

# Machine Learning Predicts Which Rivers, Streams, and Wetlands the Clean Water Act Regulates

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# Summary

## Research questions

- Which waters are jurisdictional under Clean Water Act rules?

## Approach

- Train deep learning model (“WOTUS-ML”) on jurisdictional decisions
- 34 input layers
- Predict probability jurisdictional, separately by rule
- Apply to 4 million+ points across US

# Summary

- **Model accuracy**

- All AJDs: 79% accuracy
- Over half of sites: 90% accuracy
- A fourth of sites: 95% accuracy

- **Results**

- Stream miles: NWPR v. *Rapanos* deregulates 19 pp.
- Wetland acres: NWPR v. *Rapanos* deregulates 24 pp.
- NWPR v. *Rapanos* drinking water sources deregulated: 30%
- PJDs: 40-50 pp. jurisdictional
- ACE districts matter

# What is New Here

**This paper:** First national estimate of legally-binding CWA jurisdiction

## Three regulatory regimes:

1. 1986/88 Regulatory Definition + *Rapanos v. United States*, 2006 (“*Rapanos*”)
2. Clean Water Rule, 2015 (“CWR” or “Obama rule”)
3. Navigable Waters Protection Rule, 2020 (“NWPR” or “Trump rule”)
4. (Aug 29, 2023: *Sackett* rule)

# Summary: Potential Uses?

- **Government?**

- EPA
- ACE
- State agencies (e.g., CA Water Boards)

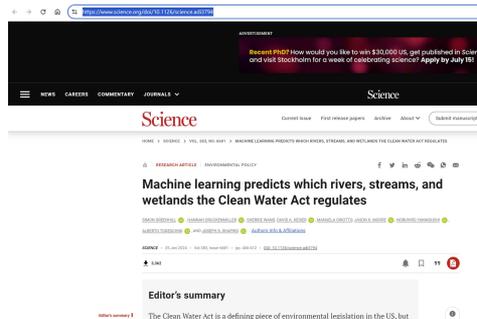
- **Non-government?**

- Developers/landowners
- Organizations: TU, ACWA, NAWM, ...
- Courts
- Industry associations
- Real estate websites
- Regulatory advisory firms

# How Can You Learn More?

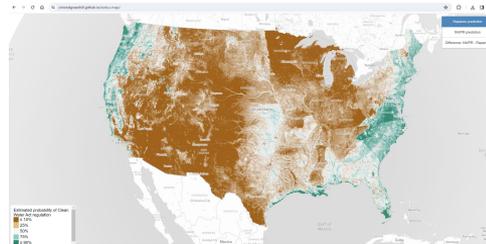
- *Science* article:

<https://www.science.org/doi/10.1126/science.adi3794>



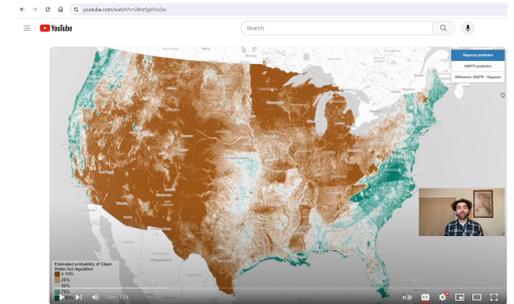
- Interactive map:

<https://simondgreenhill.github.io/wotus-map/>



- Explainer video:

<https://www.youtube.com/watch?v=Jkhz5gVUo2w>



- API?

# Questions for NAWM

- How can we make this research and tool useful?
- What important questions can this type of work can help answer?

# Overview

- **Motivation**
- Data and Methods
- Model Accuracy
- Results
- Conclusions

The Clean Water Act (1972) protects the **“Waters of the United States”**

Section 404: dredge or fill material

Law targets pollution, Section 404 affects land use



# Examples

## Definitely WOTUS



Navigable waters and their tributaries

Lakes & ponds with surface flow to navigable waters



Wetlands abutting navigable waters

## Ambiguous



Ephemeral streams



Isolated wetlands

## Definitely not WOTUS



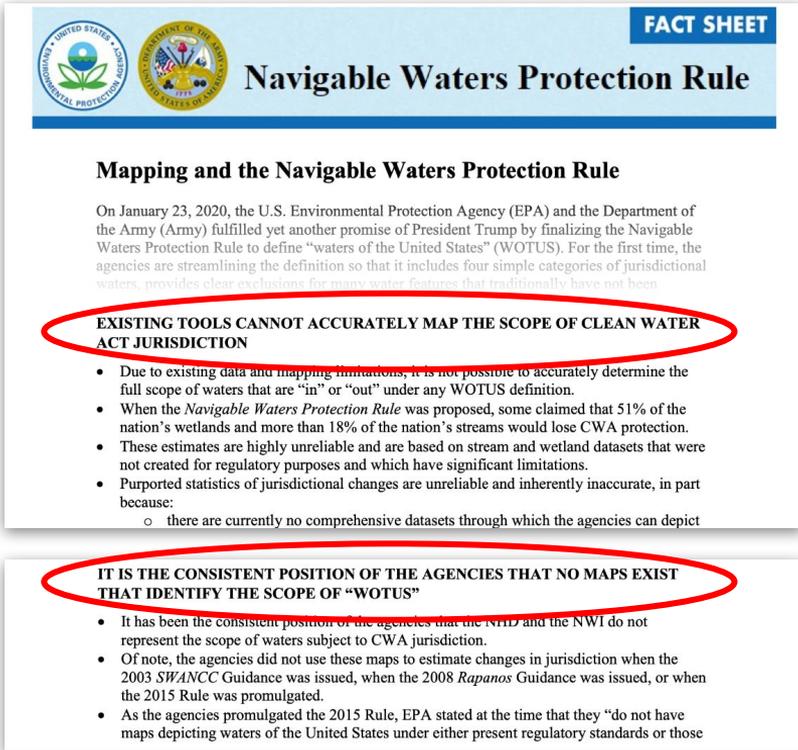
Artificial ponds in uplands / drylands

Most roadside ditches



Stormwater runoff

# Problem: No one knows exactly which waters are protected



The image shows a fact sheet titled "FACT SHEET Navigable Waters Protection Rule". It features logos for the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. The main heading is "Mapping and the Navigable Waters Protection Rule". Below this, a paragraph states that on January 23, 2020, the EPA and the Army fulfilled a promise by finalizing the rule to define "waters of the United States" (WOTUS). A red circle highlights the text: "EXISTING TOOLS CANNOT ACCURATELY MAP THE SCOPE OF CLEAN WATER ACT JURISDICTION". This is followed by a bulleted list of reasons. A second red circle highlights the text: "IT IS THE CONSISTENT POSITION OF THE AGENCIES THAT NO MAPS EXIST THAT IDENTIFY THE SCOPE OF 'WOTUS'", followed by another bulleted list.

**FACT SHEET**

## Navigable Waters Protection Rule

### Mapping and the Navigable Waters Protection Rule

On January 23, 2020, the U.S. Environmental Protection Agency (EPA) and the Department of the Army (Army) fulfilled yet another promise of President Trump by finalizing the Navigable Waters Protection Rule to define "waters of the United States" (WOTUS). For the first time, the agencies are streamlining the definition so that it includes four simple categories of jurisdictional waters, provides clear exclusions for many water features that traditionally have not been

**EXISTING TOOLS CANNOT ACCURATELY MAP THE SCOPE OF CLEAN WATER ACT JURISDICTION**

- Due to existing data and mapping limitations, it is not possible to accurately determine the full scope of waters that are "in" or "out" under any WOTUS definition.
- When the *Navigable Waters Protection Rule* was proposed, some claimed that 51% of the nation's wetlands and more than 18% of the nation's streams would lose CWA protection.
- These estimates are highly unreliable and are based on stream and wetland datasets that were not created for regulatory purposes and which have significant limitations.
- Purported statistics of jurisdictional changes are unreliable and inherently inaccurate, in part because:
  - there are currently no comprehensive datasets through which the agencies can depict

**IT IS THE CONSISTENT POSITION OF THE AGENCIES THAT NO MAPS EXIST THAT IDENTIFY THE SCOPE OF "WOTUS"**

- It has been the consistent position of the agencies that the NWI and the NWI do not represent the scope of waters subject to CWA jurisdiction.
- Of note, the agencies did not use these maps to estimate changes in jurisdiction when the 2003 *SWANCC* Guidance was issued, when the 2008 *Rapanos* Guidance was issued, or when the 2015 Rule was promulgated.
- As the agencies promulgated the 2015 Rule, EPA stated at the time that they "do not have maps depicting waters of the United States under either present regulatory standards or those

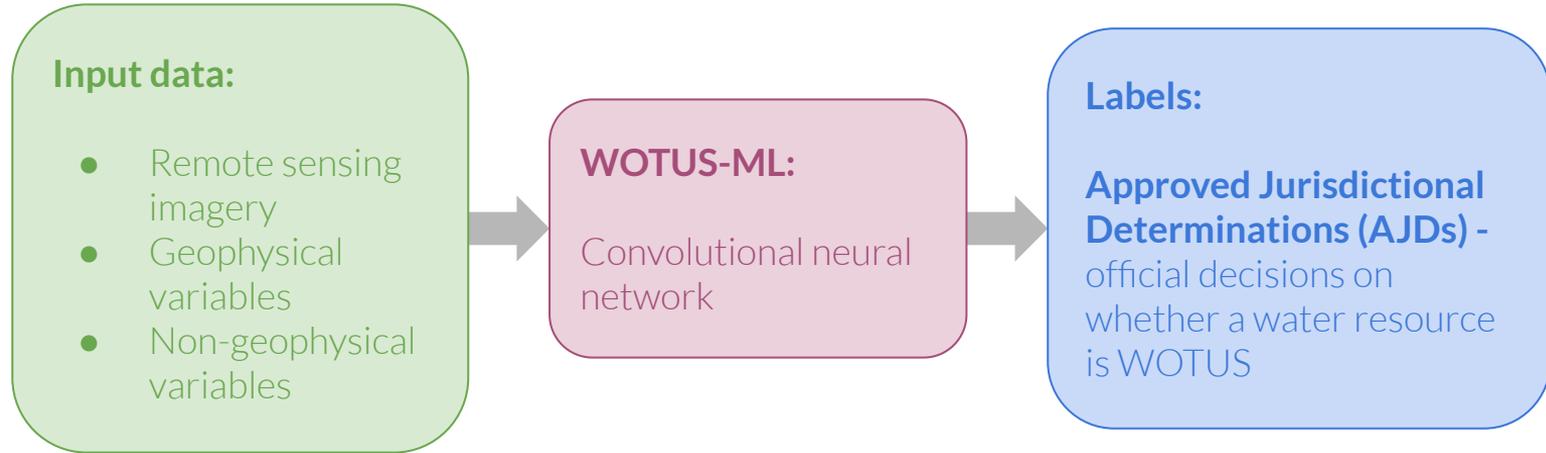
- Congress did not define WOTUS
- Depends on rules, interpretation by EPA, ACE
- How do rules change CWA coverage?
  - AWWA: NWPR eliminates CWA protection for 51% of U.S. wetlands and 18% of U.S. streams
  - "This puts drinking water for millions of Americans at risk of contamination from unregulated pollution."

- Southern Environmental Law Center

# Overview

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**Overview:** Use deep learning to recreate Army Corps decision problem about what is jurisdictional (“WOTUS”)



# Data: Approved Jurisdictional Determinations (AJDs)



- 155,000 AJDs from Aug 2015 - May 2022
- AJDs are requested by developers who think waters on their land may be jurisdictional
- Pool AJDs across rules for model training

Rule	<i>Rapanos</i>	CWR	NWPR	Total
<b># AJDs</b>	84,314	7,900	62,934	155,148

## Data: Input layers

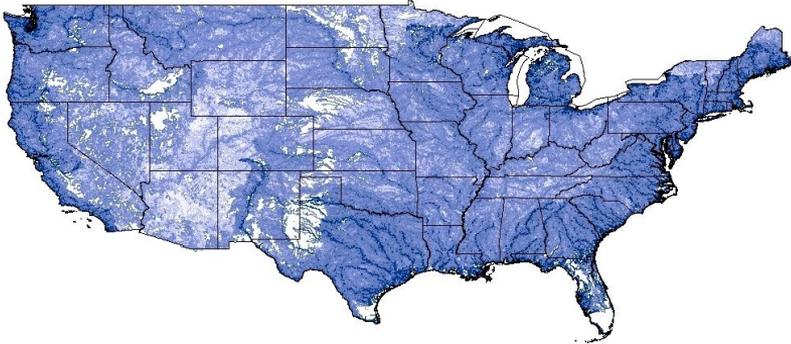
**National Agricultural Imagery Program (NAIP)**



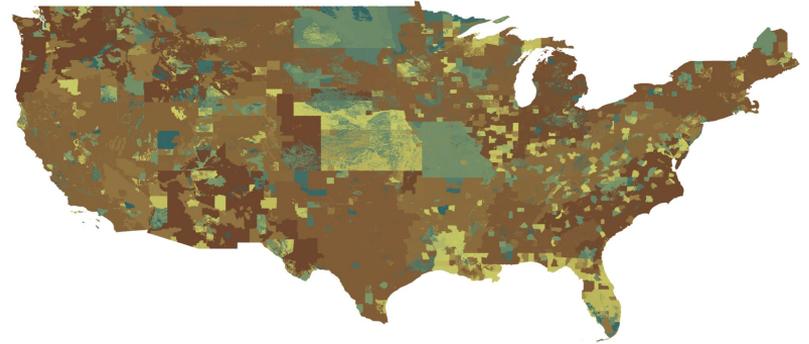
**National Wetlands Inventory (NWI)**



**National Hydrography Dataset (NHD)**



**gridded National Soil Survey (gNATSGO)**



# Data: Input layers

## NAIP

(1-3) RGB

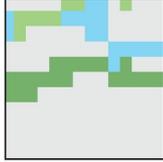


(4) NIR



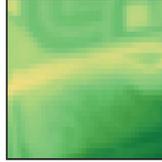
## NWI

(5) Wetland type



## 3DEP

(6) Elevation



## NLCD

(7) Land cover



## PRISM

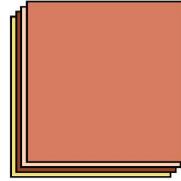
(21) Precipitation

(22) Mean temperature

(23) Minimum temperature

(24) Maximum temperature

(25) Mean dew point temperature



(26) Minimum vapor pressure deficit

(27) Maximum vapor pressure deficit

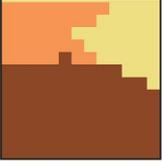
(28) Solar radiation (total)

(29) Solar radiation (clear)

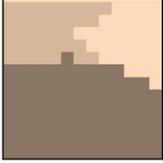
(30) Cloud transmittance

## gNATSGO

(8) Taxonomic class



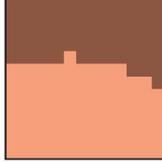
(9) Hydric rating



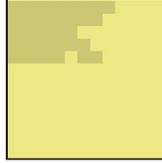
(10) Water table depth



(11) Flooding frequency



(12) Ponding frequency



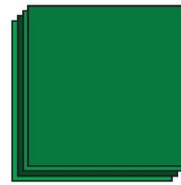
## Geography

(31) State

(32) ACE district

(33) Distance to ACE headquarters

(34) Ecoregion (level IV)



## NHD

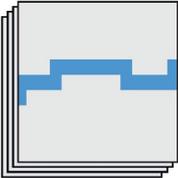
(13) Fcode

(14) Stream order

(15) High flow

(16) Low flow

(17) Path length

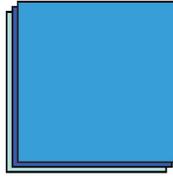


## WOTUS RULE

(18) *Rapanos*

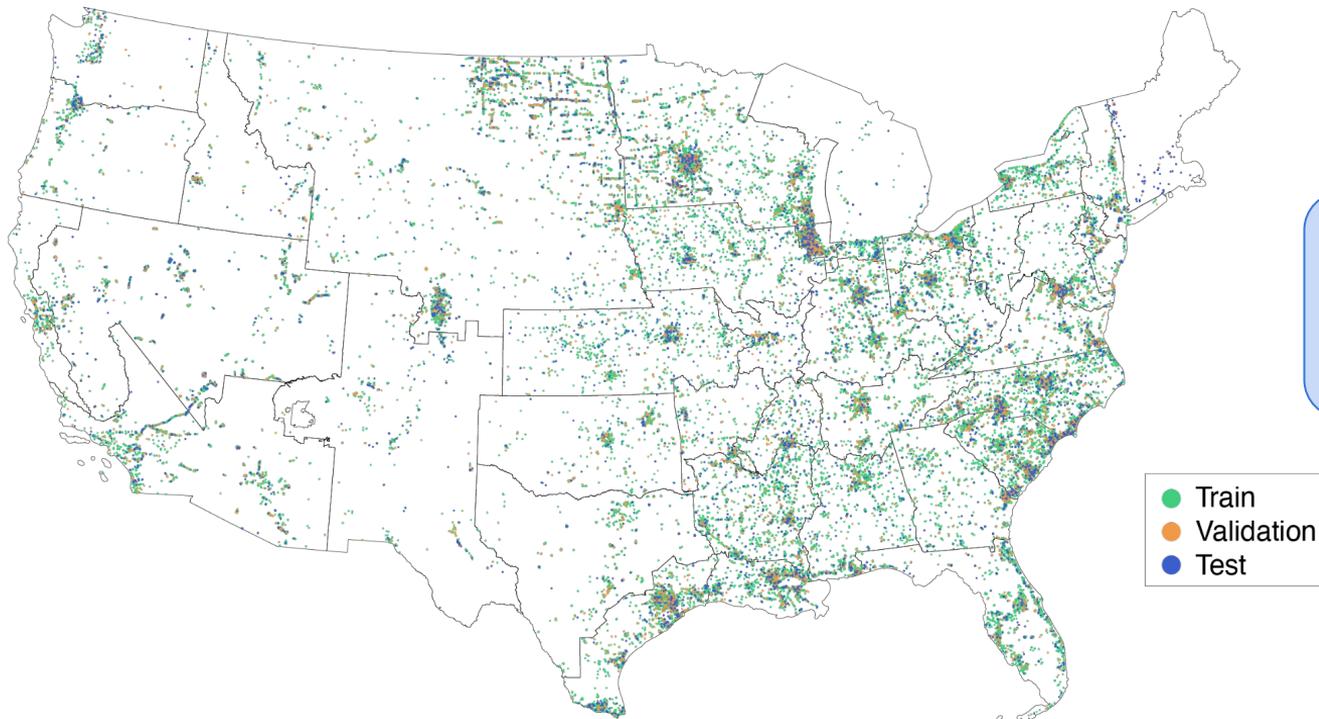
(19) CWR

(20) NPWR



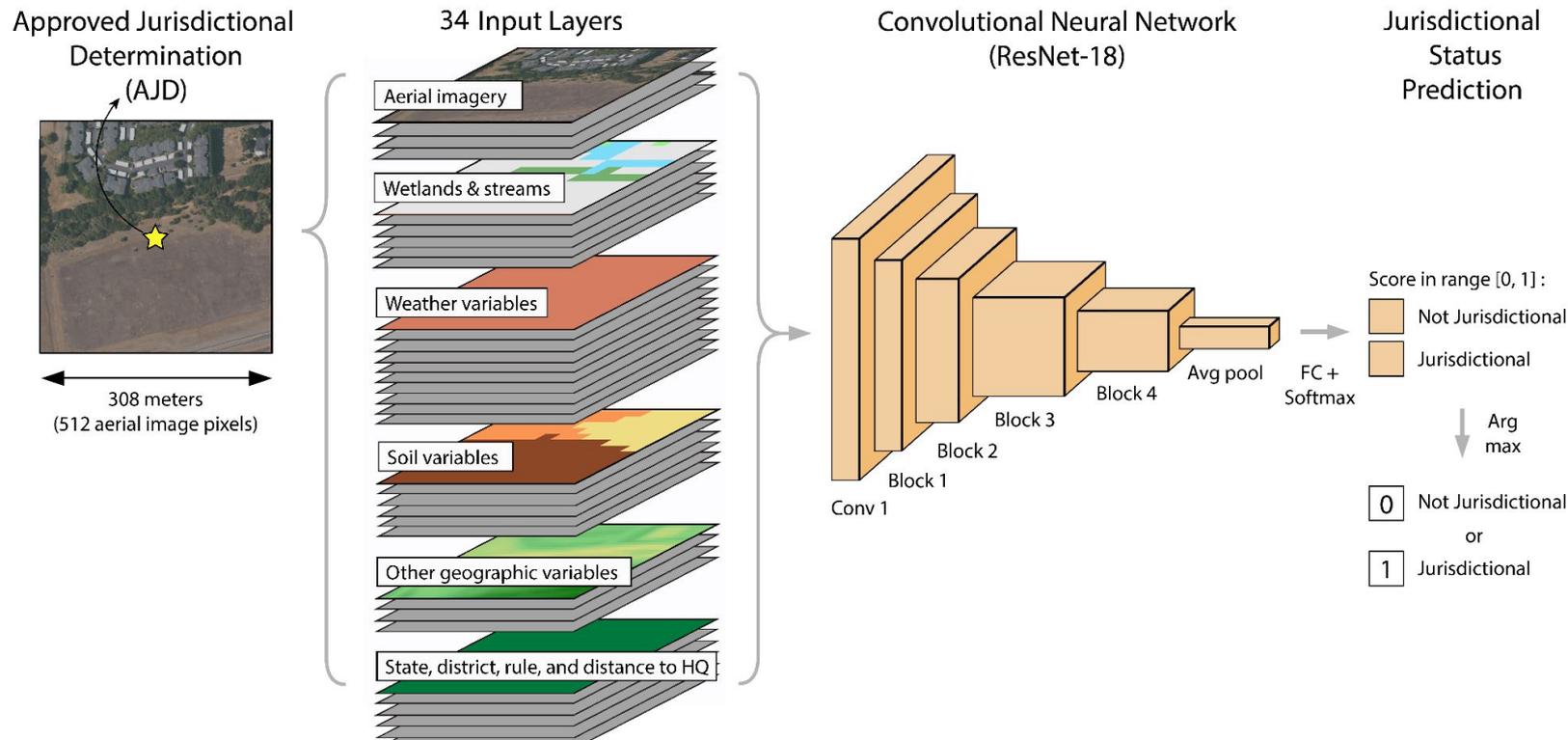
**Data:** Training, validation, and test sets are split geographically

### AJD Geographic Distribution



AJDs with overlapping image footprints are placed in the same split to avoid leakage

# Method: WOTUS-ML uses a ResNet-18 neural network architecture



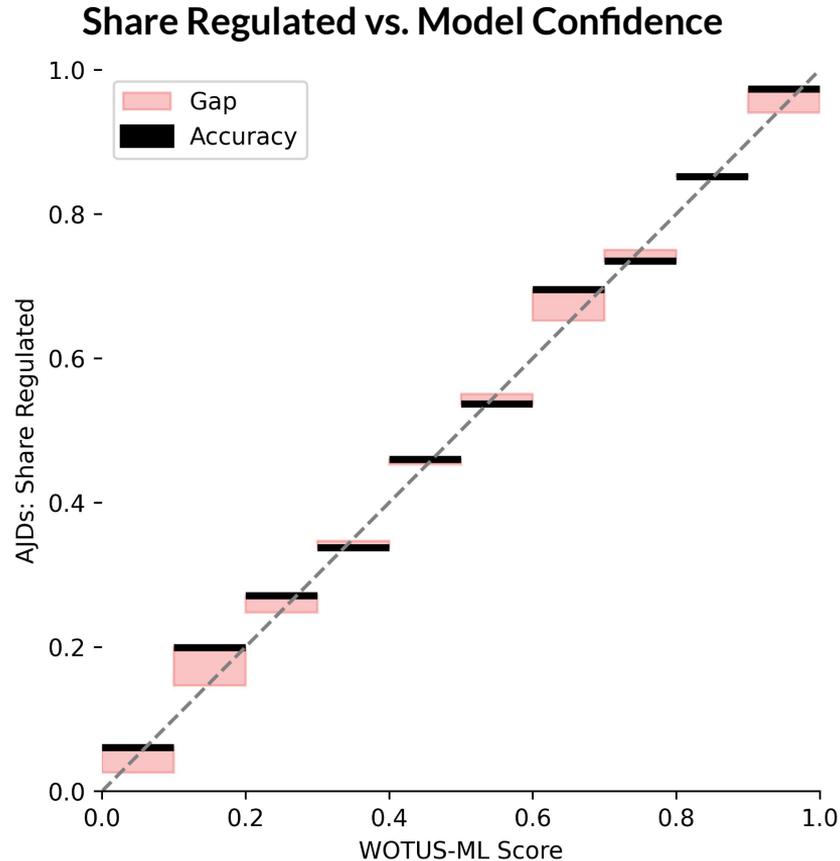
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- Motivation
- Data and Methods
- **Model Accuracy**
- Results
- Conclusions

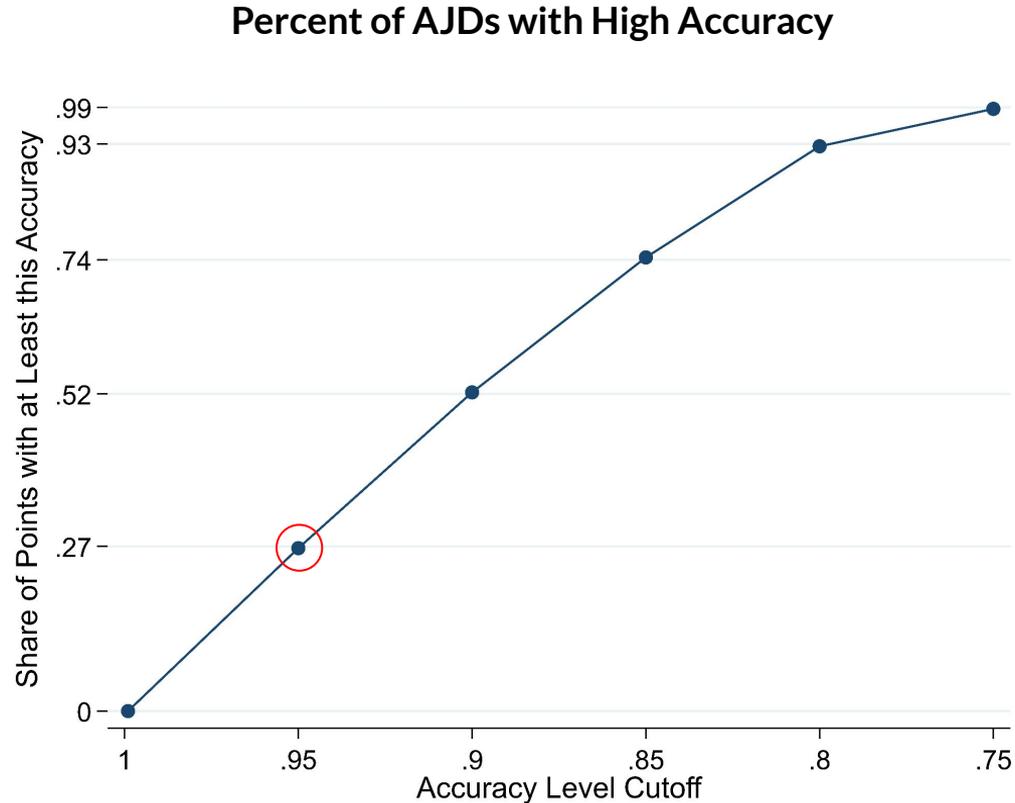
## Accuracy: WOTUS-ML predicts AJD outcomes with **79% accuracy**

	True fraction WOTUS	WOTUS-ML score > 0.5	Accuracy	N (test set)
All AJDs	0.35	0.29	0.79	15,970
<i>Rapanos</i>	0.41	0.37	0.78	8,198
NWPR	0.26	0.15	0.79	6,299
USACE field visit	0.46	0.38	0.74	7,198
USACE no field visit	0.26	0.21	0.82	8,772

# Accuracy: Nearly unbiased estimate of jurisdiction



# Accuracy: WOTUS-ML has potential as decision support tool



## Accuracy: WOTUS-ML can save resources

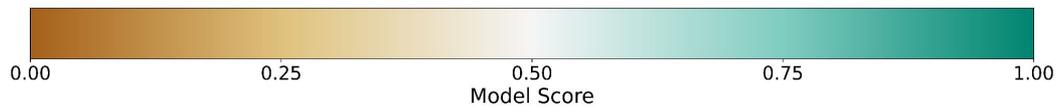
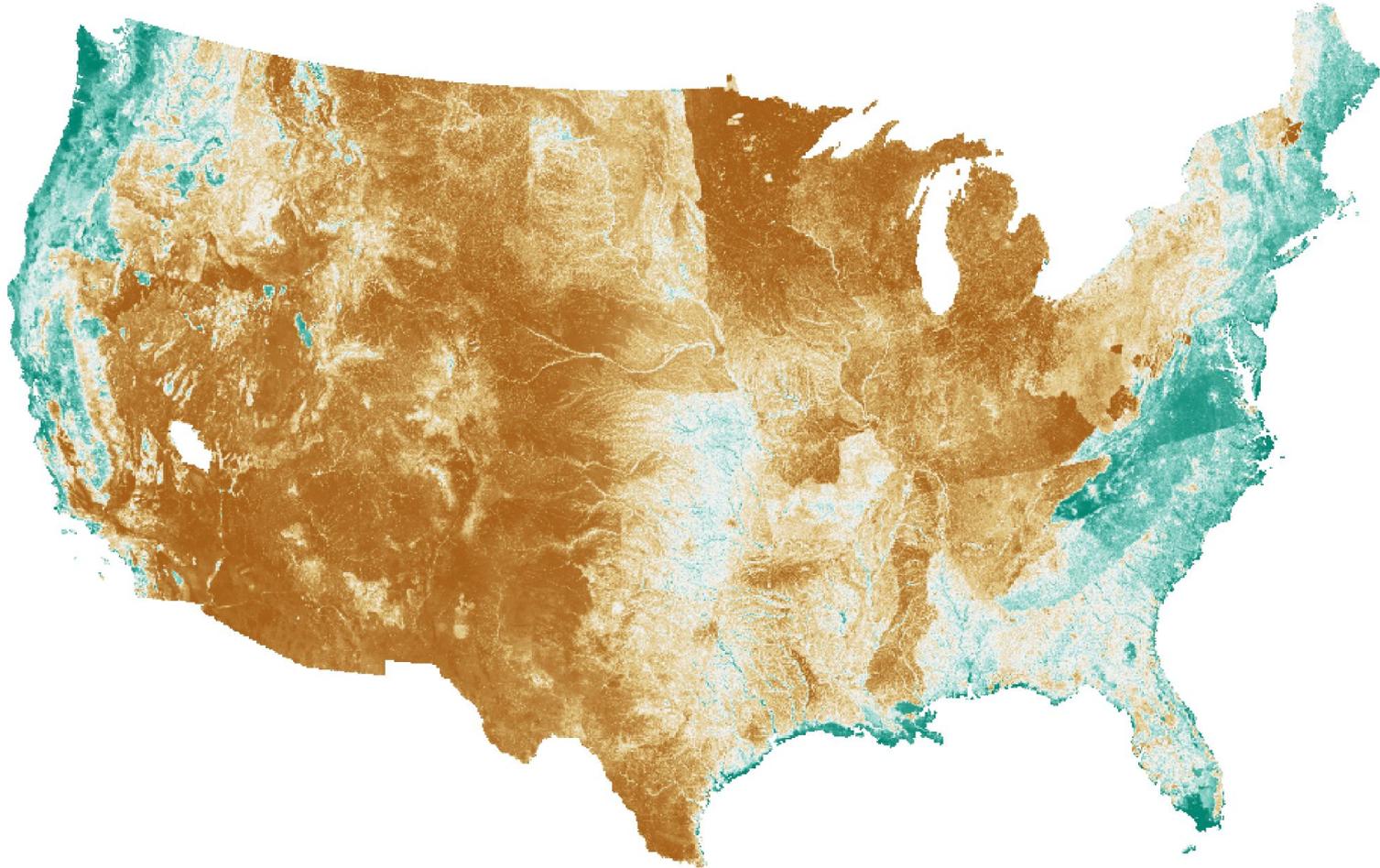
- Section 404 permit costs \$5,000 to \$39,000 (EPA 2022)
  - Out of pocket costs; economic costs larger?
  - No estimates for AJD cost?
- Imagine: use WOTUS-ML for cases with 95% accuracy
  - Would save \$209mn to \$1.6bn over our sample

## **Application:** Applying WOTUS-ML to

1. 4 million **randomly sampled** points across the U.S.
  - Sampled 50 points in each of 0.1 x 0.1 degree grid cells
2. 3,000 points around **Sackett property** on Priest Lake, ID
3. 6,200 points along **navigable waters**
  - Regulated under every WOTUS rule
  - Test model's out-of-sample performance
4. 101,000 Preliminary Jurisdictional Determinations (PJDs)

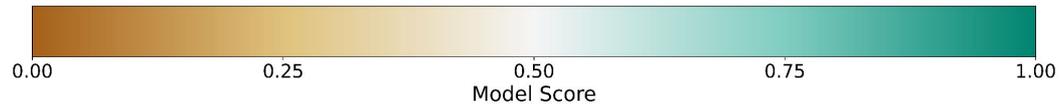
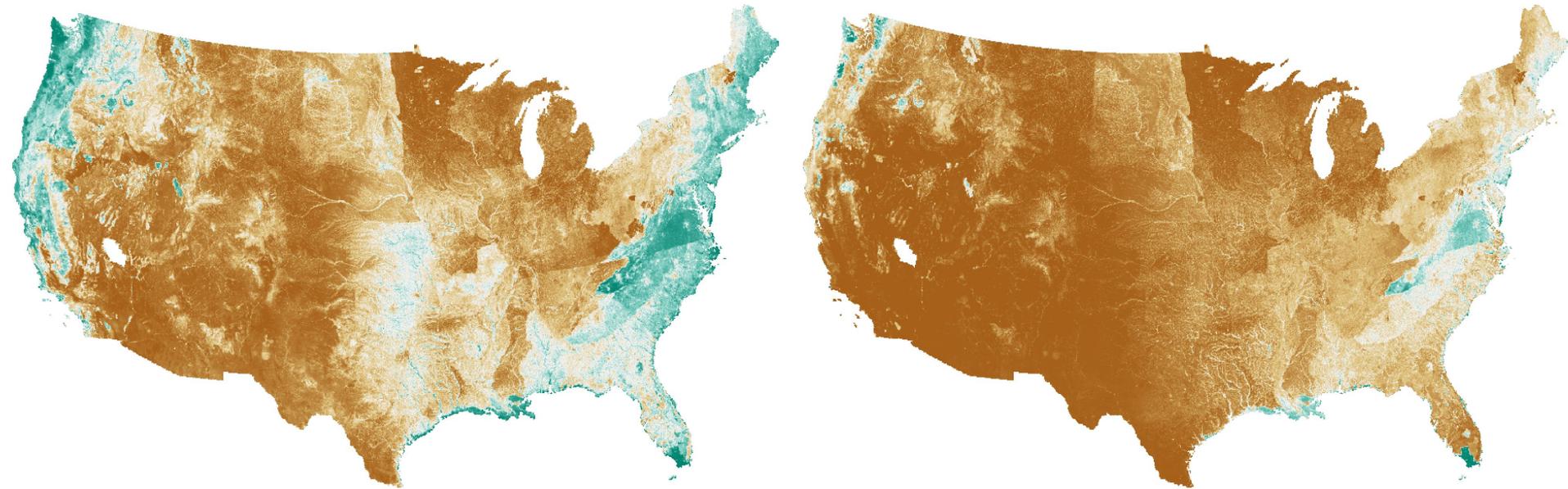
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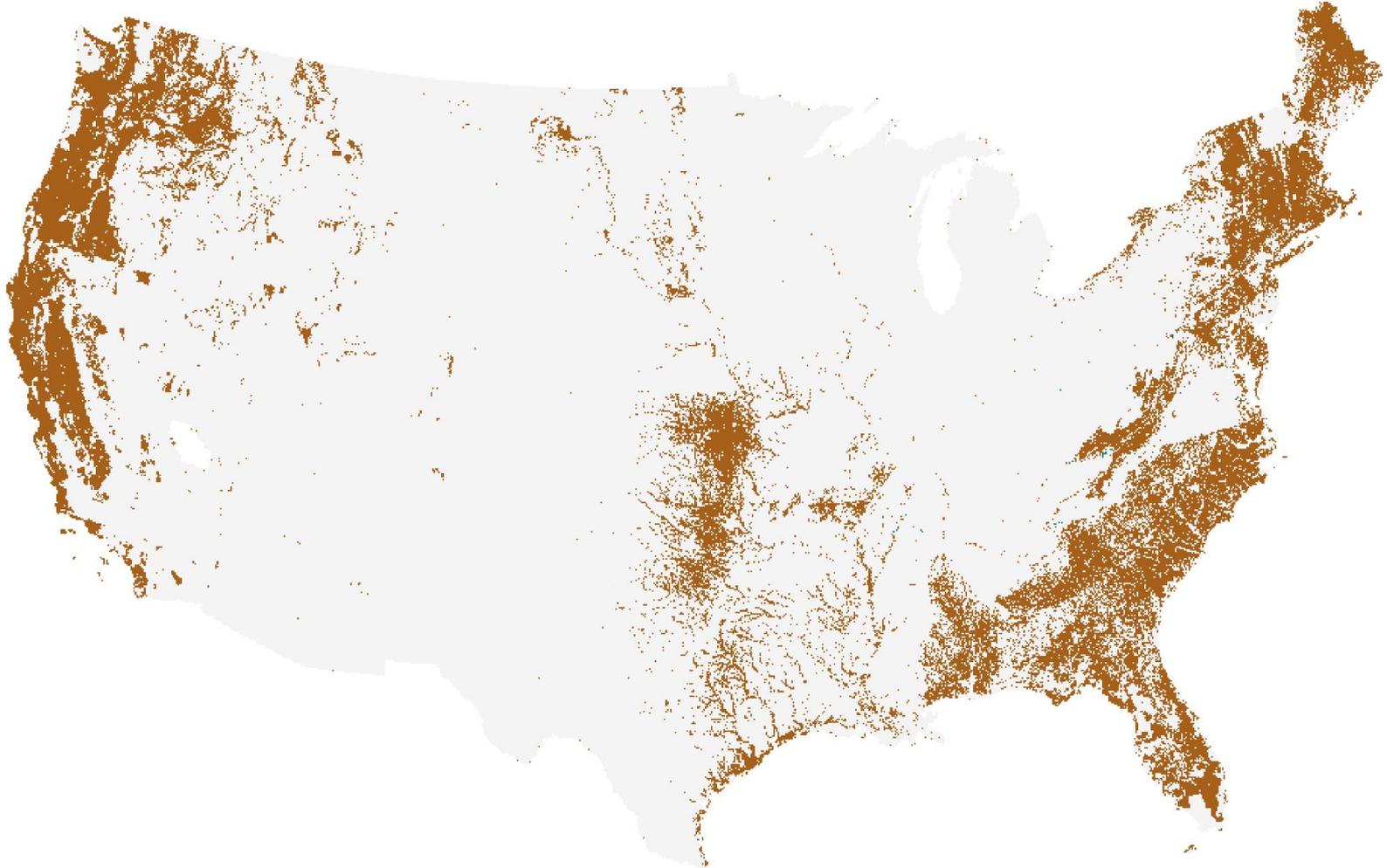


*Rapanos*

NWPR



# Many points change jurisdiction, *Rapanos v. NWRP*



## Result: WOTUS-ML says all navigable waterways regulated

Rivers and streams	Share predicted to be WOTUS	
	<i>Rapanos</i>	NWPR
All	0.67	0.46
Navigable	1.00	1.00
Perennial	0.83	0.67
Intermittent or ephemeral	0.55	0.30

## Result: NWPR deregulates 19% of rivers/streams

Rivers and streams	Share predicted to be WOTUS	
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All	0.67	0.46
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**NWPR deregulates** 608,000 stream miles

Equal to all streams/rivers in CA, FL, IL, NY, OH, PA, TX, combined

## Result: NWPR deregulates 24% of wetlands

Wetlands	Rapanos	NWPR
All	0.52	0.27
Emergent	0.47	0.20
Forested	0.59	0.32
Adjacent or abutting	0.88	0.57
Isolated	0.39	0.14

**NWPR deregulates** 32 million wetland acres

Equals 14% of wetland area in US at time of European settlement

\$482bn in present flood mitigation value (Taylor & Druckenmiller 2023)

\$406bn in land value (Nolte 2020)

# Result: Case studies show what is regulated, how WOTUS-ML works

NAIP image

*Rapanos*

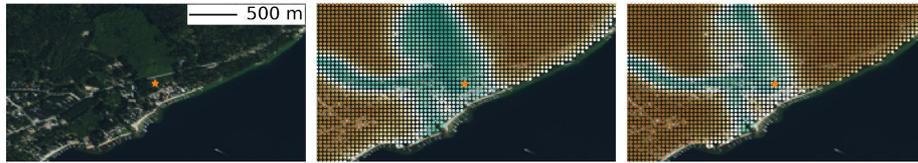
NWPR

NAIP image

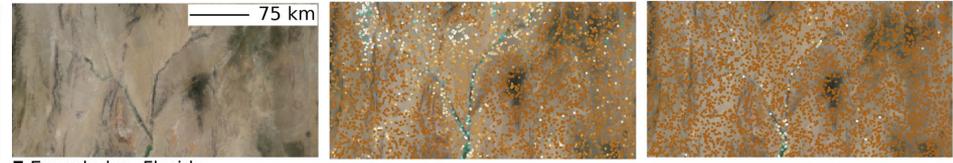
*Rapanos*

NWPR

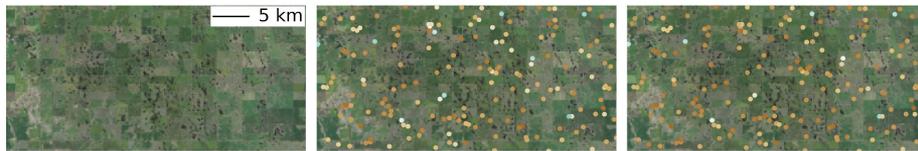
**A** *Sackett v. EPA* case, Idaho



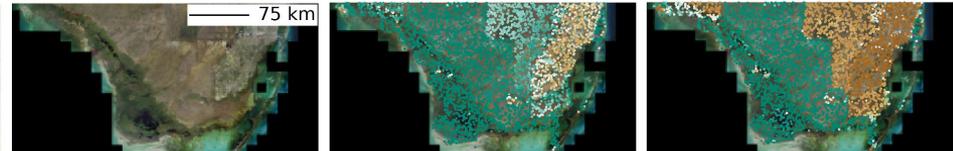
**D** Ephemeral streams, Utah/Nevada/Arizona



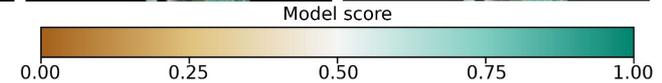
**B** Isolated wetlands (Prairie Potholes), North Dakota



**E** Everglades, Florida



**C** Mississippi River, Louisiana



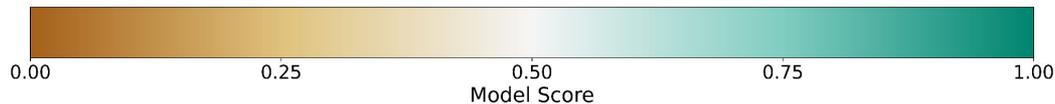
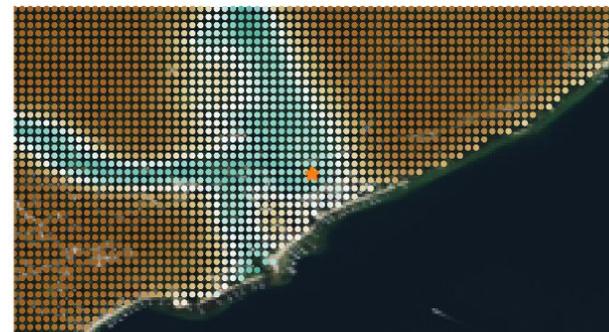
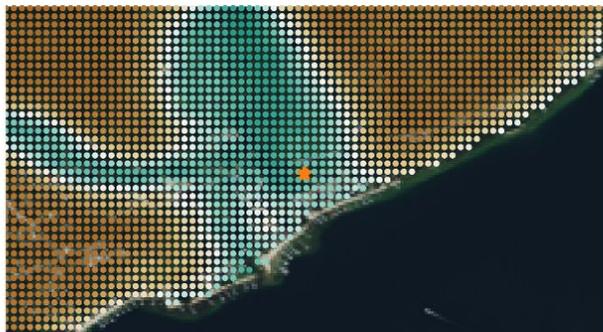
**Result:** Case studies show what is regulated, how WOTUS-ML works

**NAIP image**

***Rapanos***

**NWPR**

**A** *Sackett v. EPA* case, Idaho



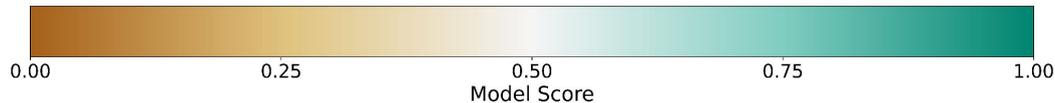
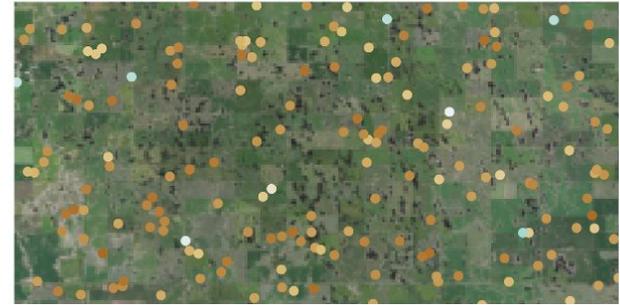
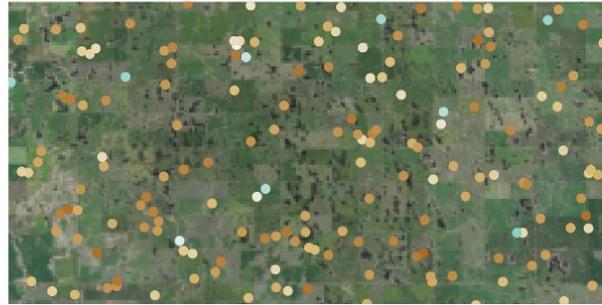
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**NAIP image**

***Rapanos***

**NWPR**

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### NAIP image

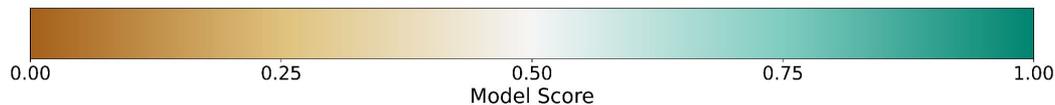
C Mississippi River, Louisiana



### *Rapanos*



### NWPR



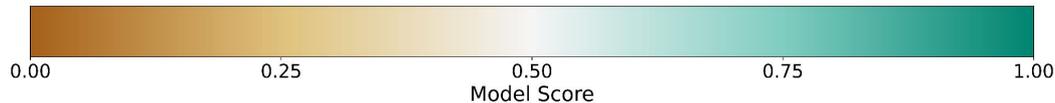
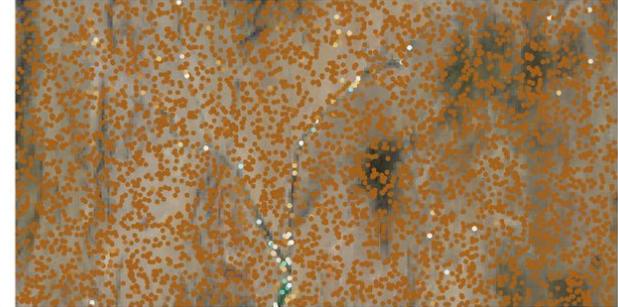
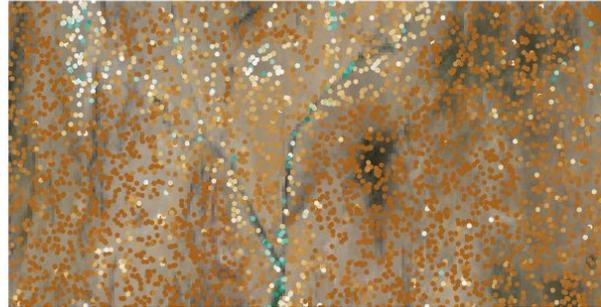
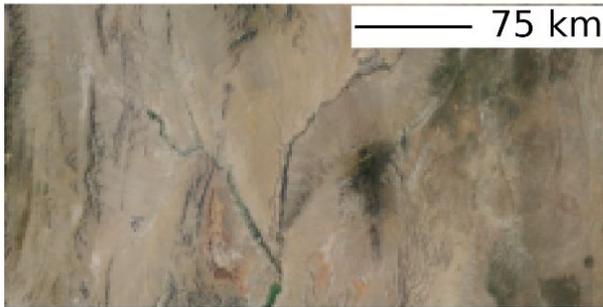
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### NAIP image

### *Rapanos*

### NWPR

D Ephemeral streams, Utah/Nevada/Arizona



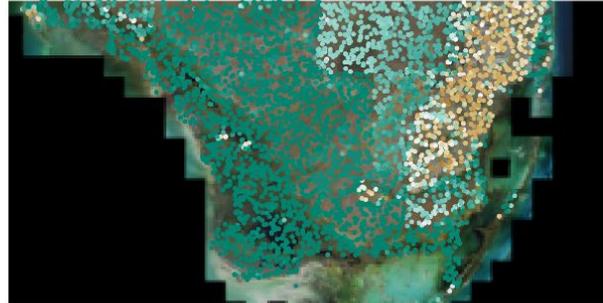
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**NAIP image**

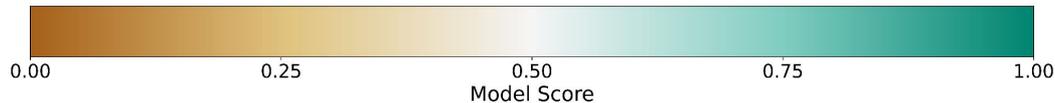
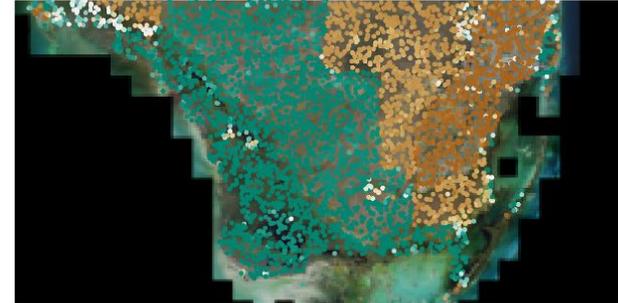
**E** Everglades, Florida



***Rapanos***

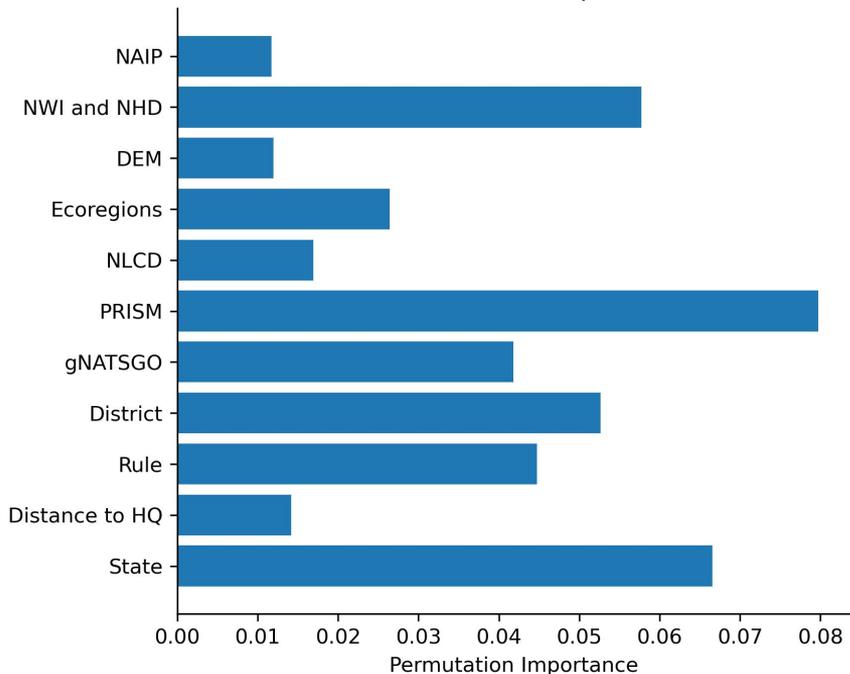


**NWPR**

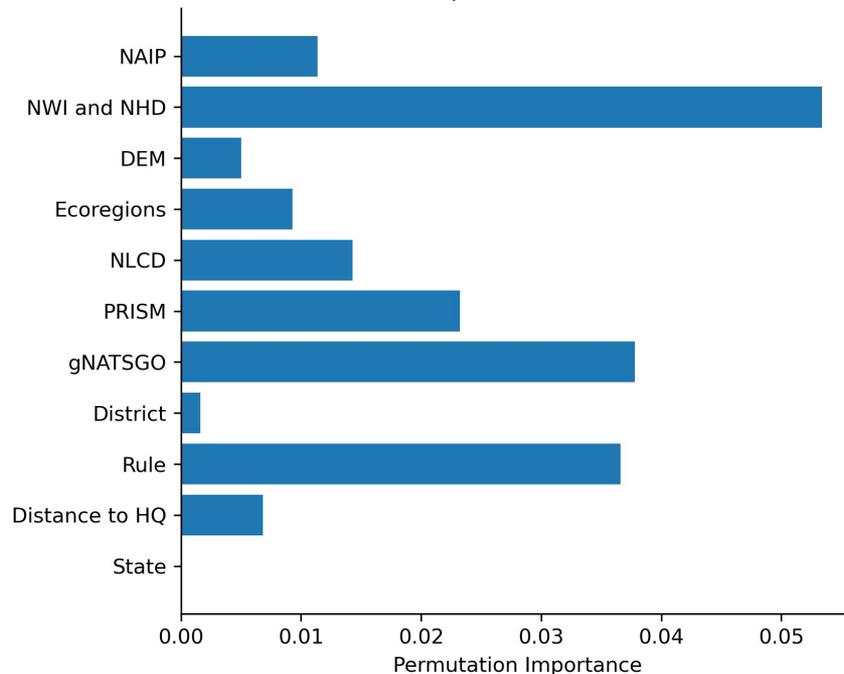


# Result: Feature Importance Analysis Helps Open Black Box of ML

## National Feature Importance



## Feature Importance within State



## Result: NWPR Deregulates Drinking Water Sources

- Take locations of all identified US drinking water intakes
  - What share of streams, wetlands in same subwatershed (HUC12) lose jurisdiction between *Rapanos* and NWPR?
  - Answer: 30%

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## **Conclusion:** First National Estimate of Legally-Binding CWA Regulation

**Political debates:** what should be regulated. **This paper:** what is regulated.

### **Results:**

- NWPR (v. *Rapanos*) deregulated 19pp of stream miles, 24pp of all wetland acres
- Hundreds of billions of \$ in flood mitigation, land value
- PJDs: only 40-50% jurisdictional
- ACE districts evaluate sites differently
- 30% of drinking water sources deregulated

**Potential users:** EPA? Developers? ACE? White House?

Machine learning for **regulatory implementation problems**

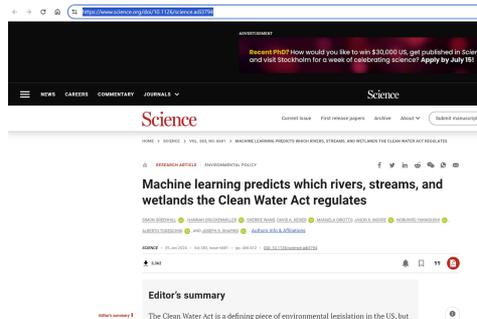
# Questions for NAWM

- **How can we make this research and tool useful?**
- **What important questions can this type of work can help answer?**

# How Can You Learn More?

- *Science* article:

<https://www.science.org/doi/10.1126/science.adi3794>



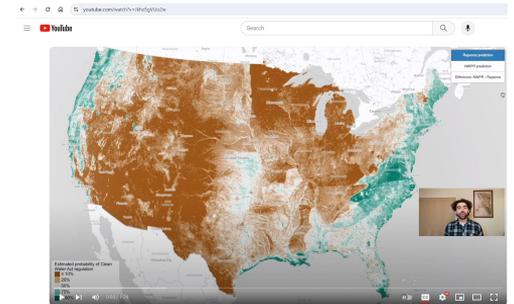
- Interactive map:

<https://simondgreenhill.github.io/wotus-map/>



- Explainer video:

<https://www.youtube.com/watch?v=Jkhz5gVUo2w>



- API?

**Accuracy:** Similar for streams and wetlands (by Cowardin)

	True fraction WOTUS	WOTUS-ML score > 0.5	Accuracy	N (test set)
All rivers and streams	0.43	0.31	0.78	4,353
Wetlands	0.38	0.28	0.77	8,203
Uplands	0.00	0.17	0.83	2,529
Estuaries	0.99	0.94	0.94	304
Lakes	0.39	0.30	0.81	352

## Accuracy: By Cowardin category, *Rapanos* vs. NWPR

### *Rapanos*

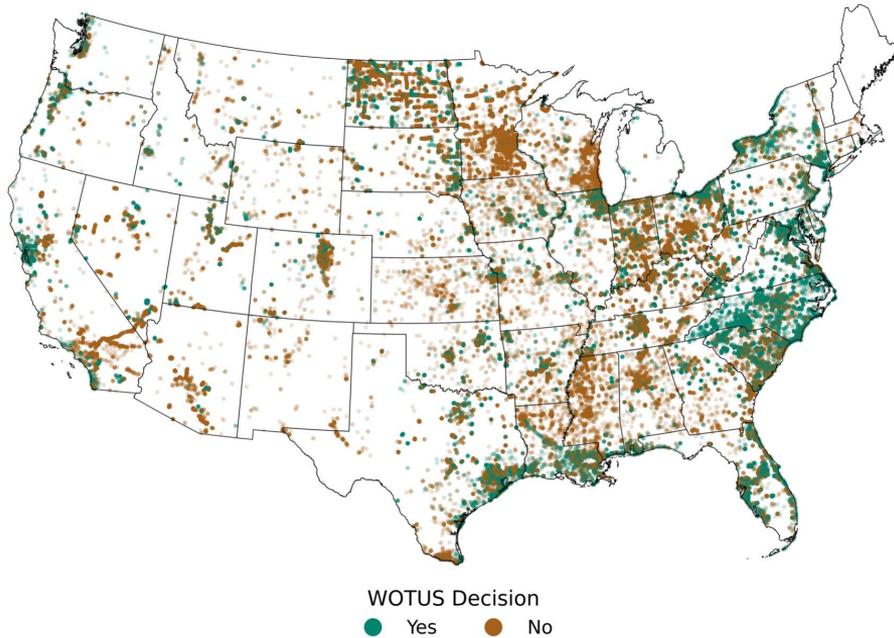
	True fraction WOTUS	WOTUS-ML score > 0.5	Accuracy
All rivers and streams	0.67	0.54	0.80
Wetlands	0.47	0.36	0.76
Uplands	0.00	0.19	0.81
Estuaries	1.00	0.96	0.96
Lakes	0.59	0.49	0.77

### NWPR

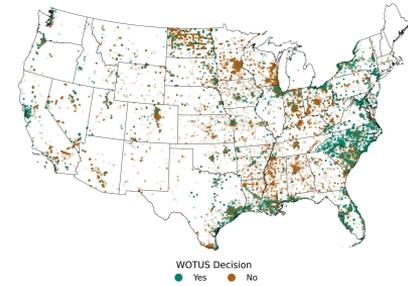
	True fraction WOTUS	WOTUS-ML score > 0.5	Accuracy
All rivers and streams	0.30	0.15	0.77
Wetlands	0.26	0.16	0.80
Uplands	0.00	0.09	0.91
Estuaries	0.88	0.79	0.73
Lakes	0.10	0.05	0.90

# Data: AJD geographical distribution

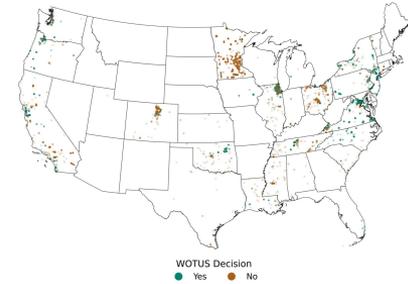
All rules



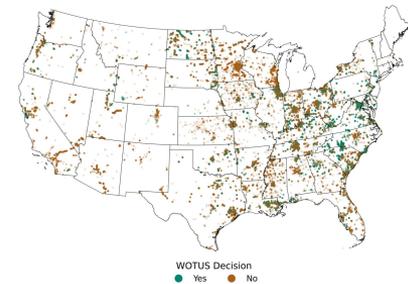
*Rapanos*



CWR



NWPR



# Data: Types of water resources (Cowardin codes)

**Table S1: Categorization of Nine Hydrological (Cowardin) Codes**

<b>Cowardin code</b>	<b>Description</b>
1. Streams, ephemeral	A wetland, spring, stream, river, pond or lake that only exists for a short period
2. Streams, intermittent	Intermittent, Riverine; Streambed, Intermittent, Riverine
3. Streams, perennial and other	Upper Perennial, Riverine; Lower Perennial, Riverine; Unknown Perennial, Riverine
4. Wetland, emergent	Emergent, Palustrine; Persistent, Emergent, Palustrine; Nonpersistent, Emergent, Palustrine
5. Wetland, forested	Forested, Palustrine; Broad-Leaved Deciduous, Forested, Palustrine; Needle-Leaved Evergreen, Forested, Palustrine; Needle-Leaved Deciduous, Forested, Palustrine; Broad-Leaved Evergreen, Forested, Palustrine; Indeterminate Deciduous, Forested, Palustrine
6. Wetland, other	All other palustrine
7. Estuaries	Estuarine
8. Uplands	Uplands
9. Other	Marine, lacustrine, riparian

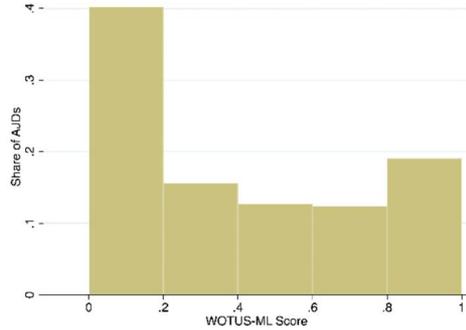
# Data: Types of water resources (Resource types)

**Table S2: Categorization of Nine Resource Types.** RPW, relatively permanent waters; TNW, territorial national waters.

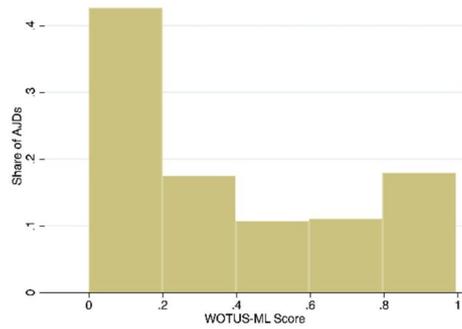
	<b>Rapanos</b>	<b>CWR</b>	<b>NWPR</b>
1. Ephemeral			(b)(3) Ephemeral feature, including an ephemeral stream, swale, gully, rill, or pool
2. Isolated	Isolated (interstate or intrastate) waters		(b)(1)
3. Non-RPW that flows directly or	Non-RPW that flows directly or indirectly into		
4. Other non-jurisdictional		(b)(1), (b)(2), (b)(3)(i), (b)(3)(ii), (b)(3)(iii), (b)(4)(v), (b)(5), (b)(7), (b)(4)(iii),	(b)(2), (b)(4), (b)(5), (b)(6), (b)(7), (b)(8), (b)(9), (b)(10), (b)(11), (b)(12), the review area is comprised entirely of dry land
5. Other		(a)(4), (a)(7),	(a)(3)
6. RPW that flows directly or indirectly into TNW	Relatively Permanent Water that flows directly or indirectly into Traditional	(a)(5)	(a)(2)
7. TNW	Traditional Navigable Water	(a)(1), (a)(2)	(a)(1)
8. Uplands	Uplands	Uplands	(b)(7)
9. Wetlands adjacent/abutting regulated waters	Wetlands Directly Abutting RPW that flows directly or indirectly into TNW; Wetland Adjacent to Non-adjacent/abutting RPW that flows directly or indirectly into TNW; Wetlands Adjacent but not Directly Abutting RPW that flows directly or indirectly	(a)(6)	(a)(4)

# Results: Histograms of WOTUS-ML confidence scores

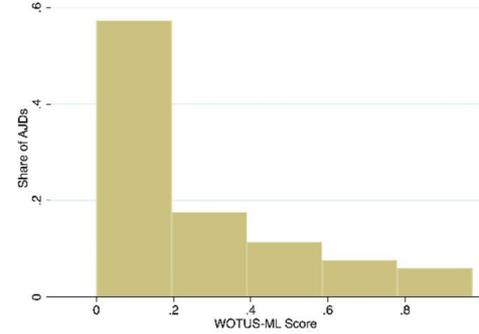
**A** *Rapanos*, AJD Test Set Points



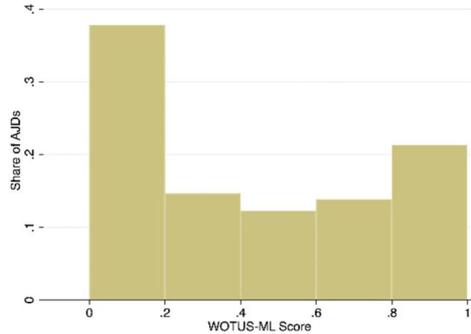
**C** CWR, AJD Test Set



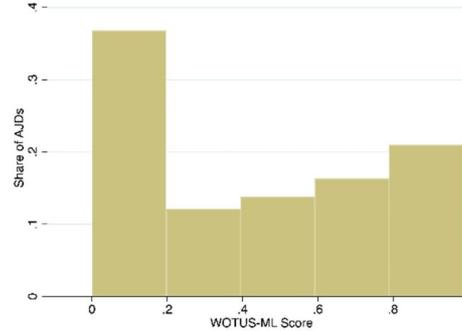
**E** NWPR, AJD Test Set



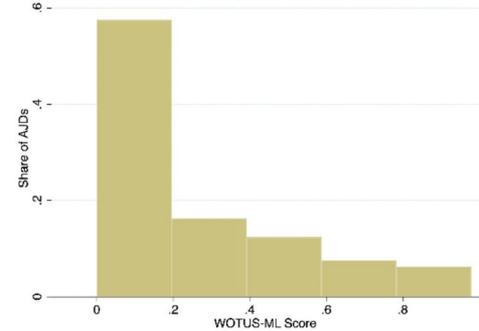
**B** *Rapanos*, Four Million Prediction Points



**D** CWR, Four Million Prediction Points

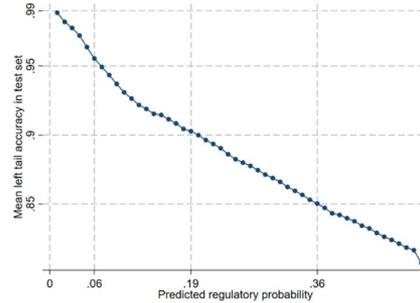


**F** NWPR, Four Million Prediction Points

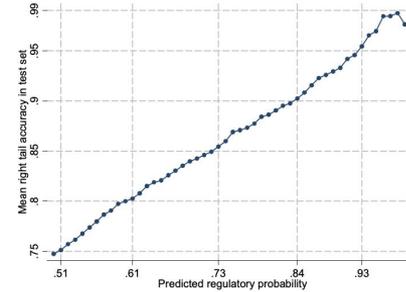


# Results: Left and right tail accuracy on AJD test set

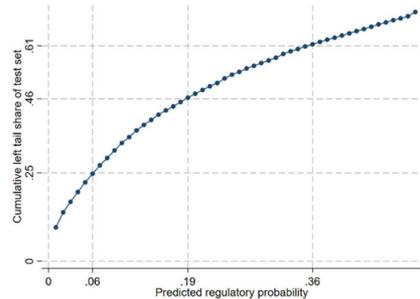
A Left Tail Accuracy



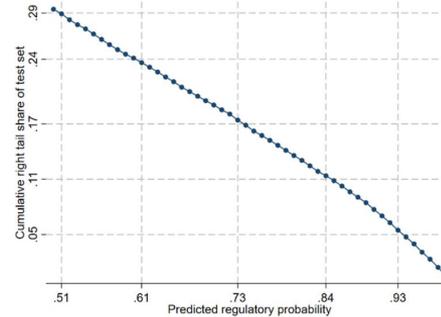
B Right Tail Accuracy



C Left Tail Share

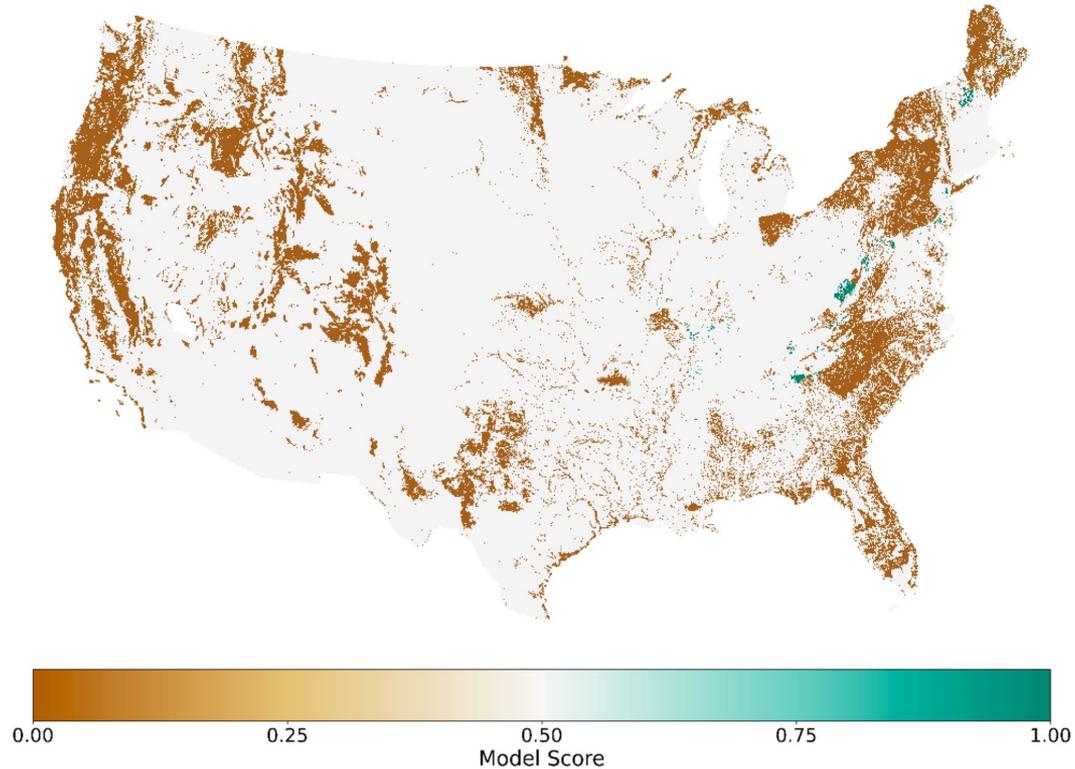


D Right Tail Share



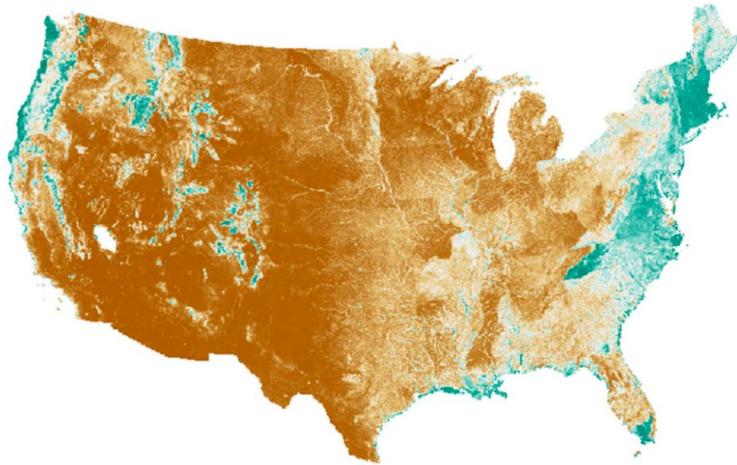
# Results: Change in WOTUS-ML score, *Rapanos* vs. NWPR

Changing regulation, NWPR - *Rapanos*

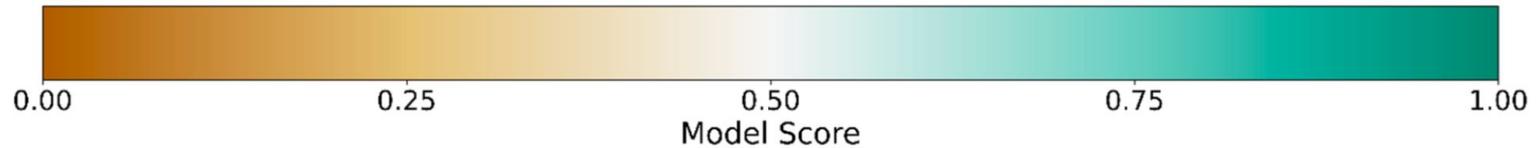
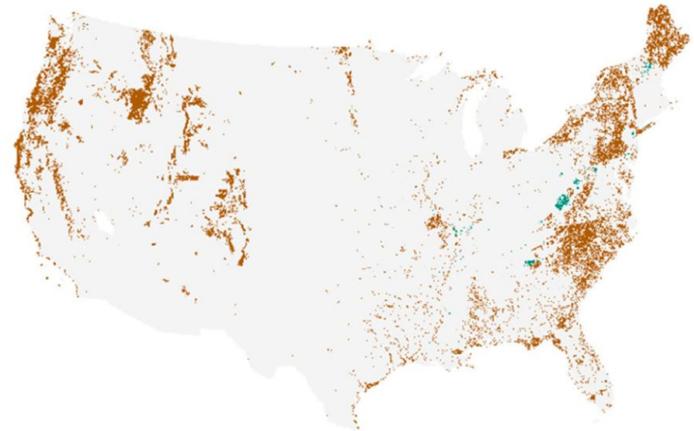


# Results: Nationwide WOTUS-ML scores under CWR

**A** CWR WOTUS-ML Scores



**B** CWR TO NWPR change



# Results: Stream miles and wetland acres regulated, by rule

**Table S6: Regulated Stream Miles and Wetland Acres, by State.** Total stream miles in (2) is from NHD stream and river flowline features. Total wetland acres in (3) is from NWI. Regulation rates in (4), (5), (6), and (7) are from WOTUS-ML, applied to the subset of four million prediction points that are within 10 meters of NHD or NWI features. The difference in column (6) is measured in stream miles, and in column (9) in wetland acres. Positive entries in (6) are associated with perennial streams, see SM section A.4.

State (1)	Total Stream miles (2)	Total Wetland Acres (3)	Stream miles regulated			Wetland acres regulated		
			Rapanos (%) (4)	NWPR (%) (5)	Difference	Rapanos (%) (7)	NWPR (%) (8)	Difference
					Rapanos (6)			Rapanos (9)
All National	3,154,480	119,825,268	—	—	-608,006	—	—	-32,283,607
Alabama	72,650	4,043,348	0.85	0.87	1,700	0.89	0.77	-491,306
Arizona	139,281	262,281	0.14	0.02	-16,146	0.29	0.06	-60,826
Arkansas	78,496	2,558,428	0.81	0.68	-10,373	0.84	0.60	-605,140
California	173,028	2,789,804	0.65	0.30	-59,814	0.65	0.19	-1,266,757
Colorado	93,255	1,522,952	0.56	0.13	-40,069	0.41	0.11	-466,165
Connecticut	5,215	304,750	1.00	1.00	0	1.00	1.00	-465
Delaware	2,234	290,940	1.00	1.00	0	0.96	0.93	-9,836
Florida	22,385	12,681,770	0.99	0.85	-3,290	0.92	0.46	-5,905,090
Georgia	64,833	6,396,737	0.96	0.95	-464	0.94	0.69	-1,602,436
Idaho	94,753	1,119,249	0.75	0.40	-33,251	0.53	0.19	-379,767
Illinois	67,074	1,271,986	0.78	0.76	-1,203	0.76	0.66	-129,289
Indiana	24,066	1,008,100	0.79	0.84	1,013	0.65	0.39	-266,726
Iowa	67,717	1,014,174	0.59	0.75	10,927	0.57	0.45	-114,820
Kansas	118,236	1,349,856	0.89	0.30	-70,578	0.61	0.16	-604,816
Kentucky	45,616	430,781	0.33	0.76	19,489	0.70	0.67	-12,767
Louisiana	43,096	8,092,819	0.81	0.83	848	0.90	0.83	-545,539
Maine	24,974	2,569,961	0.54	0.60	1,348	0.67	0.64	-64,926
Maryland	10,263	863,198	1.00	0.99	-41	0.88	0.78	-86,631
Massachusetts	7,273	775,106	1.00	1.00	0	1.00	0.99	-10,407
Michigan	47,861	7,712,081	0.86	0.77	-4,387	0.69	0.18	-3,928,642
Minnesota	60,103	9,973,334	0.24	0.30	4,002	0.38	0.05	-3,371,408
Mississippi	77,386	4,534,181	0.57	0.60	2,007	0.80	0.67	-611,212
Missouri	95,347	1,388,966	0.71	0.56	-14,952	0.70	0.50	-280,342
Montana	166,847	1,589,844	0.58	0.20	-62,897	0.39	0.14	-403,248
Nebraska	72,506	549,755	0.61	0.53	-5,819	0.21	0.10	-59,029
Nevada	143,616	1,003,174	0.29	0.05	-35,181	0.51	0.07	-436,858
New Hampshire	9,374	384,706	0.98	1.00	180	0.98	0.96	-4,787
New Jersey	7,128	1,019,092	0.99	0.98	-40	0.93	0.91	-11,619
New Mexico	109,260	383,873	0.31	0.03	-30,655	0.38	0.05	-129,145
New York	48,756	2,651,158	0.93	0.94	370	0.86	0.56	-794,487
North Carolina	56,673	4,679,517	1.00	0.98	-1,139	1.00	0.90	-458,473
North Dakota	59,514	2,442,160	0.69	0.42	-16,095	0.34	0.07	-675,173
Ohio	54,736	715,219	0.85	0.88	1,725	0.77	0.49	-200,695
Oklahoma	75,615	1,274,713	0.94	0.43	-38,624	0.81	0.35	-580,106
Oregon	102,984	1,803,096	0.78	0.34	-45,550	0.71	0.20	-912,971
Pennsylvania	51,477	588,835	0.96	0.89	-3,588	0.94	0.70	-139,091

State (1)	Total Stream miles (2)	Total Wetland Acres (3)	Stream miles regulated			Wetland acres regulated		
			Rapanos (%) (4)	NWPR (%) (5)	Difference	Rapanos (%) (7)	NWPR (%) (8)	Difference
					Rapanos (6)			Rapanos (9)
Rhode Island	978	86,061	1.00	1.00	0	1.00	1.00	0
South Carolina	29,372	4,238,935	0.99	0.94	-1,478	0.97	0.68	-1,196,502
South Dakota	96,965	3,529,693	0.62	0.30	-31,587	0.26	0.13	-451,539
Tennessee	59,244	1,148,777	0.56	0.76	11,937	0.63	0.64	7,796
Texas	176,194	5,551,483	0.77	0.37	-70,753	0.65	0.40	-1,404,799
Utah	82,724	624,397	0.47	0.10	-30,866	0.49	0.09	-249,501
Vermont	7,100	287,628	0.99	0.99	0	0.93	0.85	-23,496
Virginia	49,280	1,682,396	0.99	0.98	-672	0.85	0.81	-70,360
Washington	68,964	1,297,395	0.62	0.26	-24,424	0.69	0.22	-610,242
West Virginia	30,572	81,858	0.50	0.79	8,817	0.58	0.59	470
Wisconsin	53,370	7,610,528	0.46	0.63	8,705	0.47	0.17	-2,306,962
Wyoming	106,082	1,646,169	0.35	0.09	-27,142	0.27	0.05	-357,483