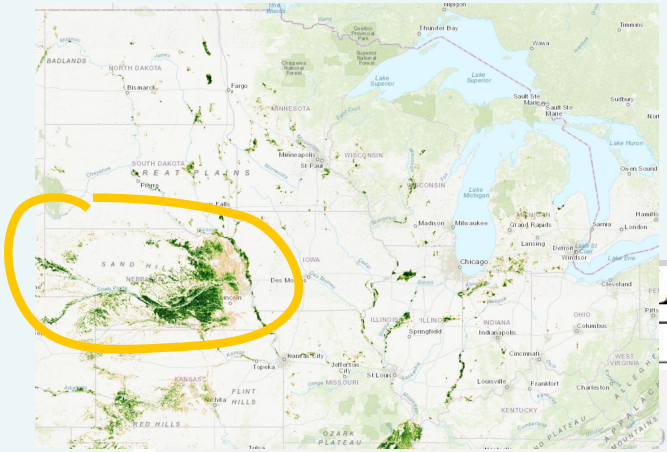
Those states are smaller on average

State-Level Summary Statistics (Means)

Variable	ND	SD	NE	KS	MN	WI	MI	IA	MO	IL	IN	OH	Midwest
Economic													
Land Value (ln($/ha))	8.19	8.57	8.89	8.75	9.48	9.80	9.87	9.77	9.46	9.72	9.69	9.82	9.56
CRP rental rate ($/acre/yr)	69.49	116.06	155.79	66.13	126.79	122.50	95.26	259.87	97.69	239.51	202.14	139.94	140.16
Total subsidies ($/prop)	4583.57	2996.19	1400.84	1064.21	722.83	240.69	131.83	929.58	341.98	429.30	382.93	75.84	621.36
Has formal conservation (%)	13.7	12.6	4.9	5.3	5.5	1.2	0.5	12.9	1.8	6.9	2.4	2.0	4.0
Has organic farm (yes/no)	0.001	0.001	0.001	0.000	0.001	0.002	0.001	0.002	0.000	0.001	0.001	0.001	0.001
Land Cover and Use													
Mean slope (degrees)	2.4	3.0	3.1	2.3	2.9	3.6	2.5	3.5	5.3	2.6	3.1	4.1	3.3
Crop Diversity (of crops)	2.6	1.4	1.4	1.5	1.0	0.8	0.7	1.3	0.4	1.1	0.8	0.5	0.91
Share of Corn/Soy cover	18	23	34	14	17	08	05	41	07	34	19	11	16
Irrigated Share (%)	02	03	36	10	01	01	01	01	03	02	02	00	03
Soil Productivity (NCCPI 0-1000)	423	450	577	578	522	474	470	748	511	701	631	596	550
Ownership													
Absenteeism (0=absentee, 1=local)	0.35	0.37	0.49	0.56	0.55	0.60	0.60	0.51	0.59	0.58	0.73	0.65	0.56
Owner is Organization (yes/no)	0.05	0.08	0.13	0.10	0.05	0.06	0.04	0.11	0.06	0.07	0.07	0.06	0.07
Property area (ac)	**173**	**184**	**180**	**139**	**56**	**30**	**19**	**74**	**47**	**48**	**27**	**21**	**54**
Holding area (ac)	37,202	13,295	280,129	33,468	43,321	85,593	66,984	116,313	20,078	86,509	140,660	217,951	97,076
Holding dispersion (km)	71	61	88	65	64	68	47	61	38	59	40	43	54
Location													
Distance to closest enrolled practice (km)	416	386	424	516	306	238	240	316	410	385	488	561	377
Distance to urban area (km)	7.8	7.3	5.254	5.1	5.4	4.5	4.5	3.7	4.5	3.2	2.7	3.0	4.3
Mean % Informal Habitat	48	59	50	61	66	74	74	47	81	53	64	71	66

Formal conservation presence – Negatively predicts informal extent especially in Nebraska and Missouri

- Formal conservation relationship with informal extent: **Most negative** in MO (β = -0.27), NE (β = -0.24)



Nebraska – way more irrigation

Level Summary Statistics (Means)

	SD	NE	KS	MN	WI	MI	IA	MO	IL	IN	OH	Midwest
		8.57	8.89	8.75	9.48	9.80	9.87	9.77	9.46	9.72	9.69	9.82	9.56
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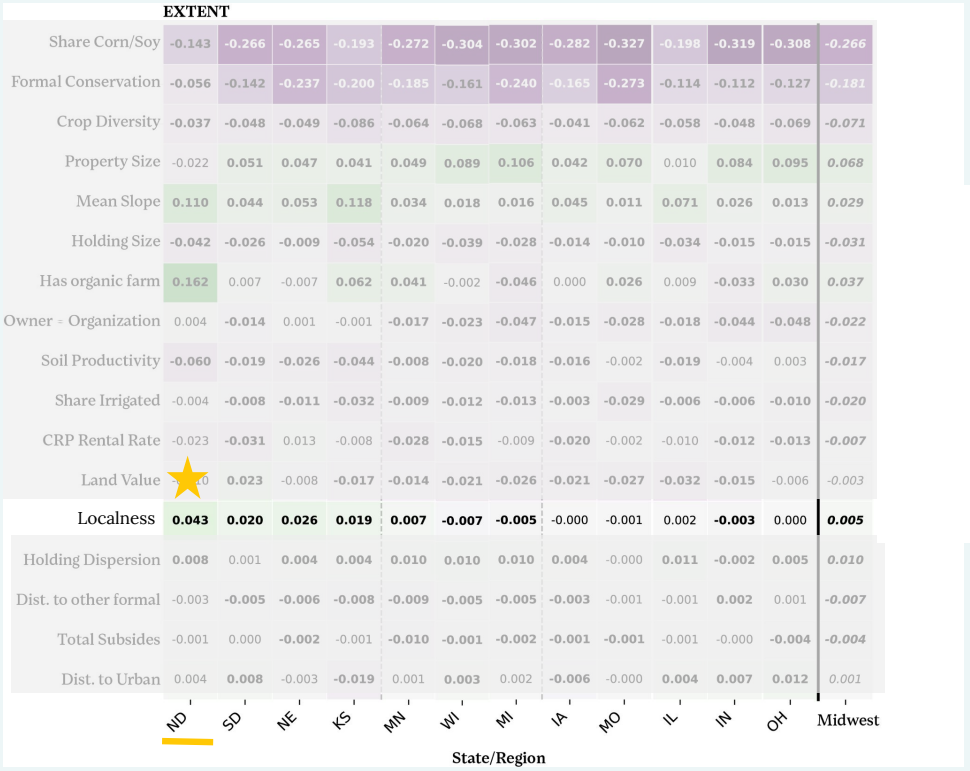
Mean % Informal Habitat	48	59	50	61	66	74	74	47	81	53	64	71	66

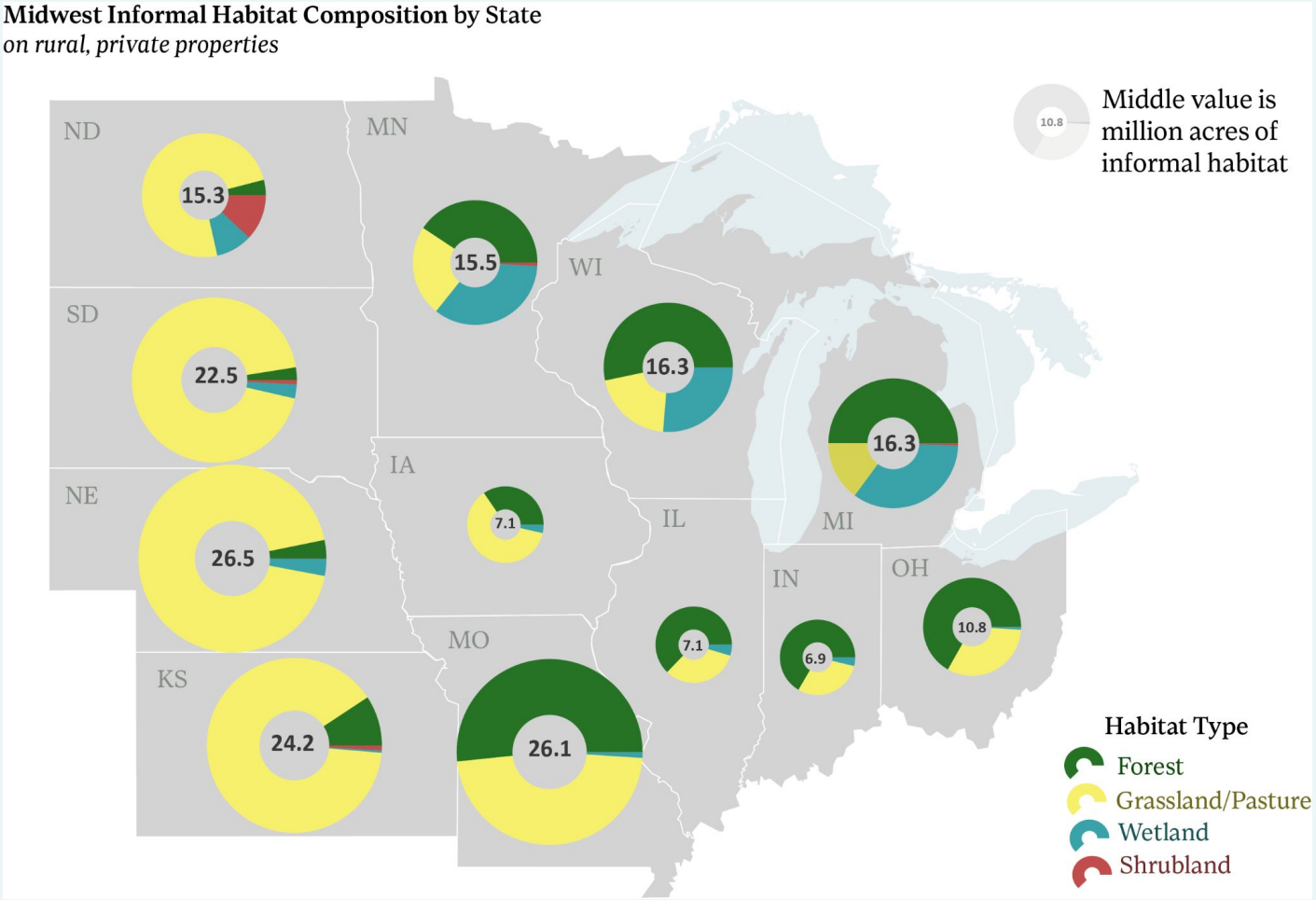
Local Ownership: Positive in Northern Plains

- **Local** ownership: **Positive** in Northern Plains
- Negative/not significant in East

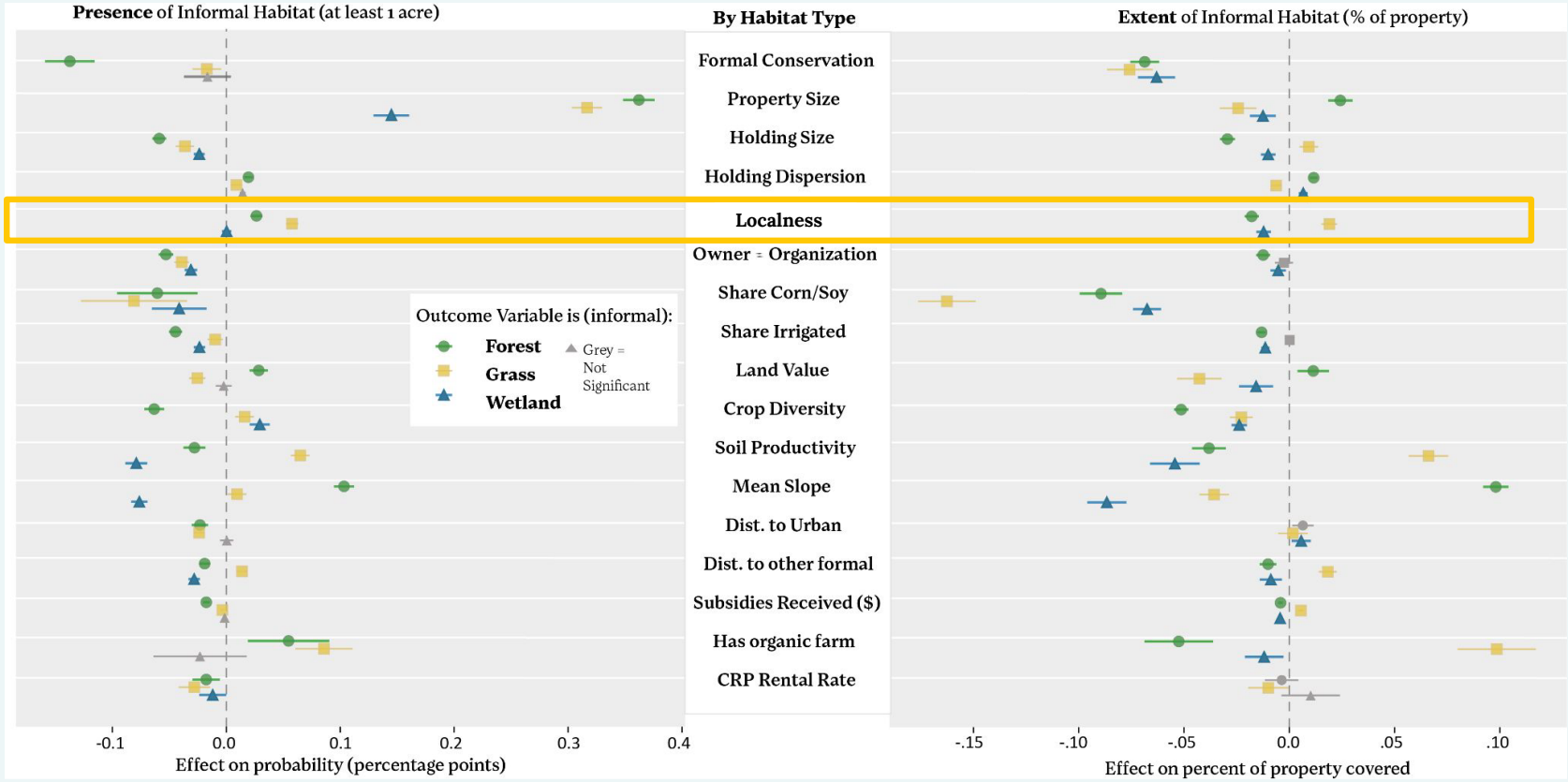


Heterogeneity by Natural Cover Type

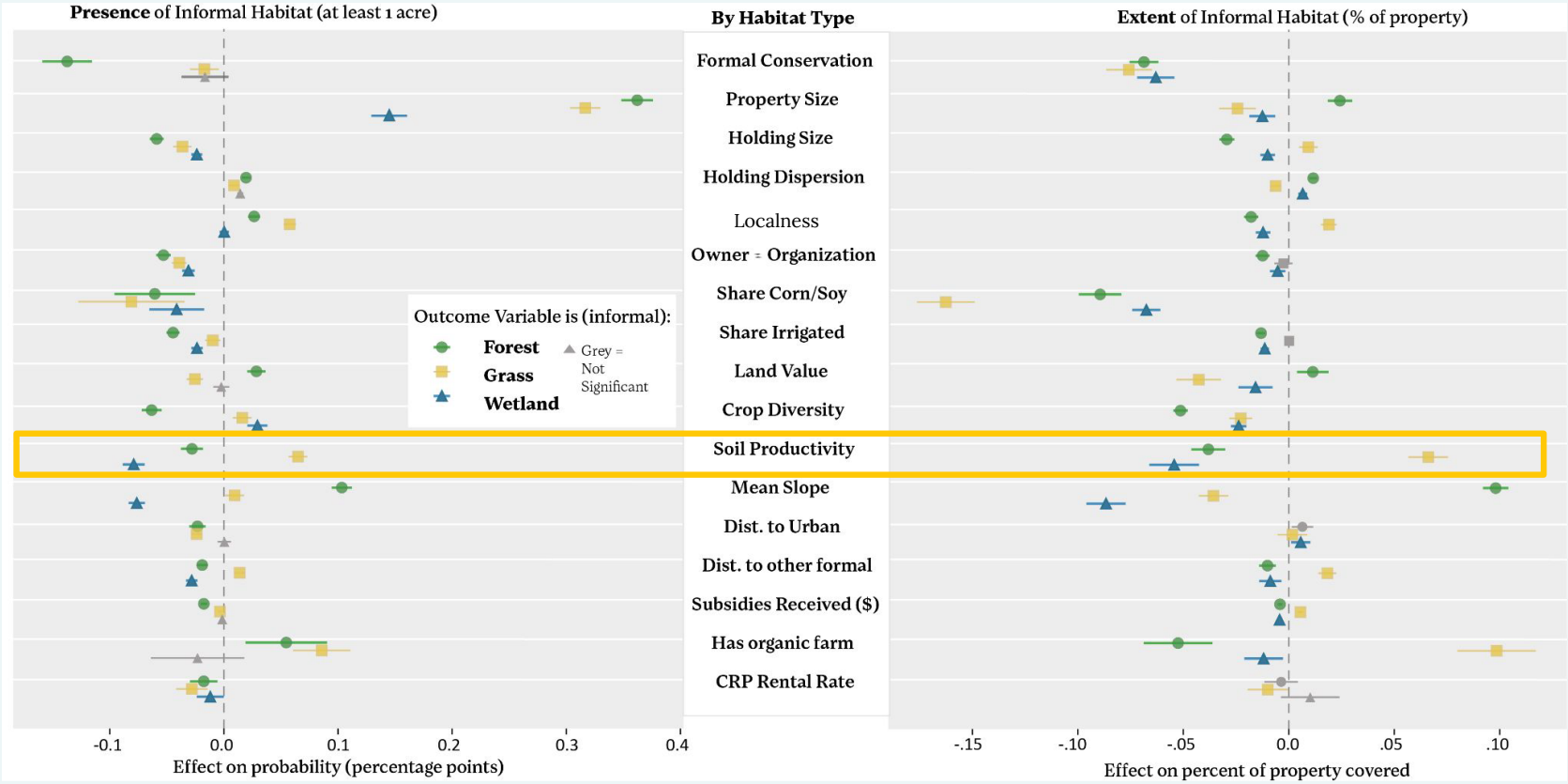
Informal Natural Land Distribution



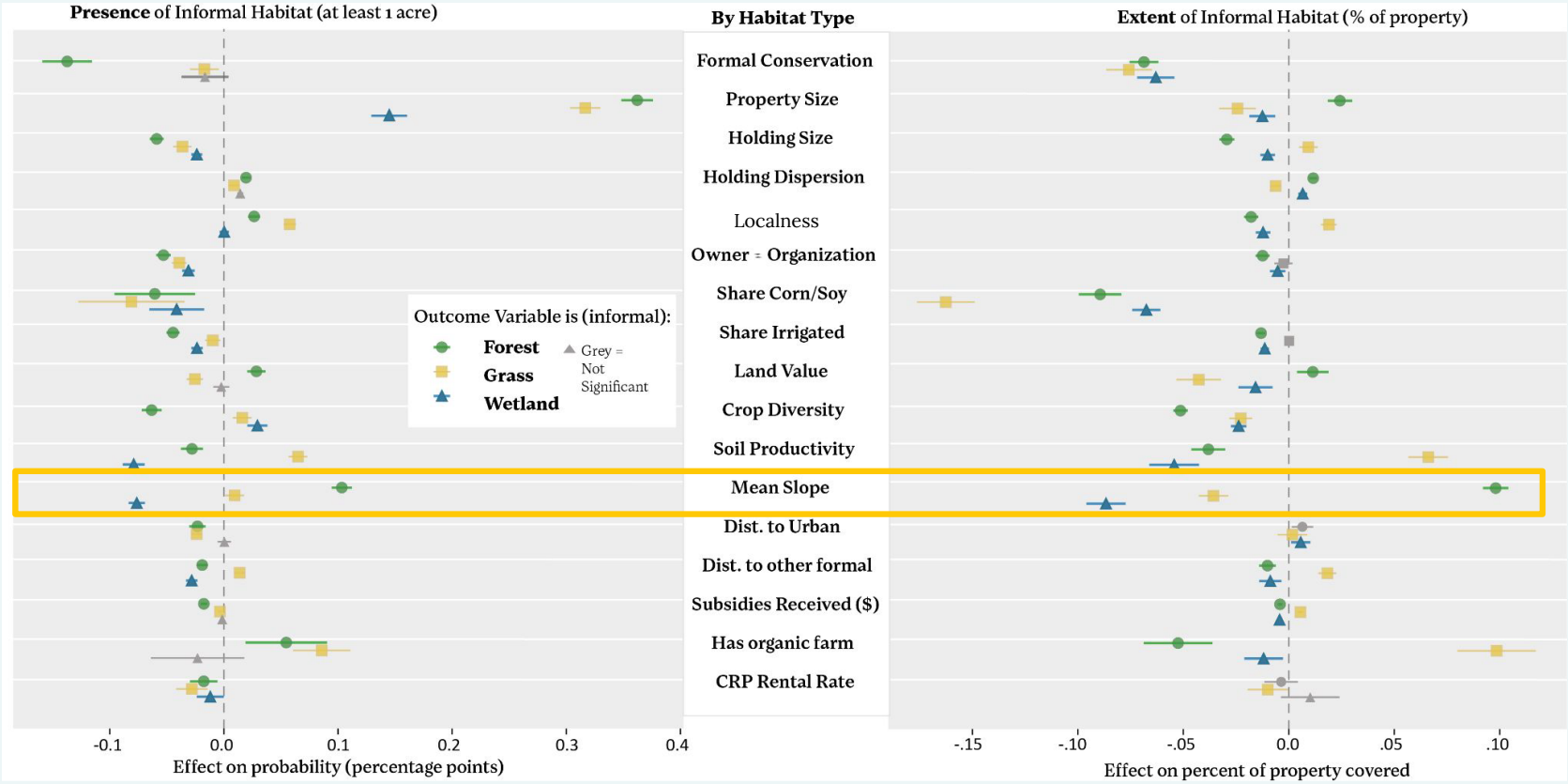
More Local → More Grass



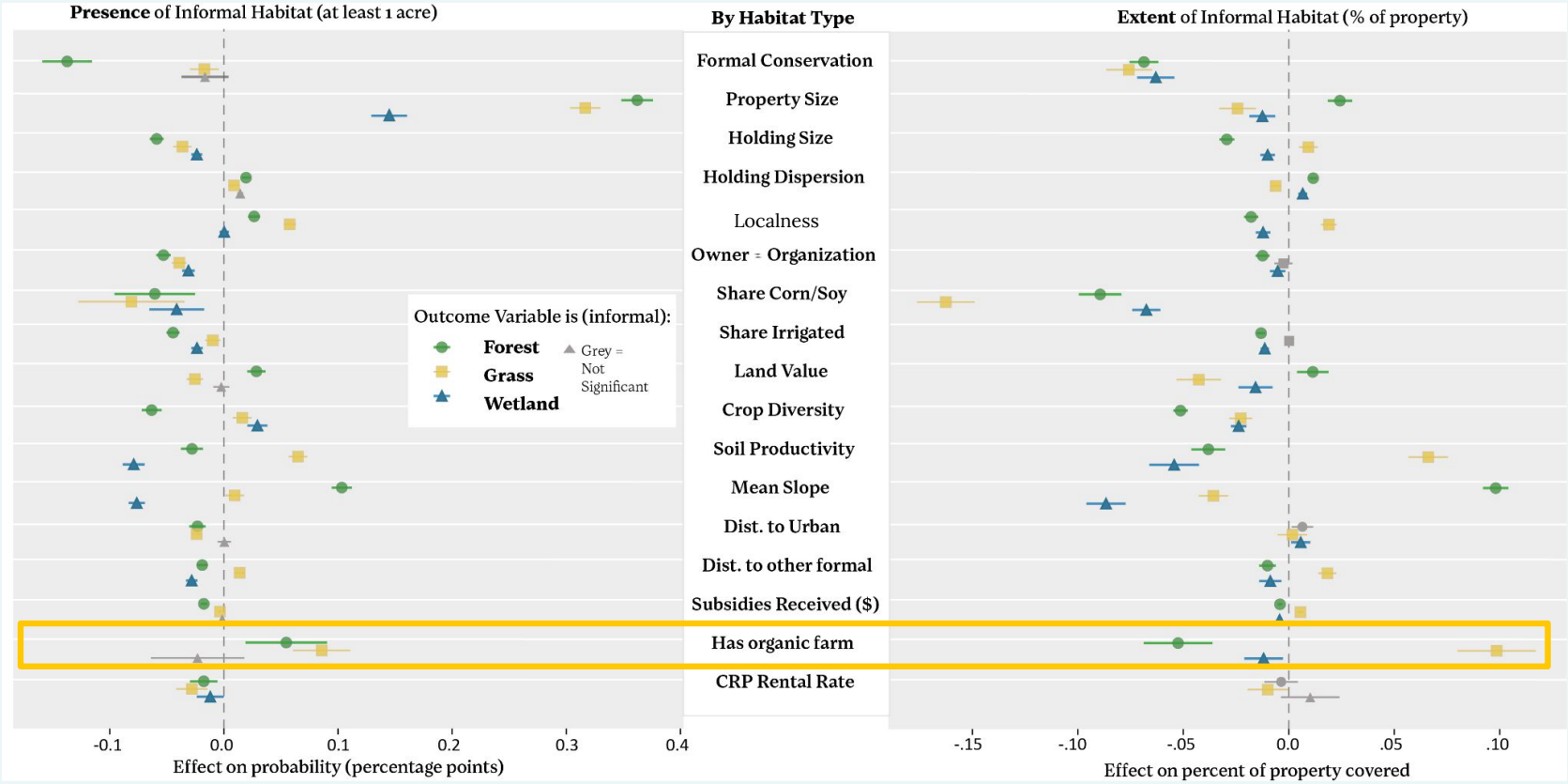
More Productive Soils → More Grass



Steeper Slopes → More Forest



Organic Farm → More grass



Organic Farm → More grass

Different Land Cover Types Need Different Conservation Approaches

- **Forests**: Persist on steep, less productive land; may have amenity/timber value
- **Grasslands**: Associated with extensive grazing and local ownership
- **Wetlands**: Most constrained by topography; weaker management associations

- Uniform conservation policies can't effectively address ecological and economic heterogeneity across cover types

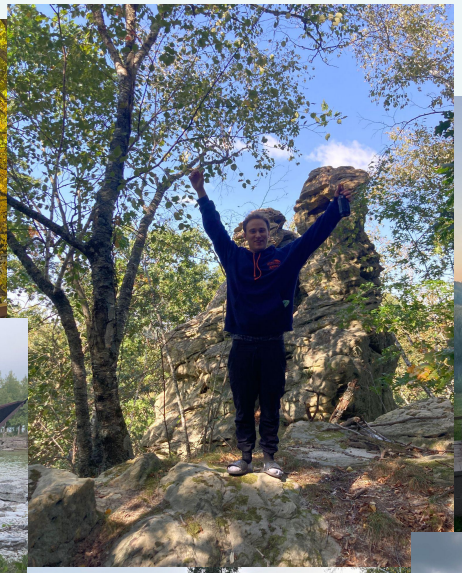
The Vast Extent of Private Lands Conservation

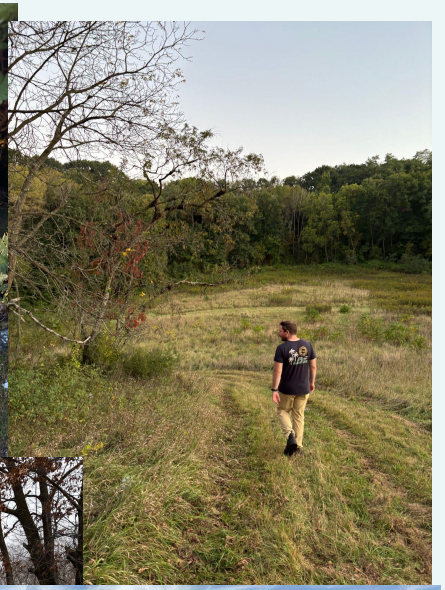
- **195 million acres** of informal natural land
- **Regional complexity** matters
  - North Dakota ≠ Ohio
- Structural **vulnerability…stability**?
- Formal programs get attention & funding

- **Path forward**
  - Understand what exists, who maintains it, what threatens it
  - Support existing stewardship alongside formal programs

Research Agenda – Now to the PhD!!

- **National assessment:** How does informal natural land vary across regions?
- **Causal analysis:** How does it respond to price changes, policy shifts?
- **Landowner interviews:** What drives decision-making?
- **Ecological value:** Biodiversity, carbon, water quality, connectivity
- **Urban/suburban:** Lawns, gardens, residential properties
    - NAIP imagery, machine learning

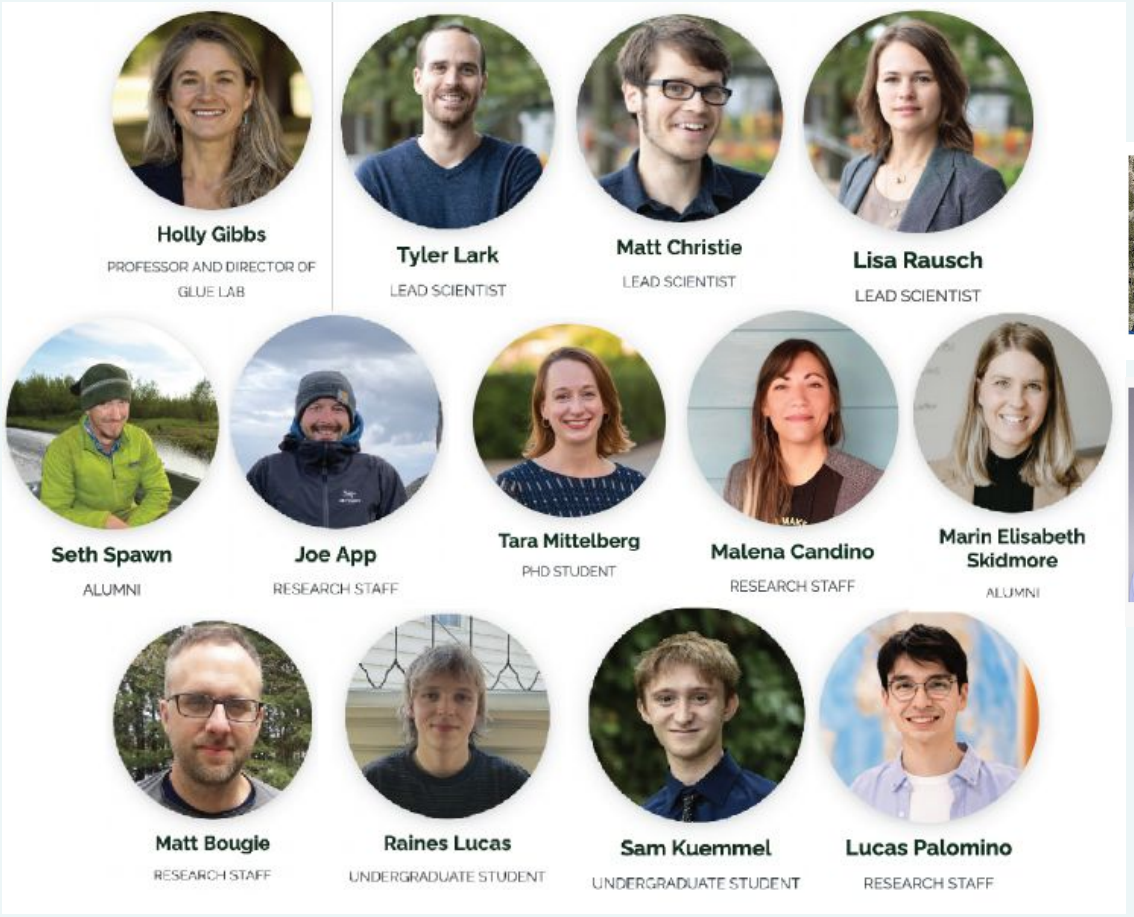







Thank you!!!!!!!!



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