Lecture 15: The Clean Water Act

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Environmental Economics
Econ 475

Two Questions from Last Time

Q: Can states permit a facility to have emissions lower than a federal New Source Performance Standard?

A: No, the federal standard is the floor of required abatement or the ceiling of permissible emissions. See section 111.

Q: Some regions have wildfires every year. Will these always be excluded from NAAQS attainment considerations?

A: States request to exclude certain days for a region and the EPA can agree. There does not appear to be a limit to how many days can be excluded. More information on Exceptional Events page and FAQs.

Why Regulate Water Quality?

The Cuyahoga is infamous for its 13 fires, but this wasn't rare. The Delaware River in Philadelphia, Baltimore harbor, the Buffalo river, and the Rouge River in Detroit also caught fire. NYC harbor had 300 oil spills in the first six months of 1973.

Figures: (from left) Cuyahoga river water, NYC oil slick in 1973, and paper mill effluent on the Androscoggin river in main. Source.

Background on the CWA

Congress has the authority to regulate interstate commerce and hence navigable waters, which provided the basis for a series of water pollution control acts culminating in the 1972 Clean Water Act (CWA).

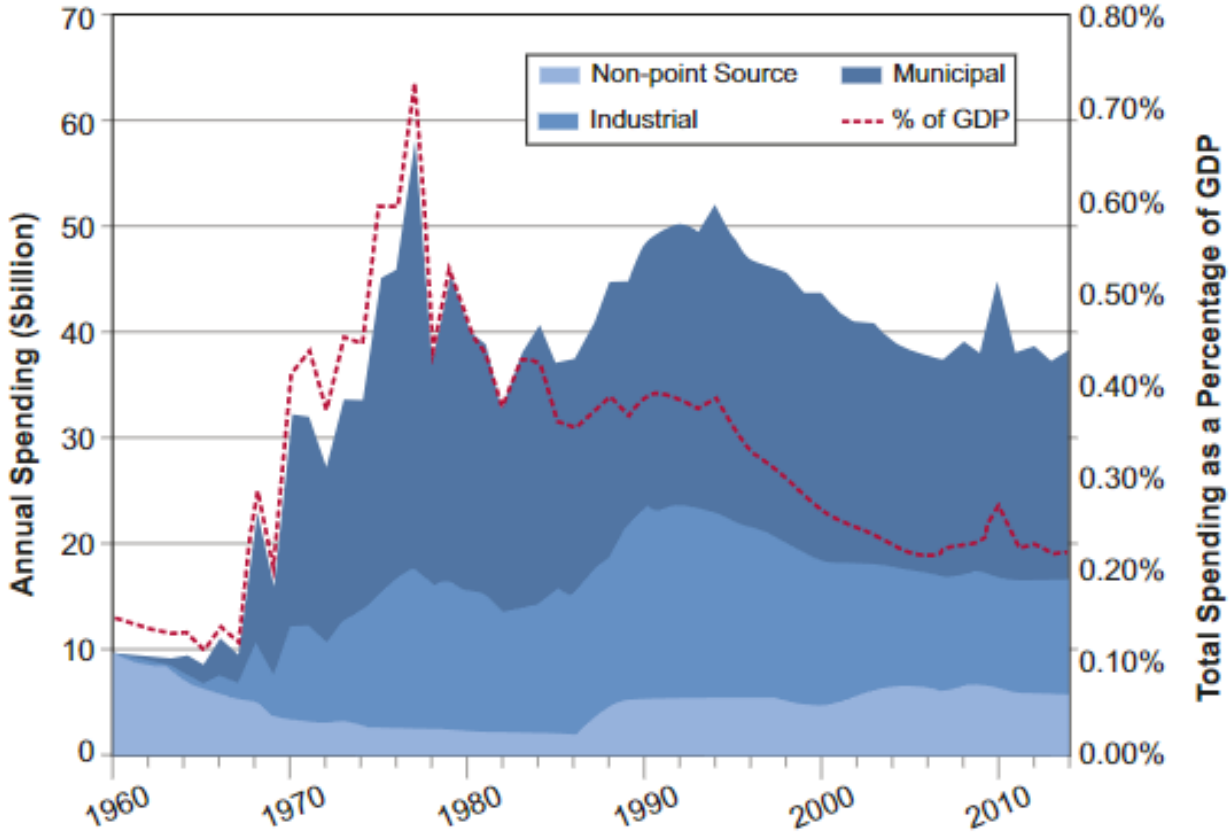
Its goals:

- Make all navigable waters (i.e., “Waters of the United States”) fishable and swimmable by 1983.
- Eliminate all discharge of pollution into navigable waters of the US by 1985.
- Prohibit discharge of toxic quantities of toxic pollutants.

The act does not directly regulate drinking water.

Background on the CWA

From 1960 - 2014, the U.S. spent $1.9 trillion total, or $140 per person per year, to abate water pollution. This was an average 0.2% of annual national income.

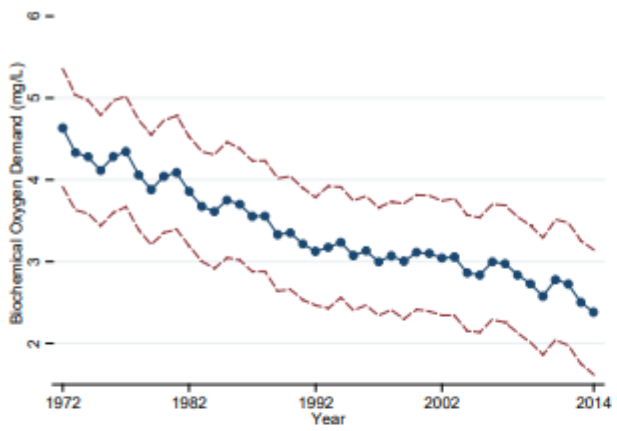


Source: Keiser, Kling, and Shapiro (2018).

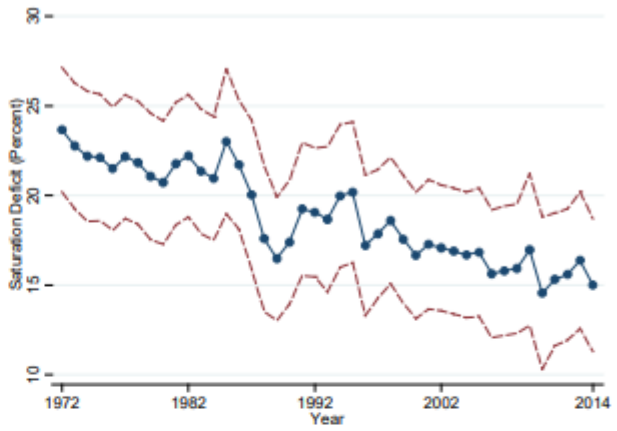
50 Years Later

Despite notable improvements in key water quality indicators, over one third of water systems in the US are estimated to remain un-swimmable and half are not suitable for fishing (Environmental Integrity Project, 2022).

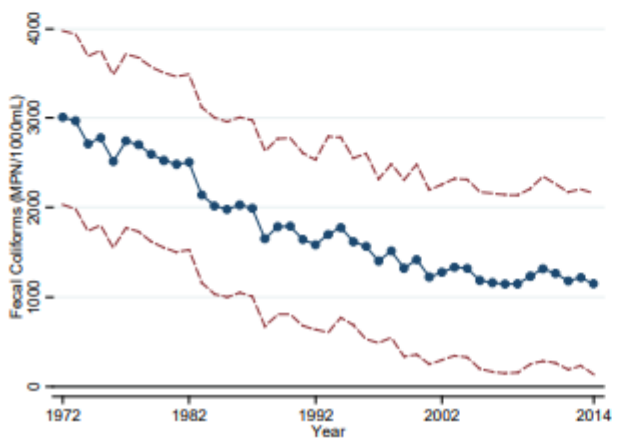
Panel A. Biochemical Oxygen Demand



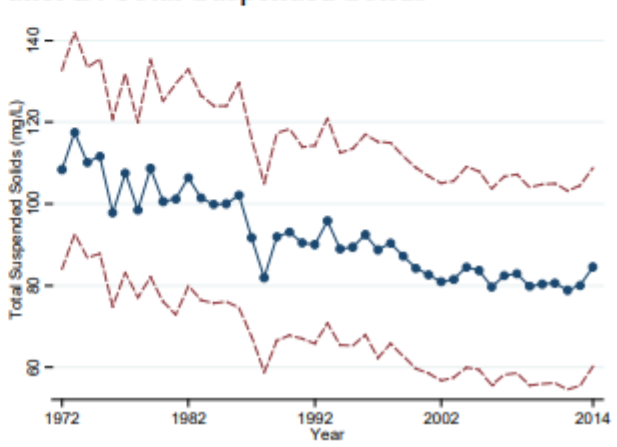
Panel B. Dissolved Oxygen Saturation Deficit



Panel C. Fecal Coliforms



Panel D. Total Suspended Solids

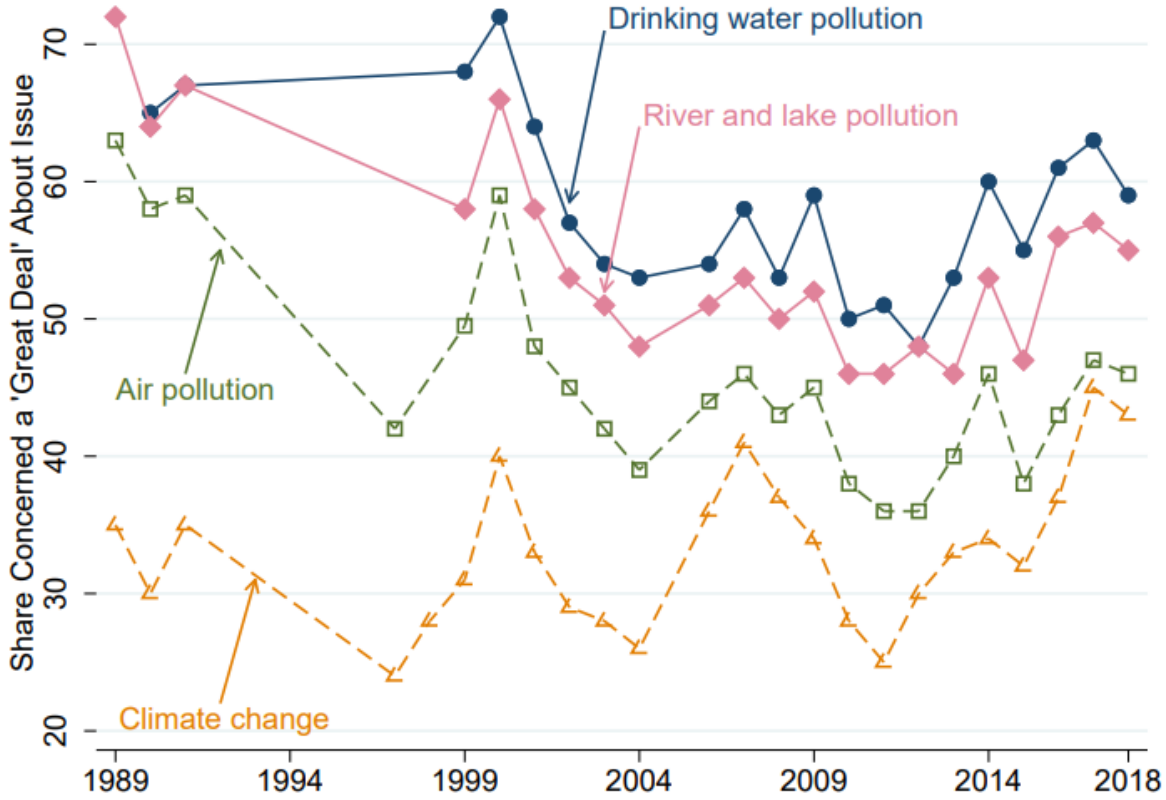


Source: Keiser and Shapiro (2019).

50 Years Later

Surface water quality is still a major concern for most Americans as of 2018.

Figure 1
Share of Americans Concerned "A Great Deal" about Various Environmental Issues, 1989-2018



Source: Keiser and Shapiro (2019).

Part 1: Regulatory Instruments in the Clean Water Act

Regulatory Instruments in the Clean Water Act

The 1972 Clean Water Act has three main regulatory instruments.

1) Water Quality Standards
2) Point source discharge regulations
   - National Pollution Discharge Elimination System (NPDES) Permits
   - Effluent Limitation Guidelines (ELGs)
3) Abatement subsidy programs
   - Grants and later loans through the State Revolving Fund (SRF)

1) Water Quality Standards

How are Water Quality Standards set for a given body of water?

- States determine potential uses of the water (e.g., swimming, fishing, boating, and drinking source).
- States then set standards for water quality that are consistent with the designated uses. There are recommended but non-enforceable federal standards.
  - Numeric vs. narrative standards (e.g., “free from floating petroleum oils”).
- States determine if a body of water is impaired. If a body of water is impaired, states implement more stringent permit limits and sometimes **total maximum daily loads** (TMDLs) to try to reduce pollutant loadings.
  - Impairment designations are updated every 2-3 years, and the public has an opportunity to comment.

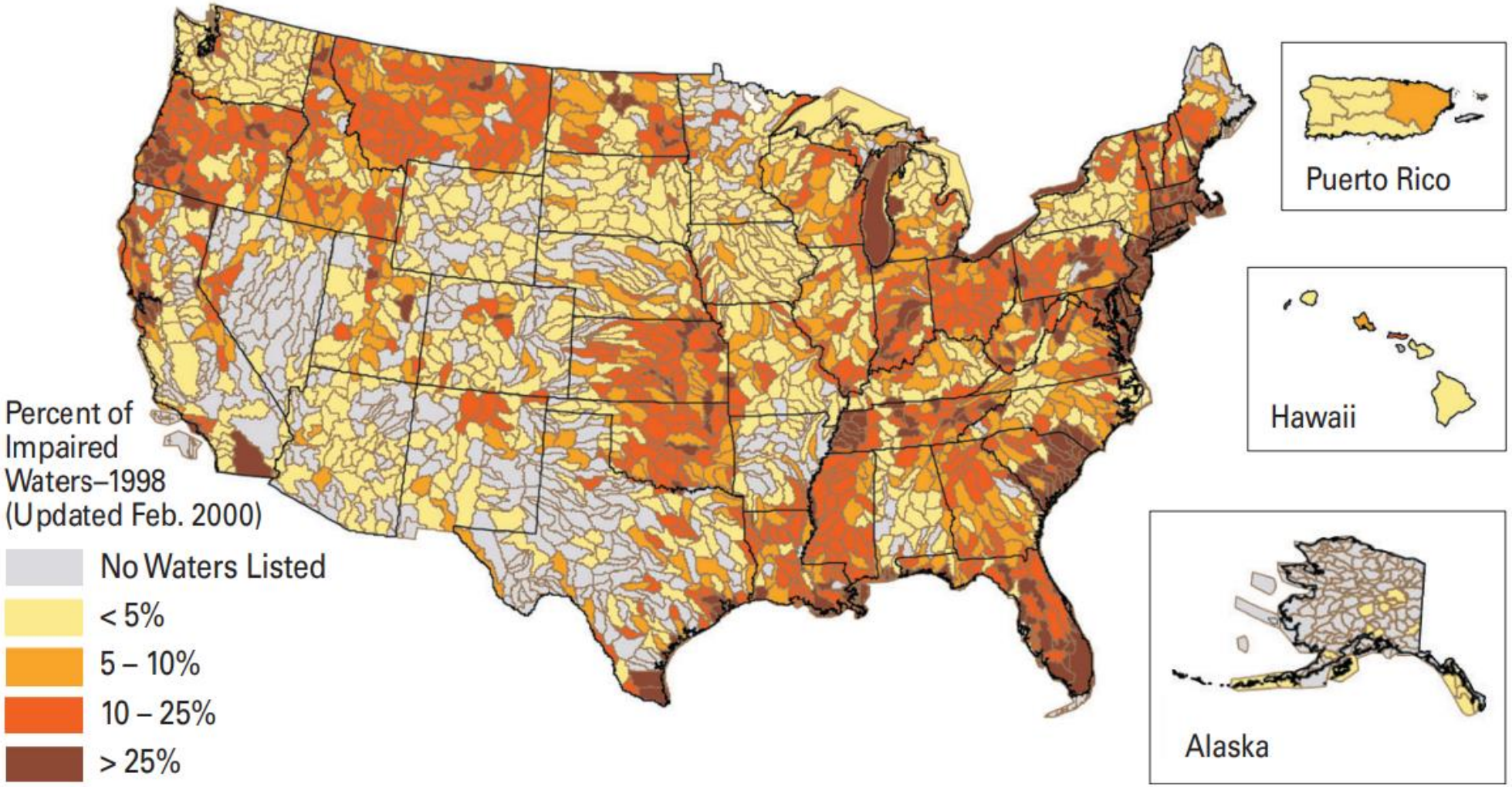
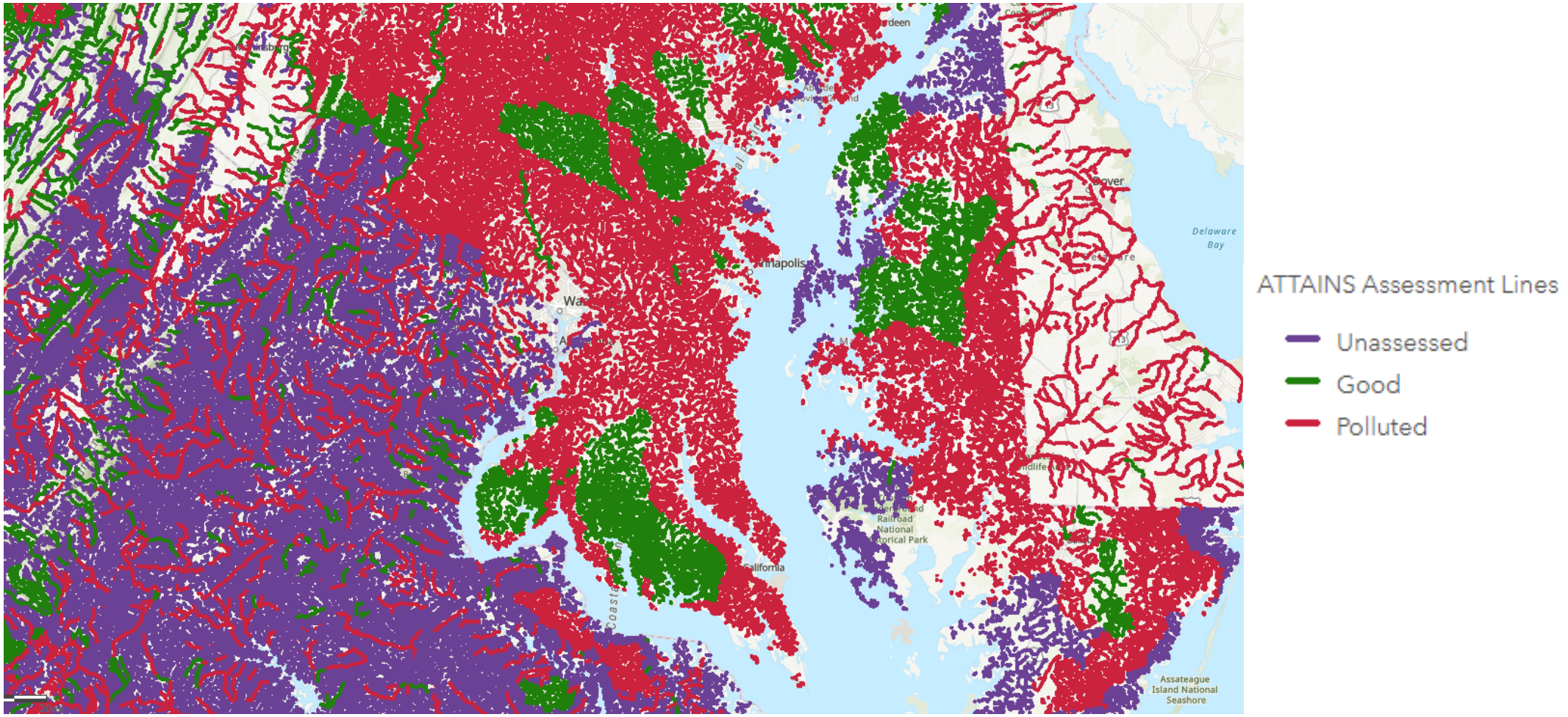


Figure 1. Map of watersheds containing impaired water bodies from the U.S. Environmental Protection Agency's 1998 list of impaired waters (USEPA, 2000).

ATTAINS Data in the Chesapeake Region



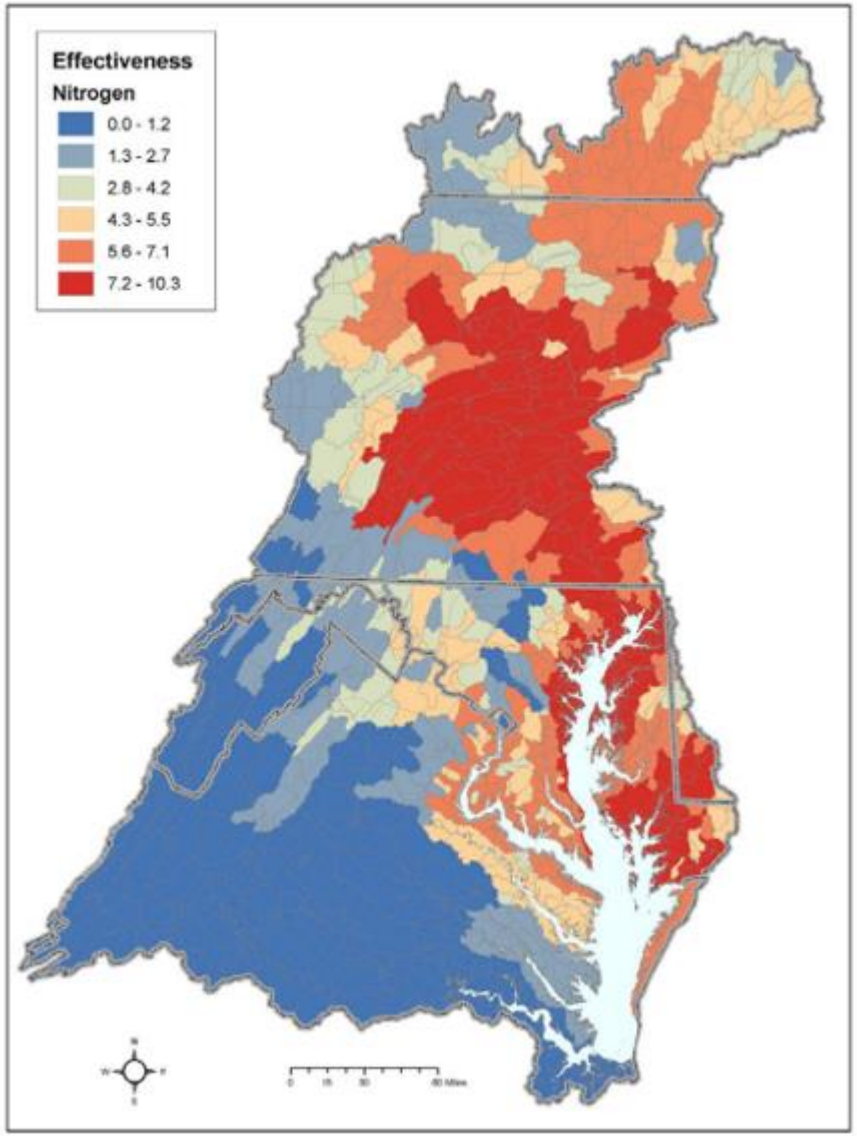
The national ATTAINS dataset provides information on impaired waters by specific stream reach. [Download ATTAINS data.]

Chesapeake Bay Total Maximum Daily Load (TMDL)

The Chesapeake Bay is impaired because of excess nitrogen, phosphorus and sediment. Several states within the watershed signed an agreement to ameliorate the bay.

- States (+DC) entered an MOU and set new water quality standards.
- Each state received allocation shares for nutrient and sediment caps based on their initial contributions.
  - 25% less N, 24% less P, and 20% less TSS relative to 2009
- Each contributor created a watershed implementation plan. Some states created trade-able permits for their allocation.
- Monitoring was enacted across the Chesapeake watershed.

Figure ES-2. Sub-basins across the Chesapeake Bay watershed with the highest (red) to lowest (blue) pound for pound nitrogen pollutant loading effect on Chesapeake Bay water quality.



Source: EPA, 2010.

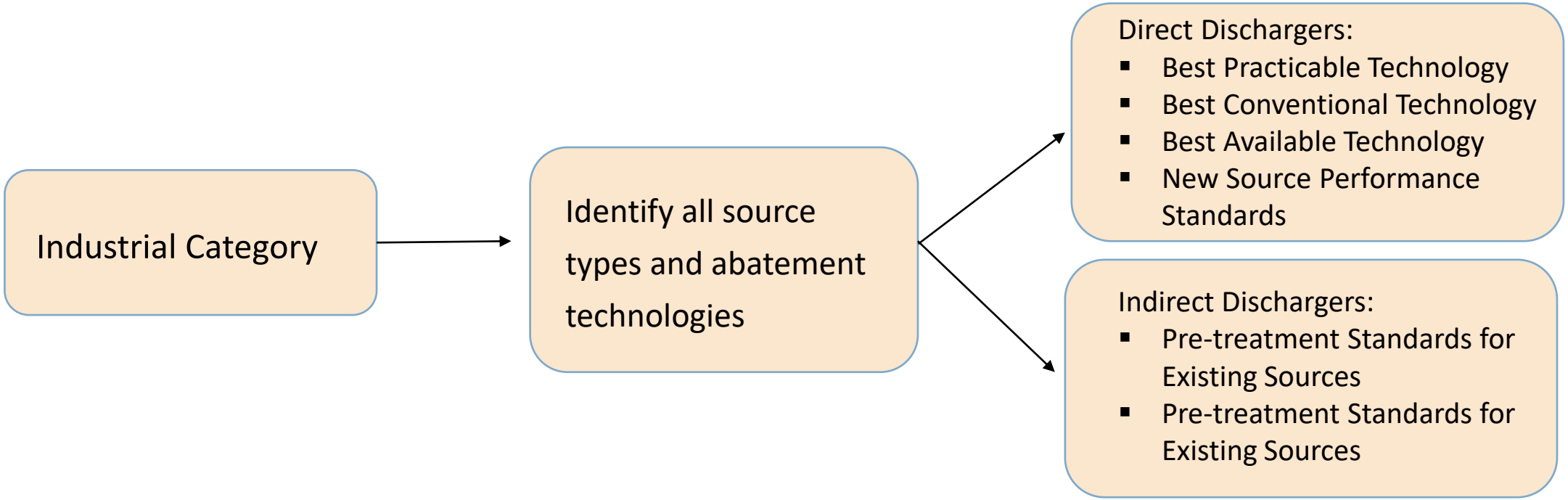
2) Point Source Discharge Regulations

Any facility that releases pollution directly into a navigable water from a point source is required to obtain a NPDES permit for that release.

- NPDES permits specify the amount of discharge permissible for a given facility.
  - Release quantities cannot result in loss of a current designated use for a body of water.
  - Permits must be renewed every five years, and thus can be made more stringent over time.
  - All permitted facilities and discharge quantities can be accessed on Enforcement and Compliance History Online's Discharge Monitoring Reports.
- All facilities with a NPDES permit must measure *conventional* pollutant releases.
  - Biochemical oxygen demand (BOD), Total suspended solids (TSS), pH, Fecal coliform, Oil and grease.

Effluent Limitation Guidelines

For some industrial categories, NPDES permits must follow **Effluent Limitation Guidelines** (ELGs). These are numeric limits based on the performance of specific technologies, but specific techs are rarely required. Permit limits are mostly set by states using "Best Professional Judgement."



Efficiency vs. Cost Effectiveness

Effluent limitation guidelines identify technologies that are referred to as "best." For example:

- Best Practicable, Best Conventional, and Best Available technologies.

In these cases, best is a cost-effectiveness criterion. This is not the same as economic efficiency.

- Cost effectiveness: Given *some* abatement (e.g., in pounds), what is the average cost of one technology compared to another.
- Efficiency: net benefits are maximized.

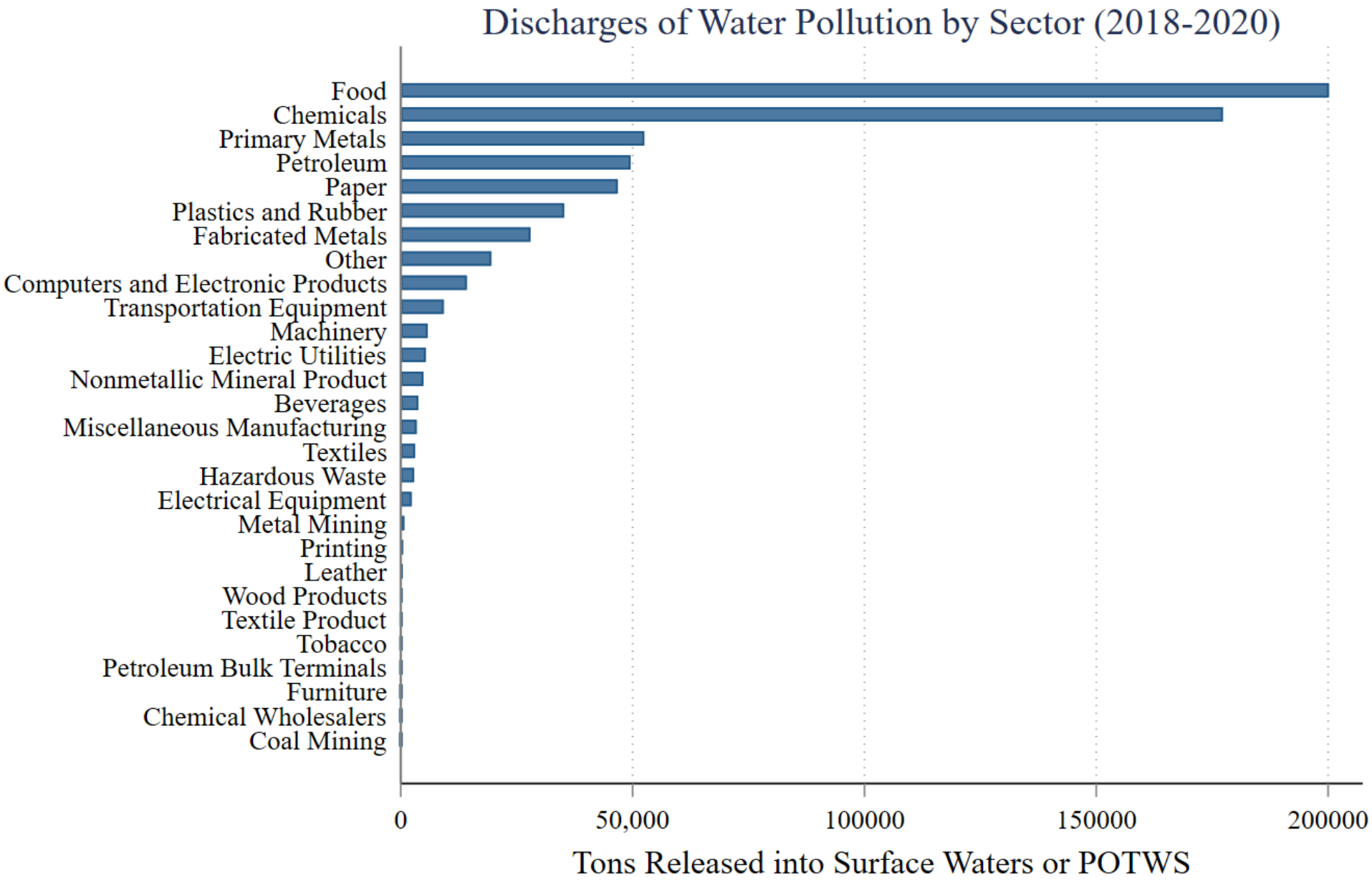
Cost "reasonableness" is a two-part *cost-effectiveness* test that underpins certain "best" technologies and hence possible performance standards:

1) POTW test
2) Industry test

ELG Examples

Many industrial source categories, although ELGs are not updated frequently for newer technologies:

- Steam-Generating Power Generating Plants
- Coal Mining
- Dental Offices
- Meat and Poultry Products
- Textile Mills
- Oil and Gas Extraction
- Landfills



Source: TRI Basic, 2018-2020 files.

3) Abatement Subsidy Programs

Publicly-Owned Treatment Works (POTWs) receive and treat wastewater before discharging it.

- The CWA established grant programs to improve treatment practices.

In 1987 the grants program was ended and replaced with the Clean Water State Revolving Fund (CWSRF):

- Low-interest loan program to communities, companies, non-profits, states. Also features other types of subsidies.
- Funds a broader set of projects such as nonpoint source amelioration, green infrastructure, water reuse, stormwater treatment, watershed protection programs, etc.

Part 2: Some Key Terms

"Point Source"

The CWA distinguishes between point source and non-point source water pollution. Point sources are:

“discernible, confined, and discrete conveyance, including … any pipe, ditch, channel, tunnel, conduit, well, fissure, container, rolling stock, concentrated animal feeding operation, or vessel … from which pollutants are or may be discharged.”

Wastewater discharge from the Bucks Steam-Generating Electricity Plant in Bucks, Alabama.

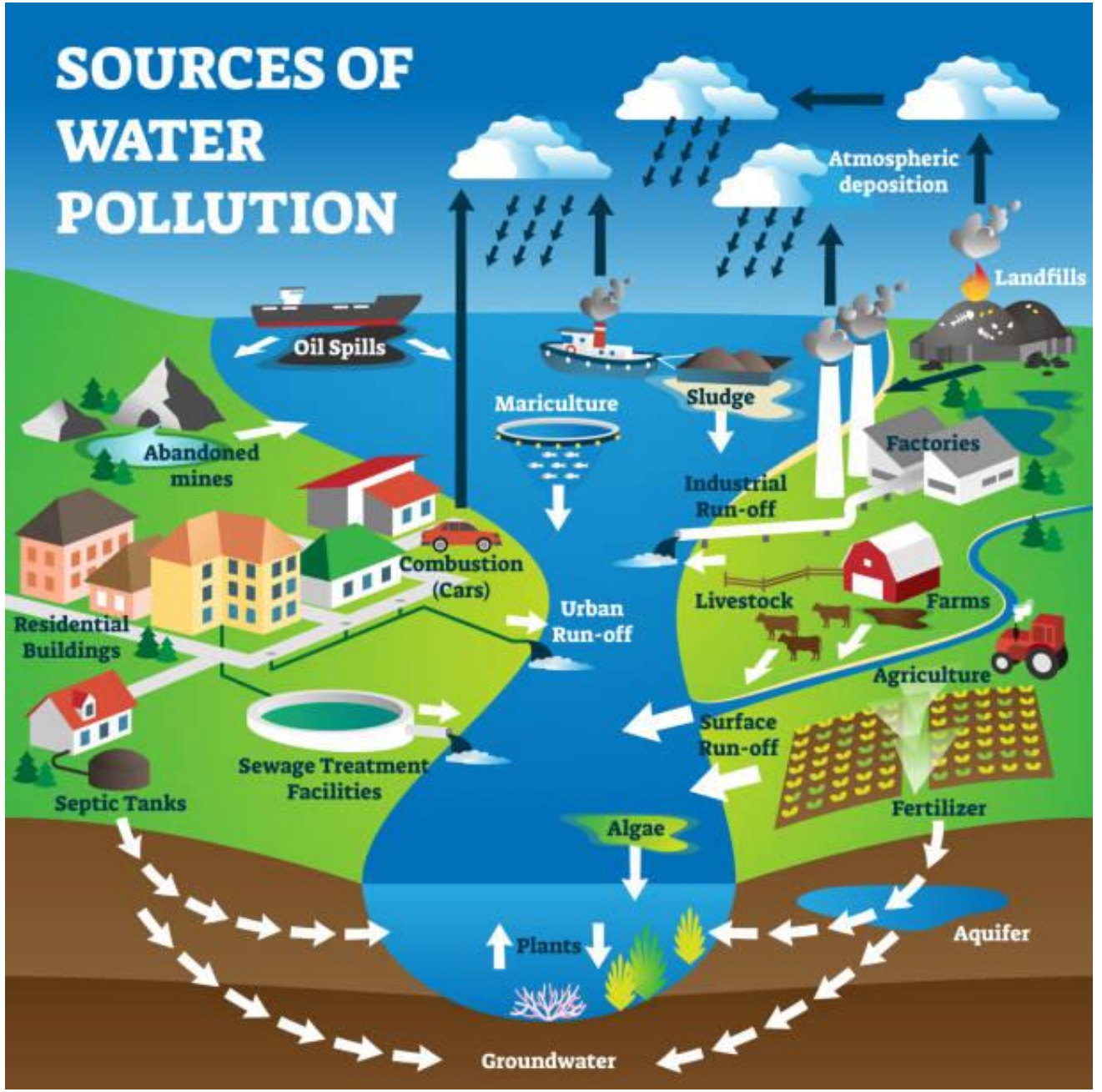


Image source: iStockphoto by Getty images.

Aside: Point Sources and CAFOs

Concentrated animal feeding operations are specifically listed as a "point source," but what is a CAFO?

A CAFO is any livestock operation where animals are kept for at least 45 days a year and not pastured.

Source: "Lagoons of Pig Waste Are Overflowing After Florence." NYT.

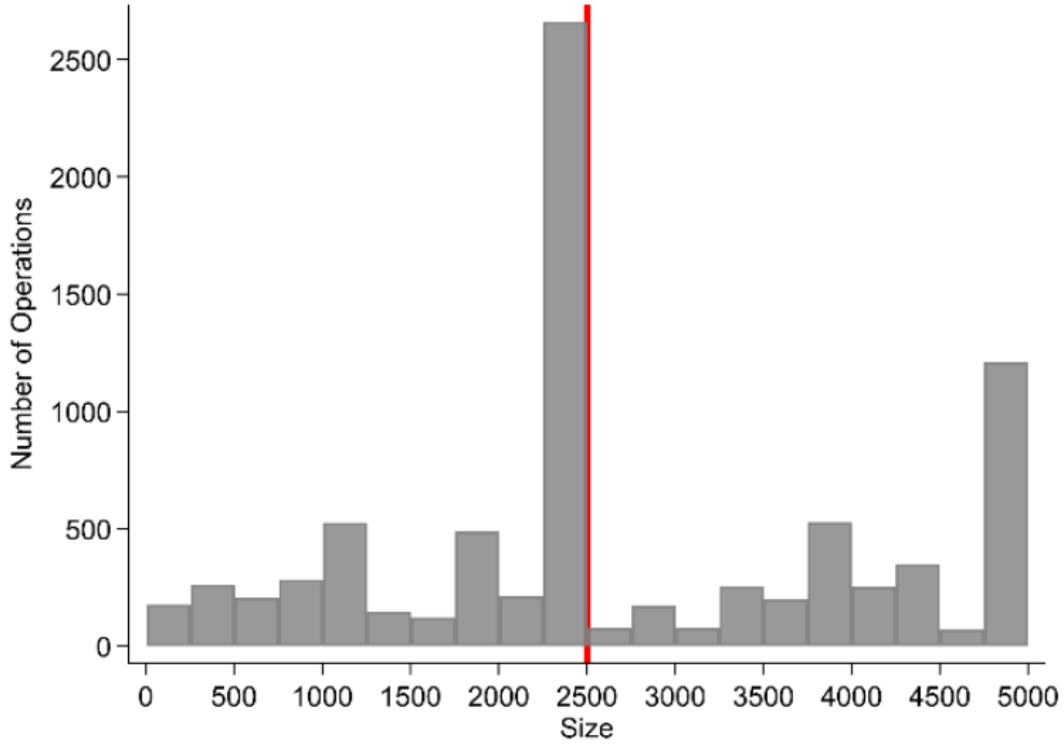
Aside: Point Sources and CAFOs

Only some “large” CAFOs and rarely medium-sized ones require a permit.

2,500 pigs is “large.”

Size-based regulations create perverse incentives to avoid permitting and oversight.

Figure 1: Hog AFOs Size Distribution



Source: Size-based regulations, productivity, and environmental quality. Chen et al. (2019).

"Waters of the United States"

Clear examples of WOTUS:

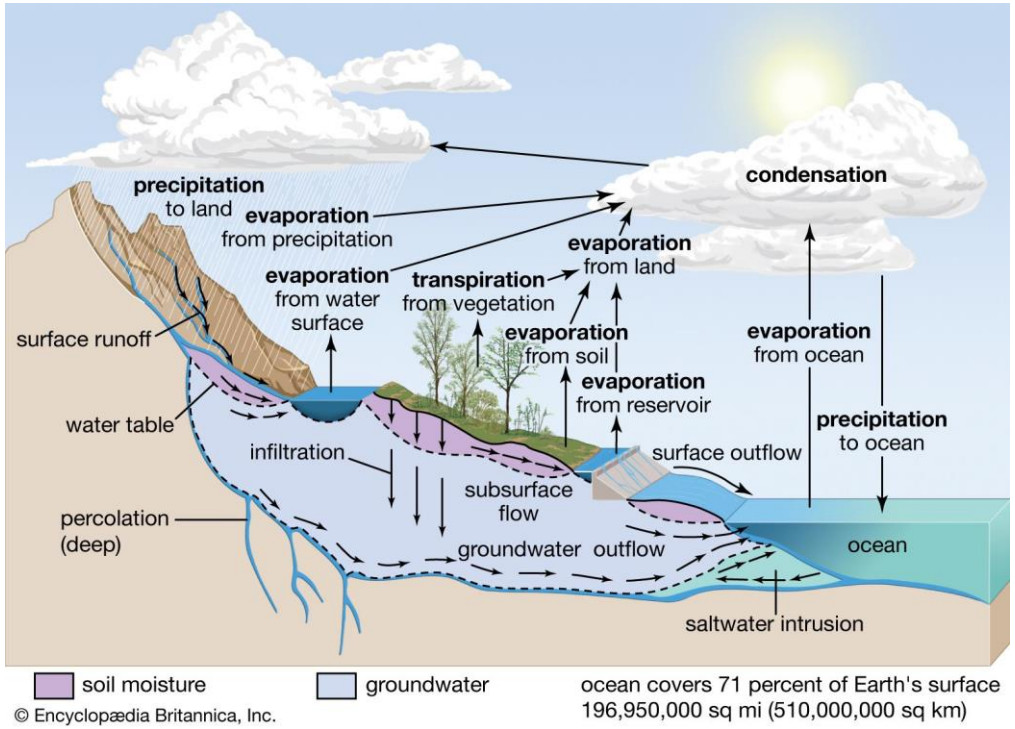
- Navigable rivers and lakes
- Interstate waters
- Territorial seas up to 200 miles

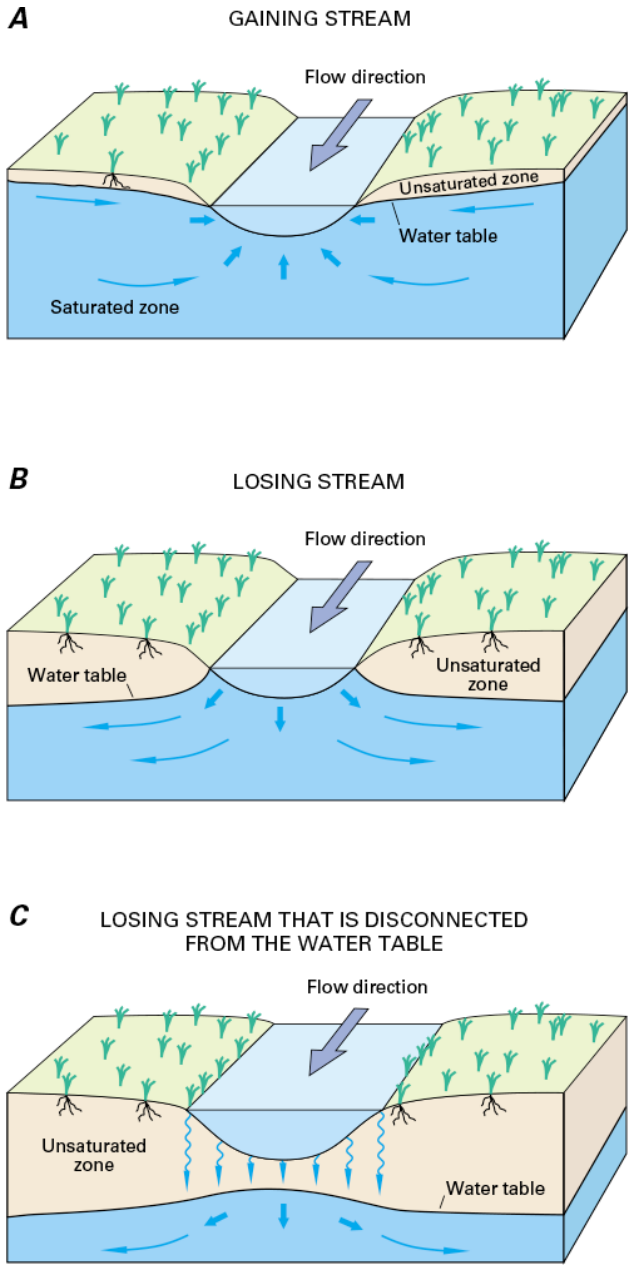
Somewhat ambiguous:

- Groundwater
- Wetlands
- Tributaries of major rivers
- Ephemeral, intermittent, and perennial streams

Basic Hydrology and Hydrogeology

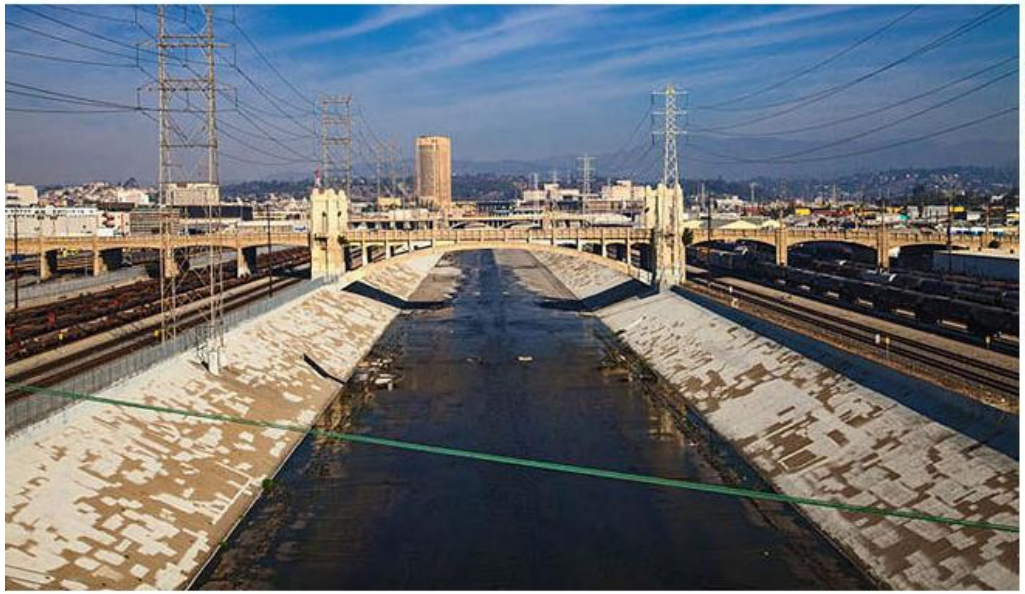
Congress required the CWA “restore and maintain the chemical, physical and biological integrity of the Nation's waters.”





Sources: Integrate Student Materials and Encyclopedia Britannica.

Tension in Defining "Waters of the United States"



All google images: (from left, clockwise) The LA River, California vernal ponds, Texas prairie wetlands, ephemeral desert riverbed, pocosins in South Carolina.

Part 3: Evolution of the CWA

Early Revisions to WOTUS

The original CWA only applied to navigable waters. Several revisions were codified by Congress or established by case review. These generally expanded "jurisdictional" waters, i.e., features that are subject to the rules of the CWA:

1) 1977 Amendments
   - Non-navigable tributaries are jurisdictional because they affect navigable waters.
   - Wetlands adjacent to or hydrologically connected to WOTUS are also jurisdictional.
     - Wetlands recharge water levels, absorb pollutants, and provide habitat.
2) *U.S. v Riverside Bayview Homes* (1985) decided that waters totally confined to one state are also jurisdictional.

Rapanos vs. U.S. (2006)

John Rapanos filled over 20 acres of wetlands near Lake St. Claire, Michigan, in preparation to build a mall. He did not seek a permit, and the Army Corps of Engineers filed an injunction for him to stop building.

This was the same lake that had been the subject of the *Riverside Bayview Homes* supreme court case. State regulators argued that the wetlands had been established as jurisdictional.

Rapanos sued to avoid paying $25,000 fines per day, eventually paying settlement costs of nearly $1m without admitting fault.

Source: Lake St. Clair's chronic problems have not only gone unresolved over the decades; there isn't even consensus on what's causing them.

Rapanos vs. U.S. (2006)

The Supreme Court did not reach a firm decision, but it elaborated on two jurisdictional tests:

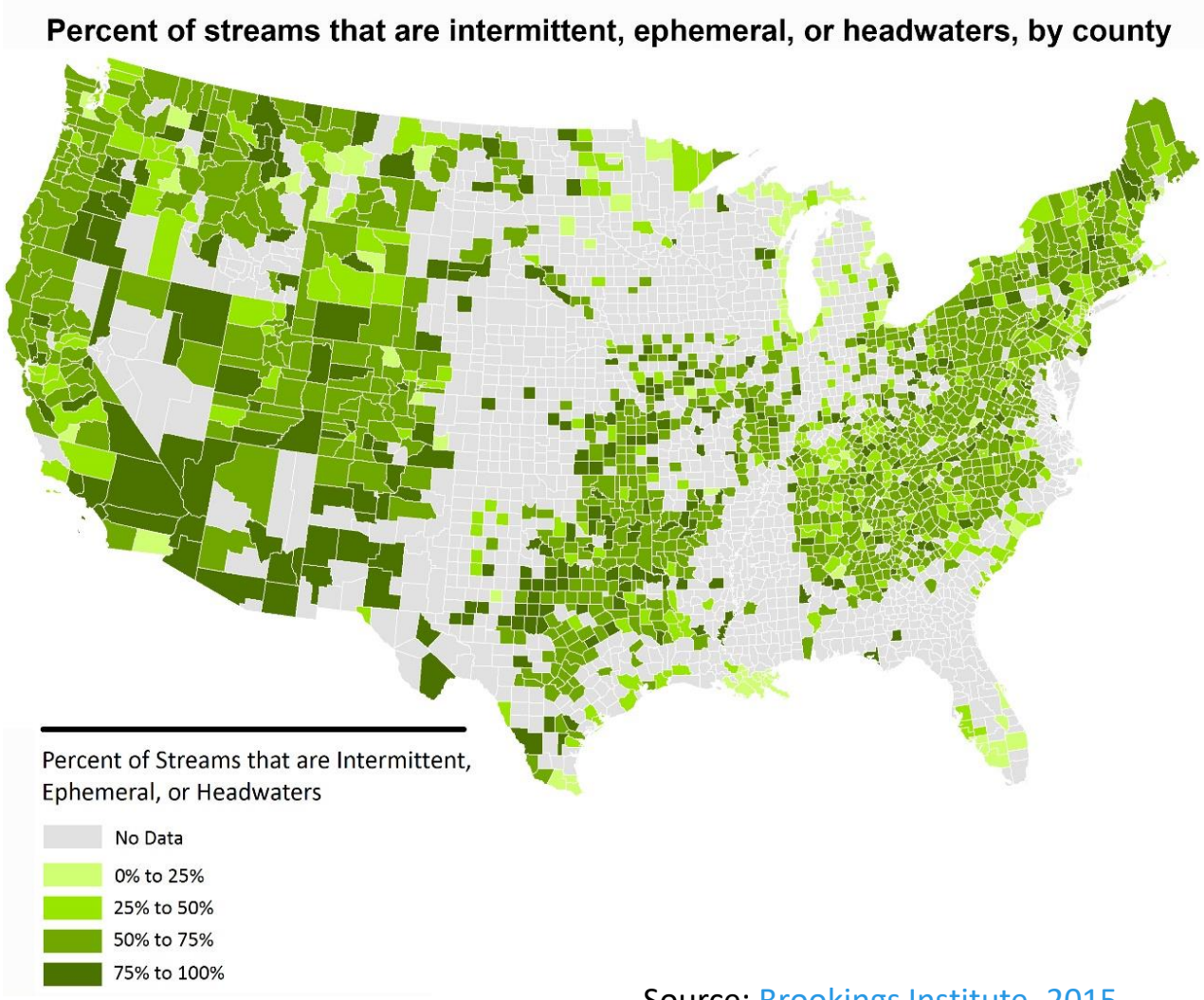
1) **Scalia test:** jurisdiction extends to relatively permanent bodies of water, including wetlands, that are connected to navigable waters.
2) **Kennedy test:** jurisdiction extends to any waters, including wetlands, acting as a **significant nexus** for traditional navigable waters.
    - Significant nexus: the wetlands or other water must "significantly affect the chemical, physical, and biological integrity" of navigable waters.

Ultimately, the Army Corps of Engineers and EPA established that a body of water is jurisdictional if it meets either the Scalia test or the Kennedy test.

Clean Water Rule (2015)

The Clean Water Rule documented the connections inherent to hydrogeologic systems, taking the **significant nexus** test to task in re-evaluating jurisdictionality.

- Previously non-jurisdictional waters were determined to significantly affect the chemical, physical, and biological integrity of WOTUS.
- Dramatic increase in jurisdictionality: intermittent streams and many wetlands– these all became WOTUS.



Source: Brookings Institute, 2015.

Navigable Waters Protection Rule

The Clean Water Rule was repealed in 2019. The “Navigable Waters Protection Rule” established a new standard for what is jurisdictional.

The NWPR excluded some ambiguous categories of WOTUS:

- Half of wetlands were excluded, including any separated by dunes or natural land from other water.
- All ephemeral streams and an estimated 70% of all streams.

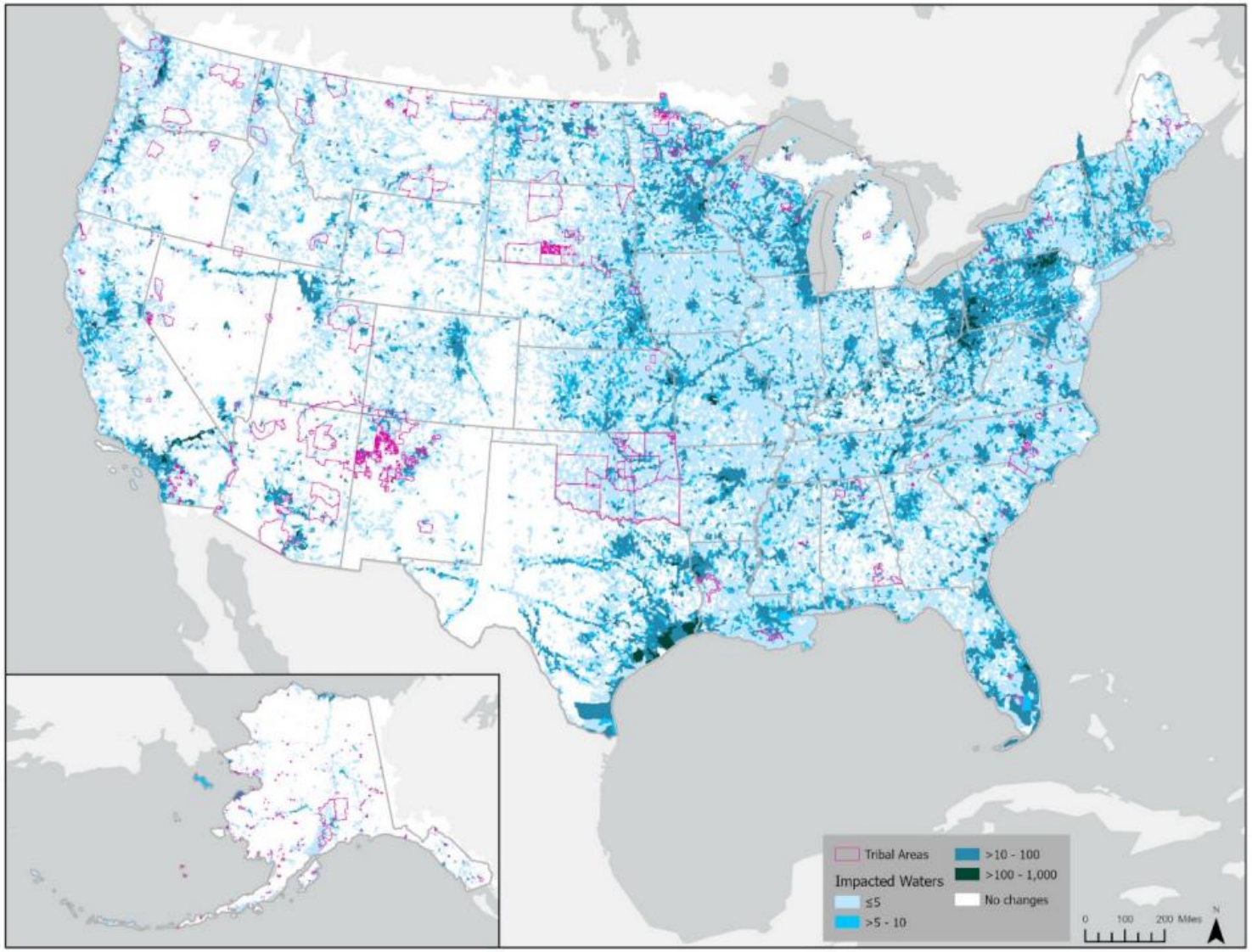
It also excluded categories of WOTUS established by precedent:

- Navigable non-interstate watersheds
- Human constructions, even if the body of water is used for drinking water or recreation.

Return to Rapanos

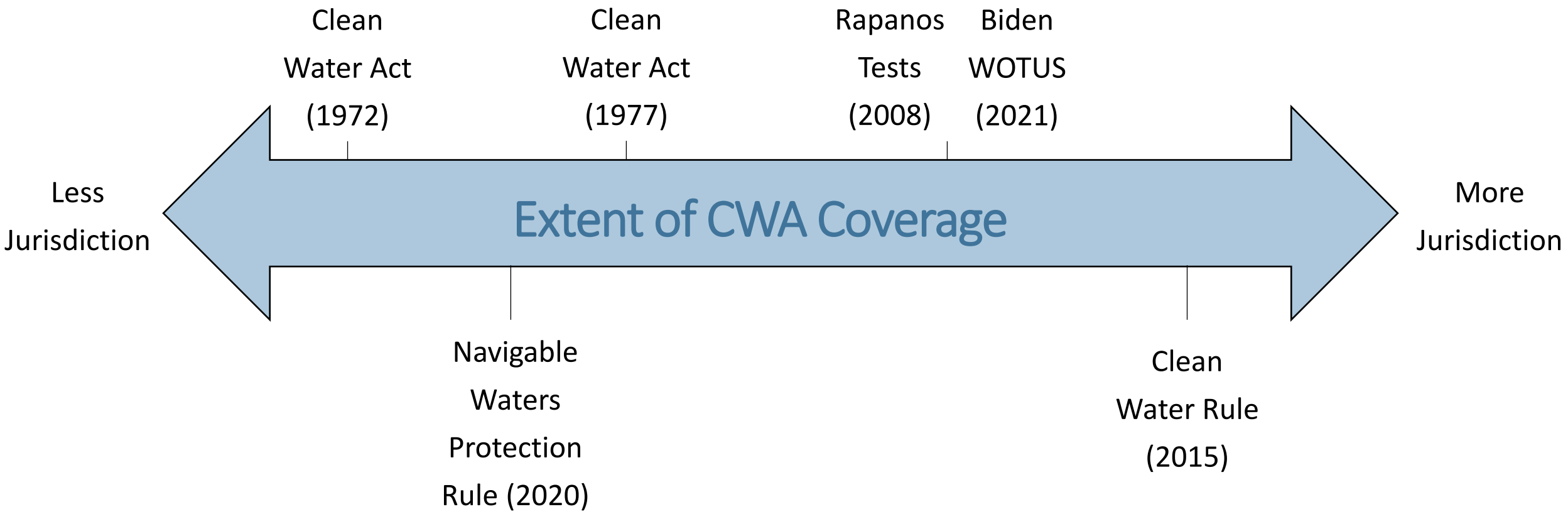
In returning to the Rapanos criteria, EPA mentioned costs of the NWPR's jurisdictional changes: filling of streams, less wetlands, less flow, water quality, species loss, lower ecosystem values, oil spill risk, drinking water treatment costs, increased flood risk.

[Shelia Olmstead's podcast with RFF on the challenges to the clean water rule.]



Source: [Economic Analysis for the Revised WOTUS (2021).]

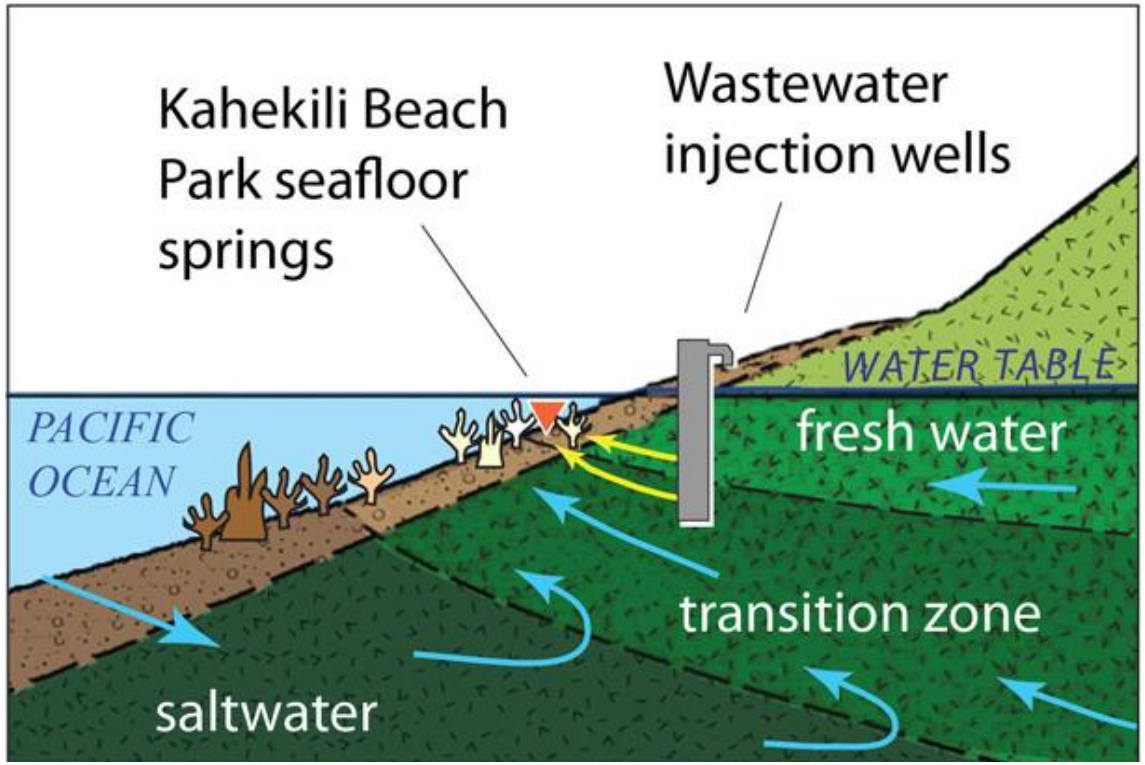
Evolution of WOTUS



Latest Developments

Other newer cases:

- County of Maui v. Hawai‘i Wildlife Fund.
  - A NPDES permit is required if the pollution into groundwater is the functional equivalent of a direct release into navigable waters through a point source.
- Sackett vs. EPA
  - Ongoing case at SCOTUS related to jurisdictionality wetlands that are not connected above ground to a nearby lake.



Source: USGS.

Part 4: Keiser and Shapiro (2019)

Keiser and Shapiro (2019)

Research Questions:

1) How has water quality changed since the CWA was passed?
2) How much of the changes were caused by the CWA's grants program?
3) How much do residents value these changes?

Keiser and Shapiro (2019)

The data collection for this project was probably the most impressive I have seen in any economics paper. A selection of some of what the authors pulled together:

1) Ambient water quality (STORET v1, STORET v2, National Water Information System)
   - 50 million observations of some water quality parameters from 1962-2001
2) Grants Information and Control System and Clean Watershed Needs Survey
   - All 35,000 CWA grants provided to POTWs through three FOIAs
3) Geolytics Neighborhood Change Database from 1970-2000
   - Home prices at the census tract level
4) National Climate Data Center Daily Files
   - Daily temperature and precipitation

Keiser and Shapiro (2019)

Two empirical strategies worth covering in more detail:

1) Effects of Clean Water Act Grants on Water Quality (high-dimensional fixed effects):

$$Q_{pdy} = \gamma G_{py} d_d + X'_{pdy}\beta + \eta_{pd} + \eta_{py} + \eta_{dwy} + \epsilon_{pdy}$$

2) Willingness-to-pay for water quality (hedonic model):

$$V_{py} = \gamma G_{py} + X'_{py}\beta + \eta_{p} + \eta_{wy} + \epsilon_{py}$$

Keiser and Shapiro (2019)

Two empirical strategies worth covering in more detail:

1) Effects of Clean Water Act Grants on Water Pollution (high-dimensional fixed effects):

$$Q_{pdy} = \gamma G_{py} d_d + X'_{pdy}\beta + \eta_{pd} + \eta_{py} + \eta_{dwy} + \epsilon_{pdy}$$

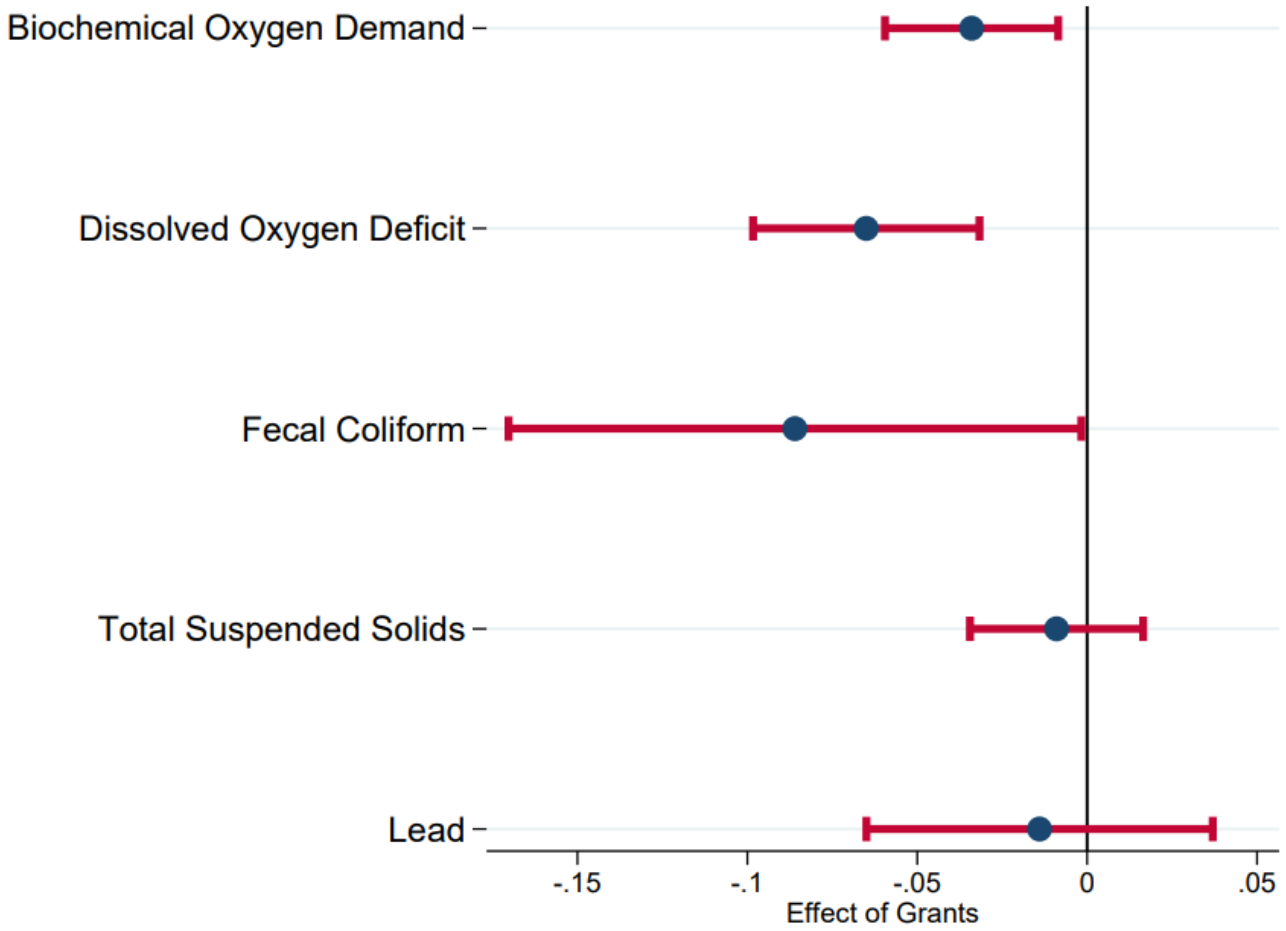
2) Willingness-to-pay for water quality (hedonic model):

$$V_{py} = \gamma G_{py} + X'_{py}\beta + \eta_{p} + \eta_{wy} + \epsilon_{py}$$

Keiser and Shapiro (2019)

Water quality findings:

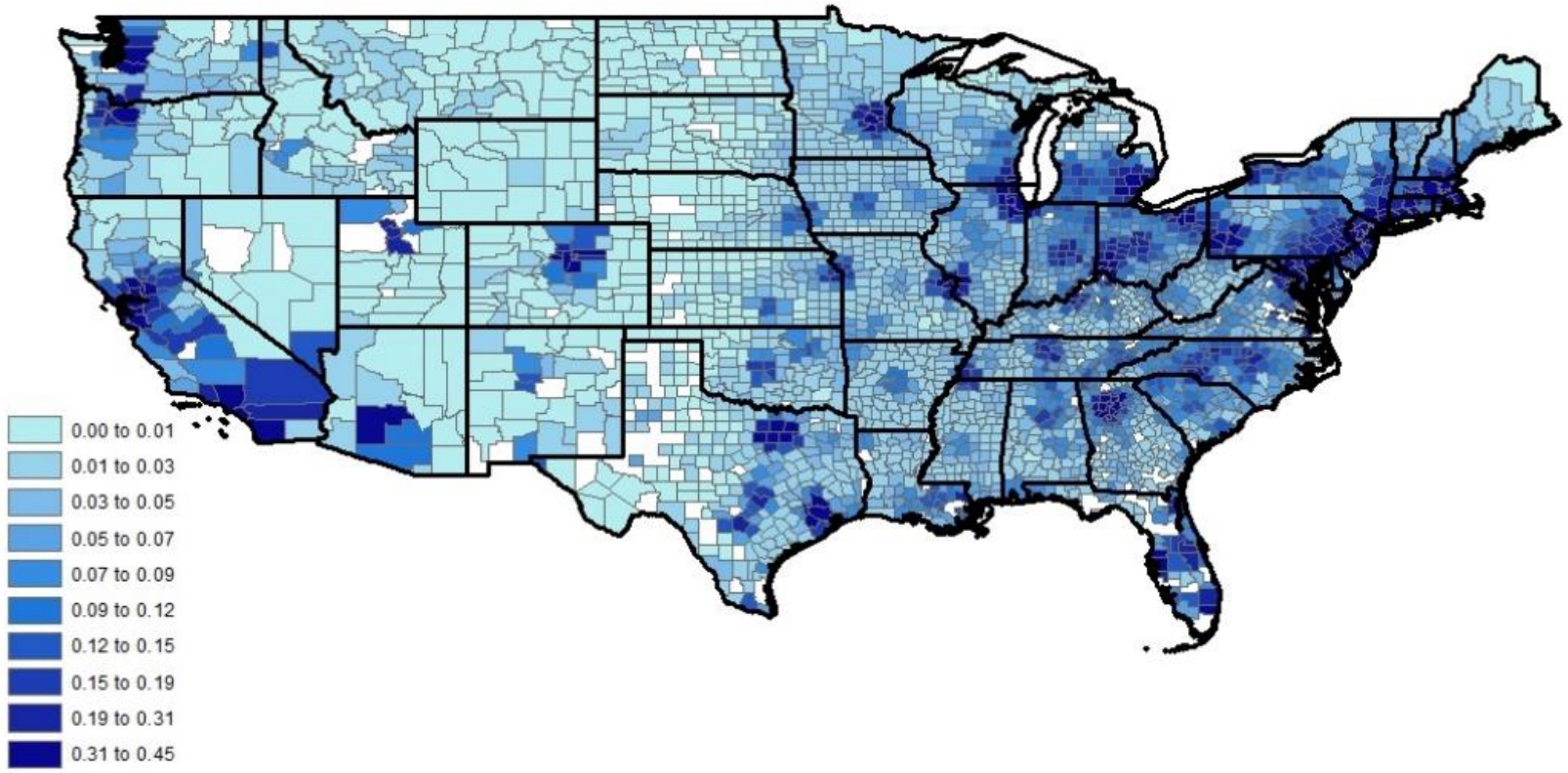
- Share of waters that are fishable grew by 12 percentage points from 1972-2001.
- Each grant decreased the likelihood that a downriver region was not fishable by 0.5 PP.
- It cost $1.5M to make one river-mile fishable.



Keiser and Shapiro (2019)

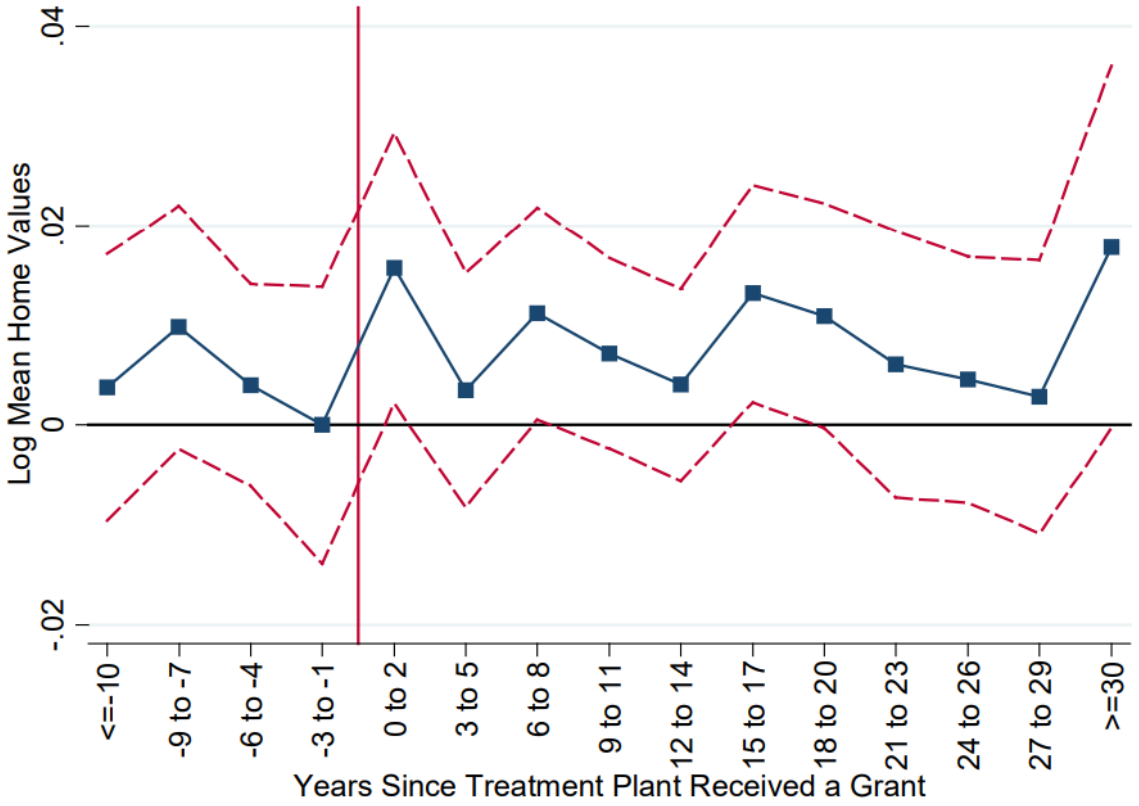
Hedonic results on home values:

- The average grant project cost $31m and increased home values within 25 miles by $7m.
- BC ratios less than one.

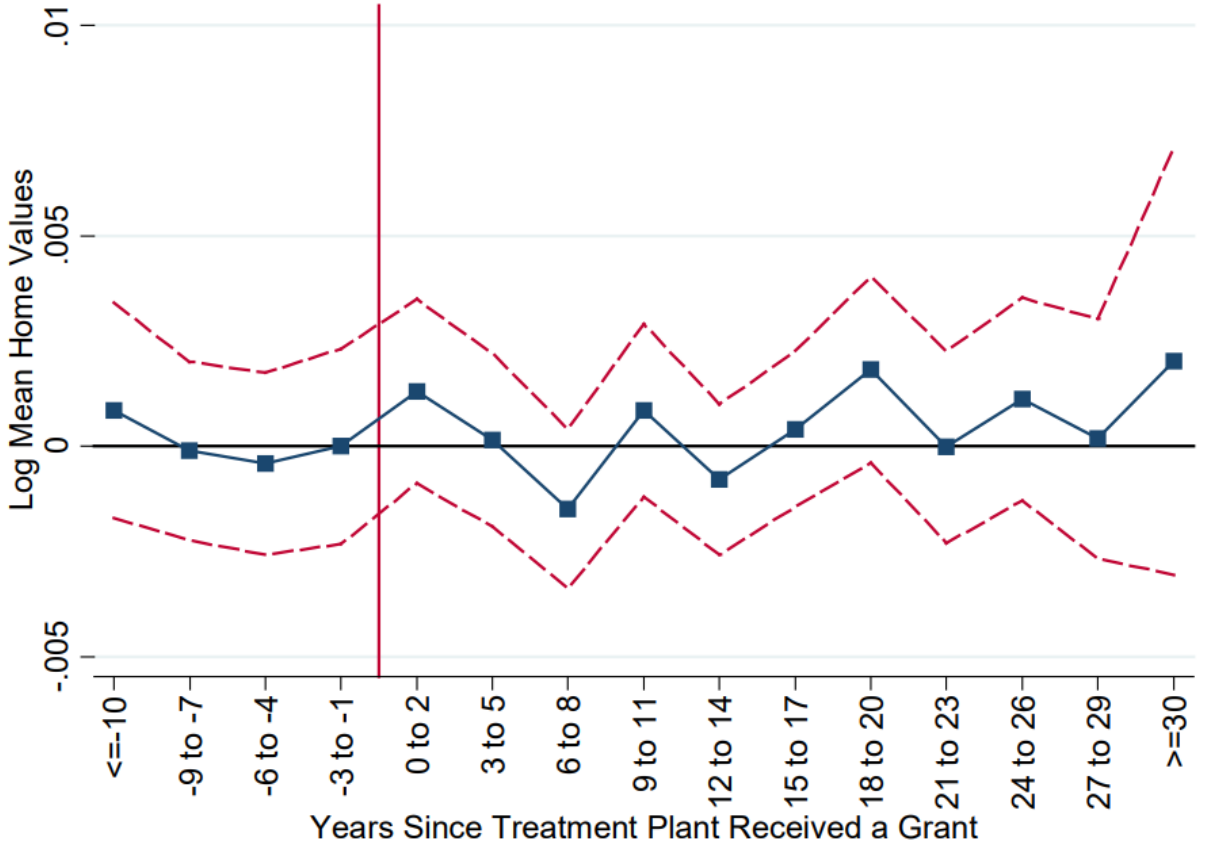


Keiser and Shapiro (2019)

Home values within 0.25 miles.



Home values within 25 miles



Keiser and Shapiro (2019)

Why might hedonic estimates undercount?

- General equilibrium price results with nearby substitutes.
- Health impacts are uncertain even though they may be substantial (Flynn and Marcus, 2022).
- Existence and non-use values.
  - Exxon Valdez SP WTP was 1000x revealed preference (Kling et al., 2012).

Can stated preference help? In some cases, but more research is needed.

- Intrinsic value of ecosystem food webs.
- Cultural values associated with the existence of species, habitats, and specific features.
- Iconic bodies of water.

A Puzzle for BCA in Water Rules

Table 1. CBAs of water quality programs

Regulation	Study time frame	Benefit-to-cost ratio	Benefits, per year	Costs, per year
CWA				
Freeman (6)	1985	0.19–1.23	$13.6B to $65.9B	$53.7B to $71.6B
Carson and Mitchell (7)	1990s	0.61–1.25	$98.1B	$78.3B to $160.2B
Lyon and Farrow (8)	1990s	0.25–1.16	$10.9B to $22.0B	$18.9B to $43.7B
US EPA (21, 61)	1990s	0.79–0.88	$18.9B	$21.5B to $24.0B
Keiser and Shapiro (1)	1962–2001	0.24	$3.9B	$16.3B
WOTUS				
Obama Administration	2015	1.10–2.41	$0.3B to $0.6B	$0.2B to $0.5B
Trump Administration	2017	0.11–0.30	$0.03B to $0.07B	$0.2B to $0.5B
CRP				
Hansen (47)	2000s	0.76–0.87	$2.1B	$2.4B to $2.7B
Effluent Guidelines				
Centralized Waste Treatment	2000	0.07–0.23	$4M to $14M	$60M
Landfills	2000	0.00	<$0.1M	$13M
Transportation Equipment Cleaning	2000	0.11–0.33	$3M to $9M	$27M
Waste Combustors	2000	0.15–0.5	$0.3M to $1M	$2M
Coal Mining	2002	>1	$22M to $24M	$0M
Iron and Steel Manufacturing	2002	0.11–0.58	$2M to $11M	$19M
Concentrated Animal Feeding Operations	2003	0.61–1.06	$320M to $557M	$526M
Metal Products and Machinery	2003	0.09	$2M	$22M
Concentrated Aquatic Animal Production	2004	0.05	$0.1M	$2M
Meat and Poultry Products	2004	0.05	$4M	$86M
Construction and Development	2009	0.39	$429M	$1,108M
Steam Electric	2015	0.94–1.18	$464M to $582M	$493M

Source: Keiser, Kling, Shapiro (2018) The low but uncertain benefits of US water quality policy.

Continuing Challenges

- Jurisdictionality.
- Nonpoint source pollution.
- Missing benefits.
- Quantity of water use.
- Climate change.

The Rhine river in August of 2022. Source: CNN, 2022.

Next class

- Next class will cover the Safe Drinking Water Act. I will also go over your third case study assignment.

- Two readings for Wednesday:
  - Allaire et al. (2018)
  - Fedinick et al. (2022)