Lecture 19: The Clean Water Act

Prof. Austin
Environmental Economics
Econ 4075

Roadmap

Topics on the Clean Water Act:

- Motivation
- Regulatory Instruments
- Key Terms
- Evolution of the CWA
- Economics and the CWA

Why Regulate Water Quality?

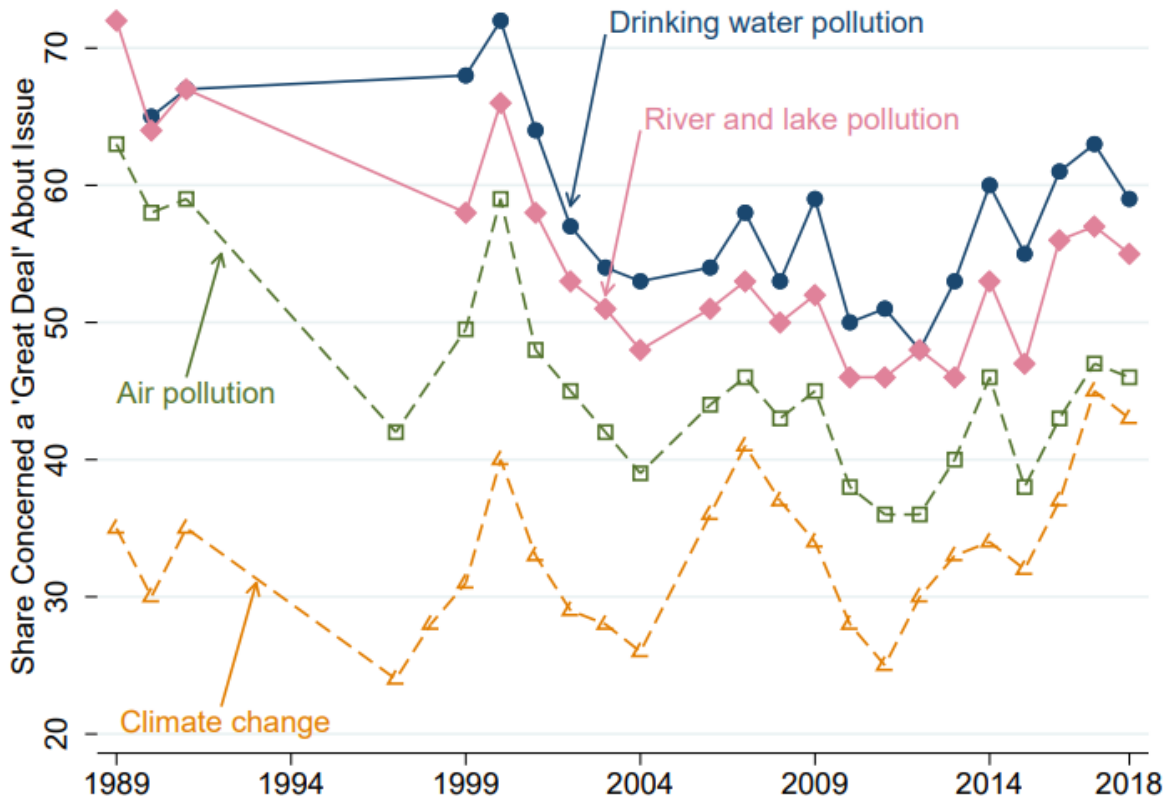
The Cuyahoga is infamous for its 13 fires, but this wasn't rare. The Delaware River in Philadelphia, Baltimore harbor, the Buffalo river, and the Rouge River in Detroit also caught fire. NYC harbor had 300 oil spills in the first six months of 1973.

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

Why Regulate Water Quality?

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).

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). The act does not directly regulate drinking water.

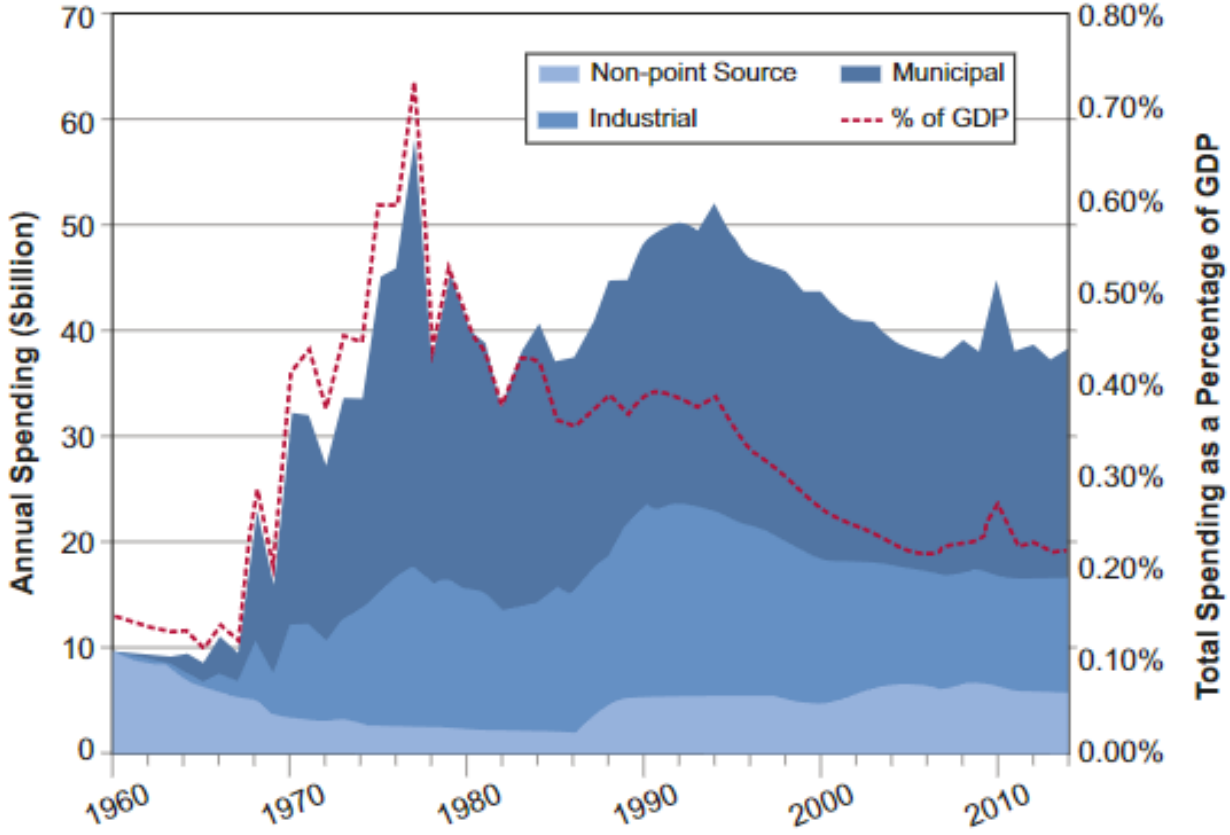
Its goals:

- 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.

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.

The CWA has been costly, controversial, and under-studied.

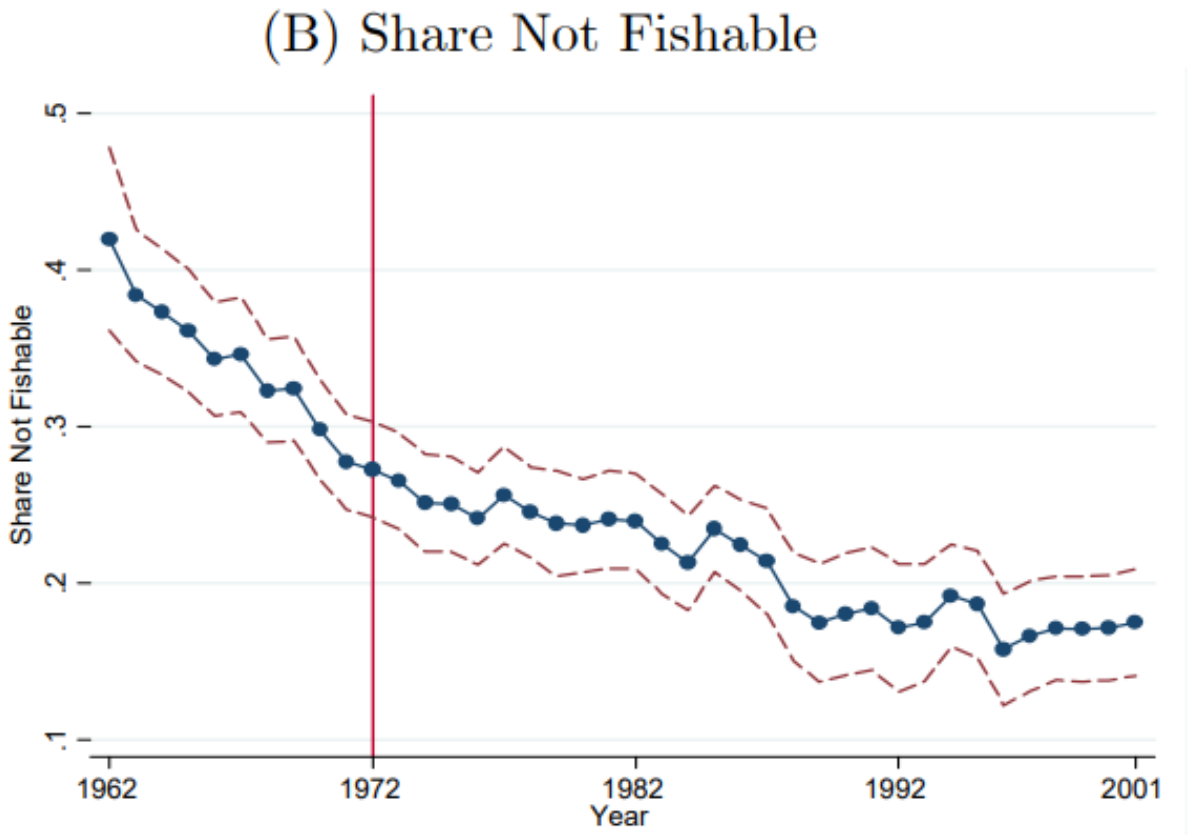


Source: Keiser, Kling, and Shapiro (2018).

50 Years Later

Share of waters that are fishable grew by 12 percentage points from 1972-2001.

It cost $1.5M to make one river-mile fishable.

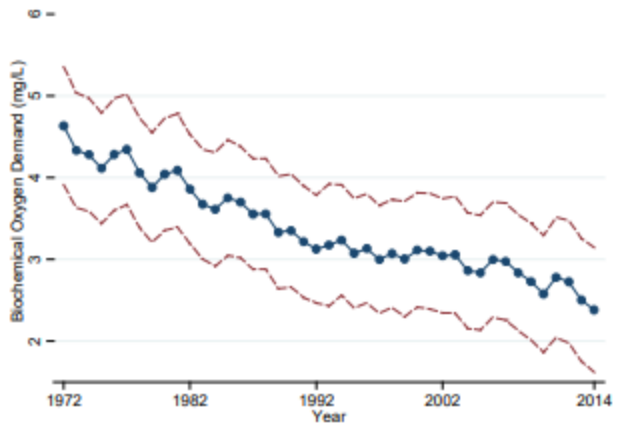


Source: Keiser and Shapiro (2019).

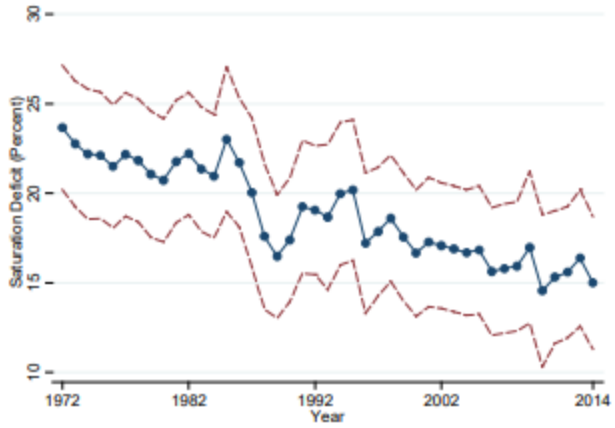
50 Years Later

- Notable improvements in key water quality indicators
- Using alternative criteria of fishability, others have estimated that over one third of water systems in the US remain un-swimmable and half are not suitable for fishing (Environmental Integrity Project, 2022).

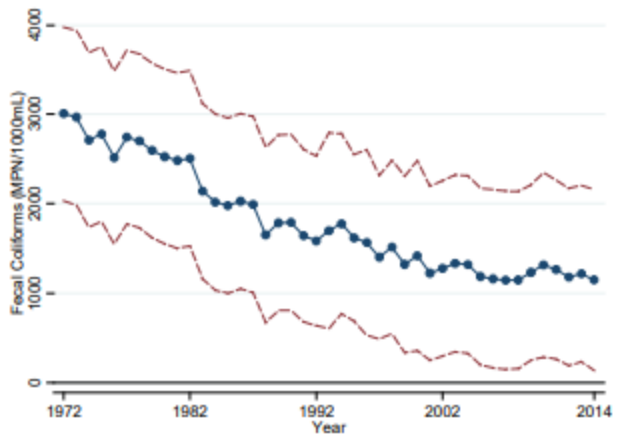
Panel A. Biochemical Oxygen Demand



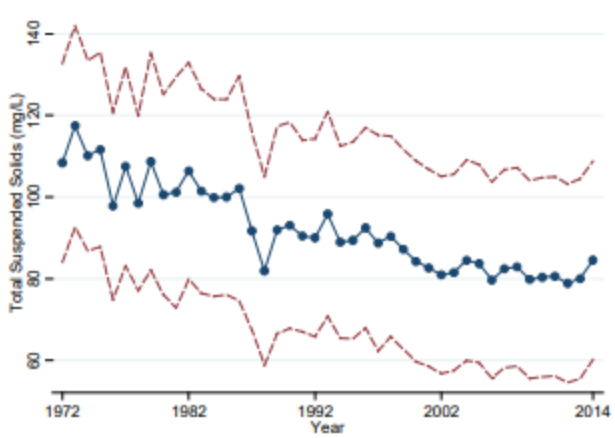
Panel B. Dissolved Oxygen Saturation Deficit



Panel C. Fecal Coliforms



Panel D. Total Suspended Solids



Source: Keiser and Shapiro (2019).

Progress 50 Years Later

William Ruckelshaus: “even if all our waters are not swimmable or fishable, at least they are not flammable.”

Image source: NYT.

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.

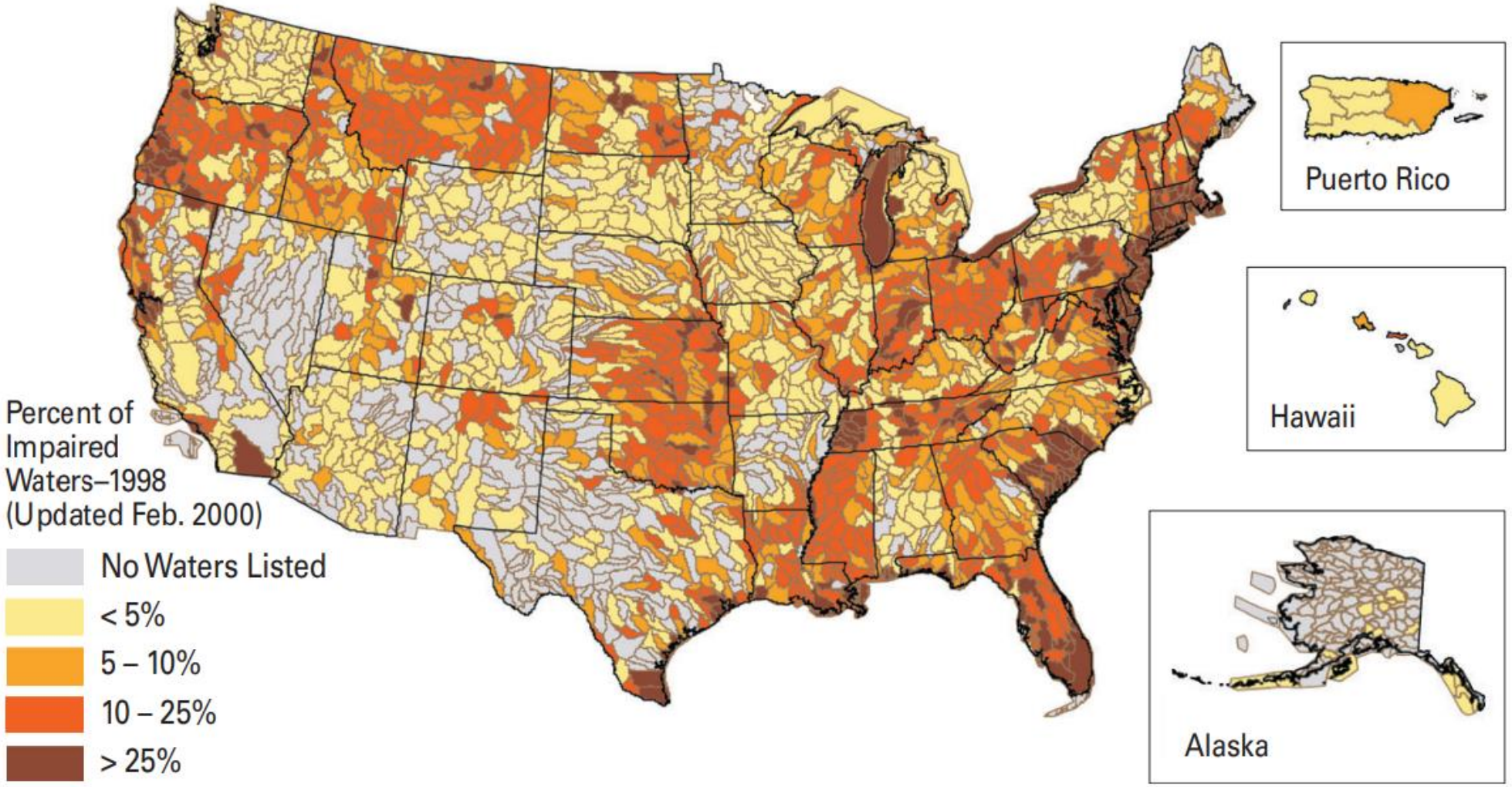
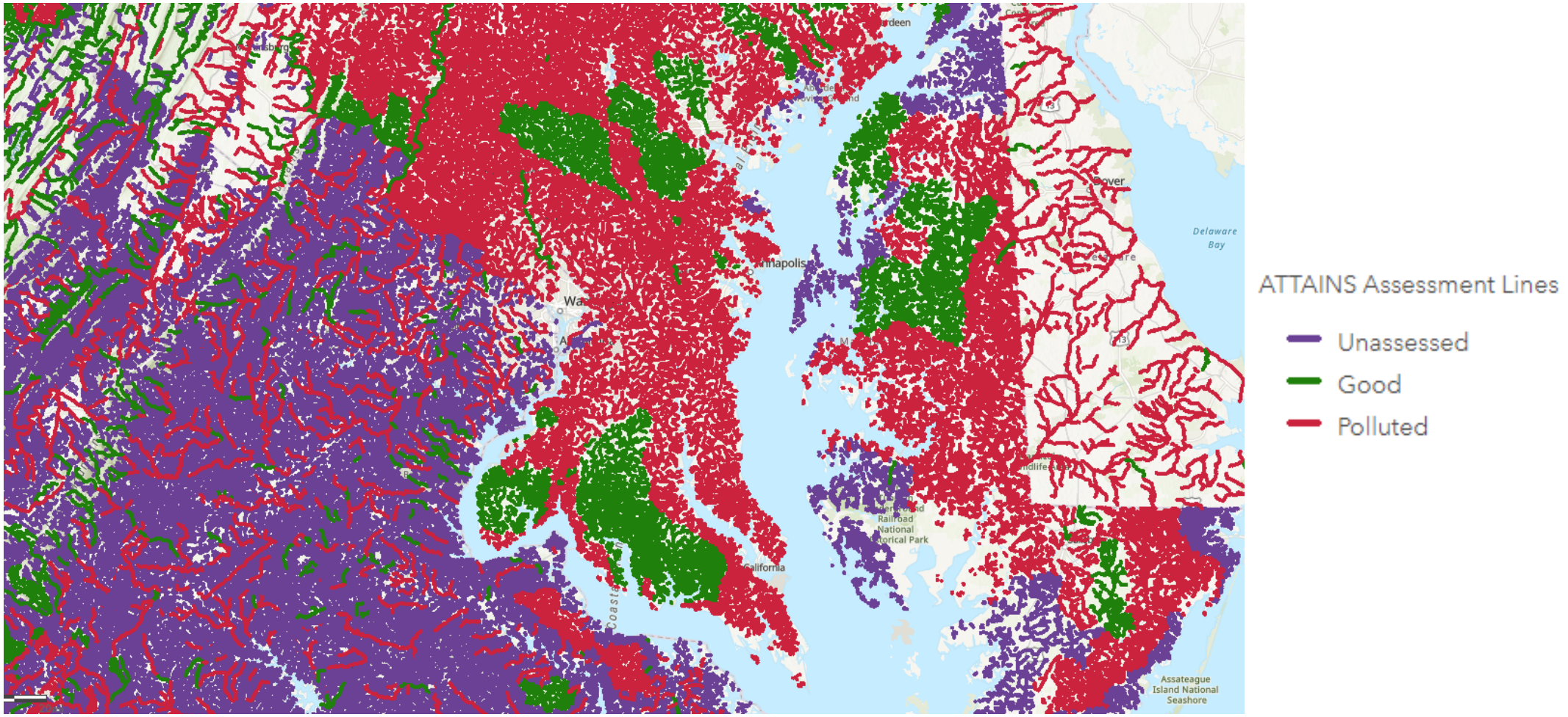


Figure 1. Map of watersheds containing impaired water bodies from the U.S. Environmental Protection Agency's 1998 list of impaired waters (USEPA, 2000).

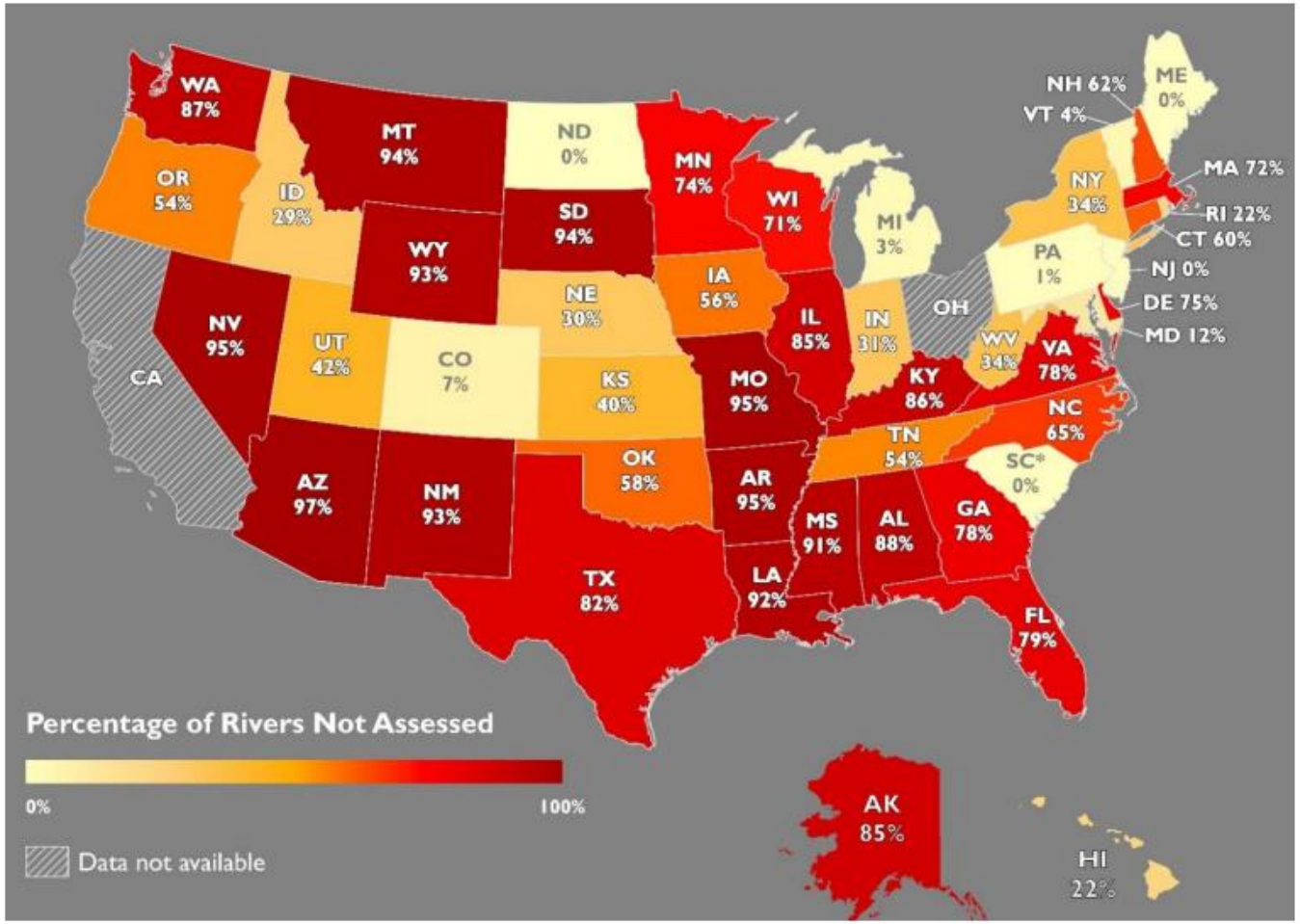
ATTAINS Data in the Chesapeake Region



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

State Performance on Assessing Water Quality Standards

MAP 6: PERCENT OF RIVER & STREAM MILES NOT ASSESSED IN LAST SIX TO TEN YEARS



Percentages are of river and stream miles not assessed as required during the most recent cycle of 6 to 10 years, depending on the state.

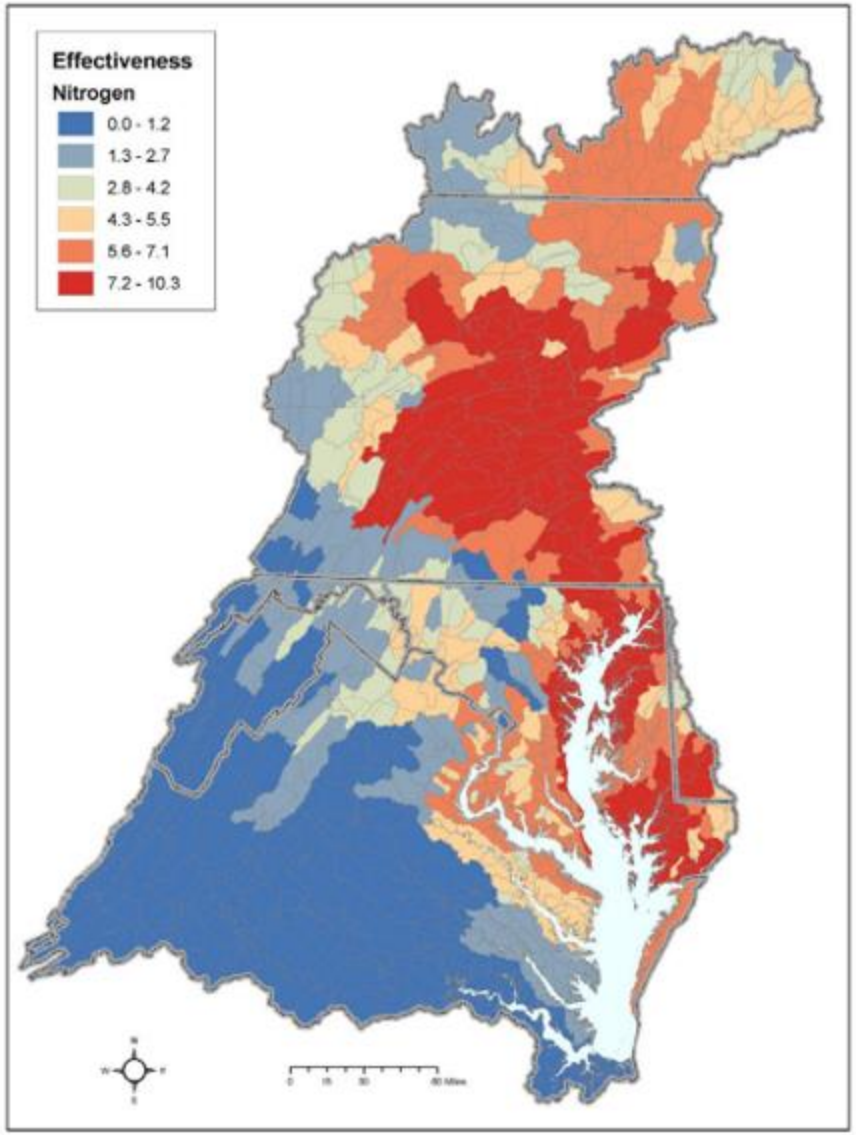
Source: Environmental Integrity Project (2022).

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.

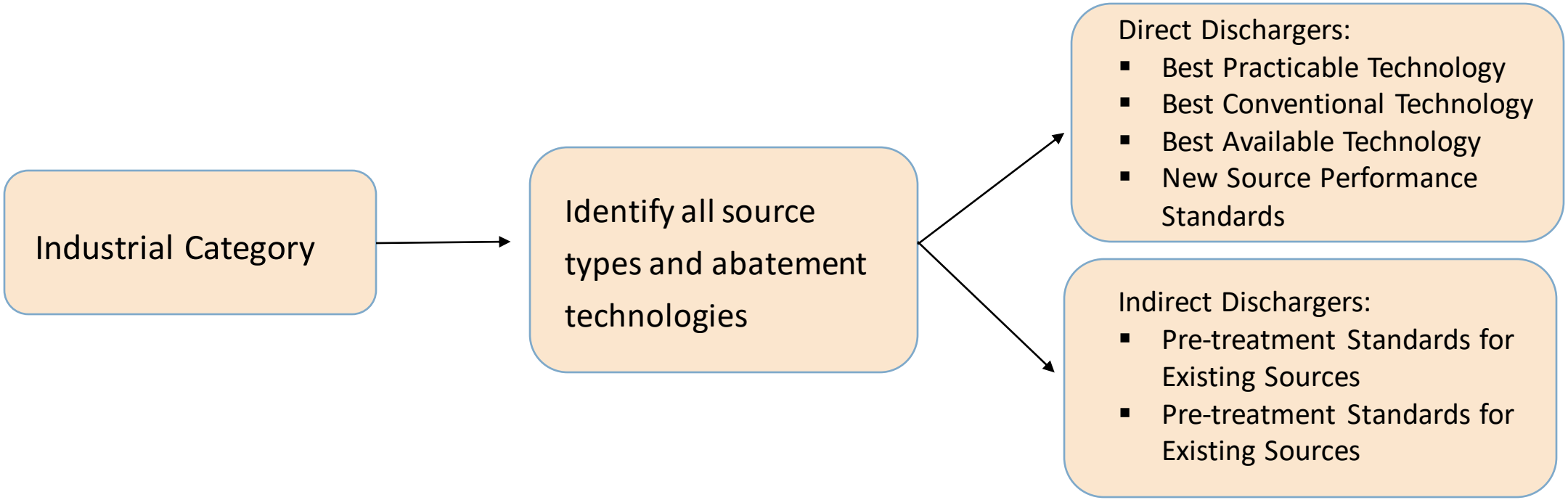
2) Point Source Discharge Regulations

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

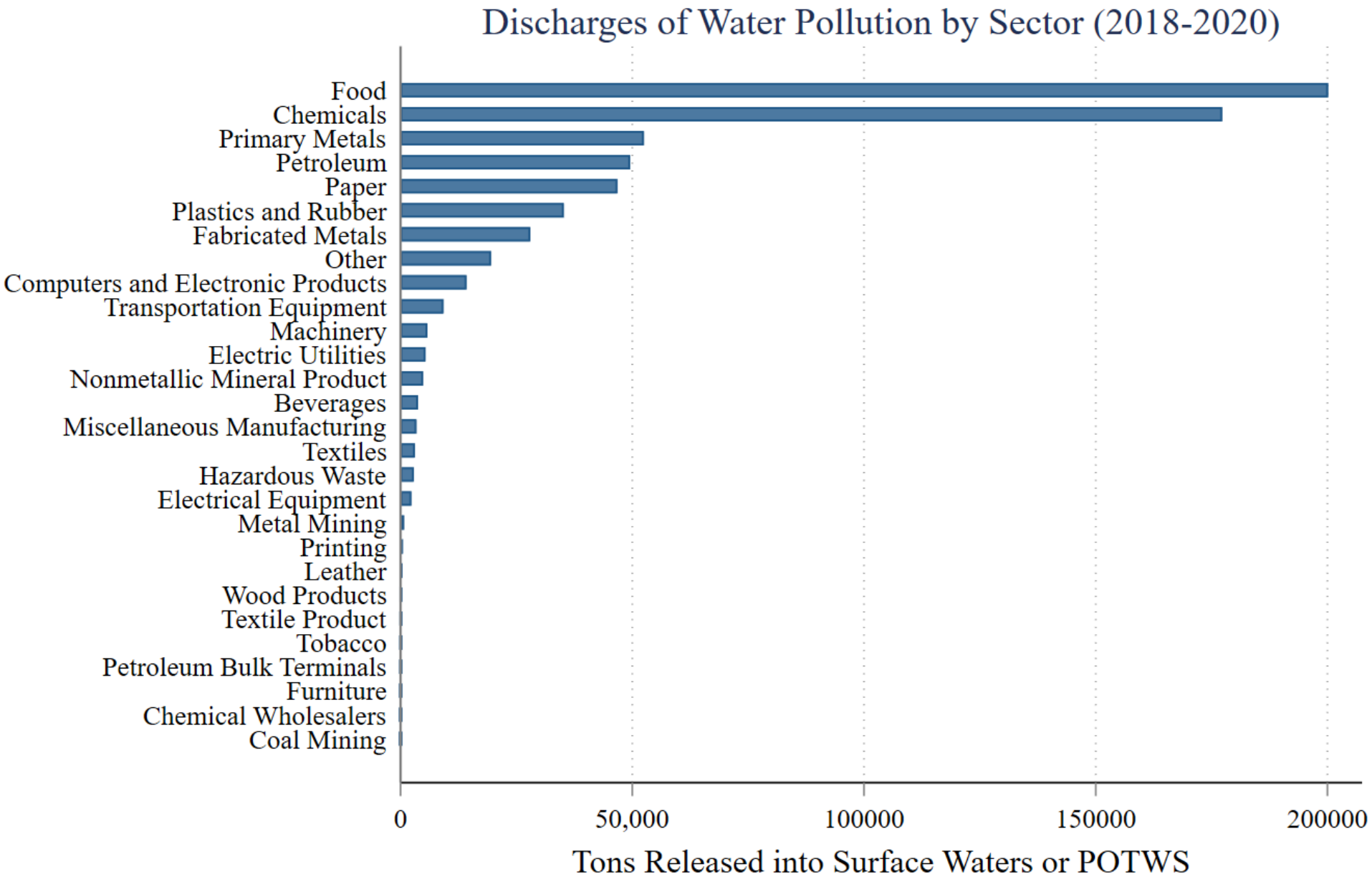
For some industrial categories, NPDES permits must follow **Effluent Limitation Guidelines** (ELGs). These are numeric limits based on the performance of specific technologies, but specific techs are rarely required. Permit limits are set by states often using "Best Professional Judgement."



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 replaced by a 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.

Los Angeles Hyperion Treatment Plant Link

Part 2: Key Terms

"Point Source"

For jurisdictionality, 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.

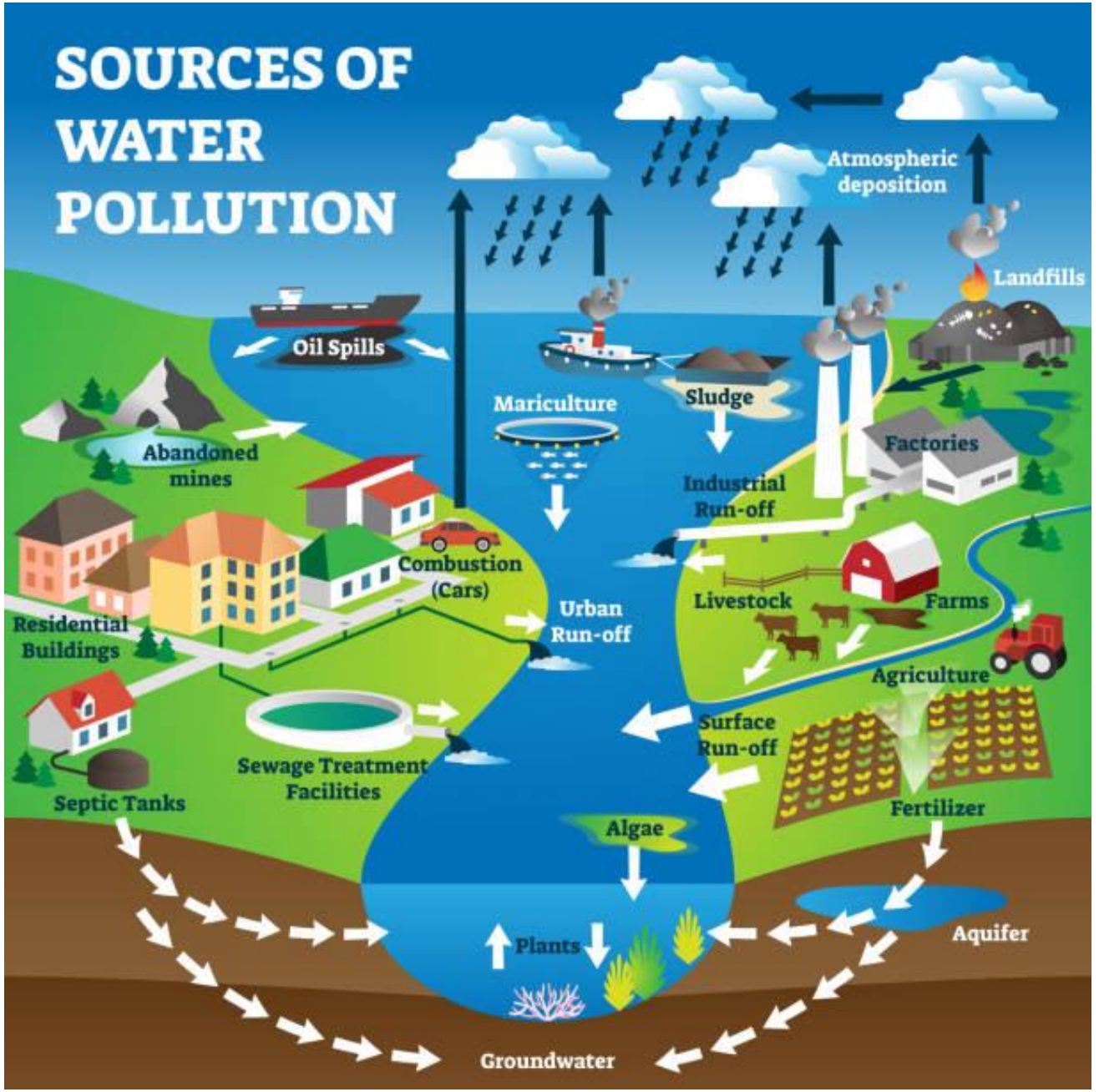


Image source: iStockphoto by Getty images.

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.

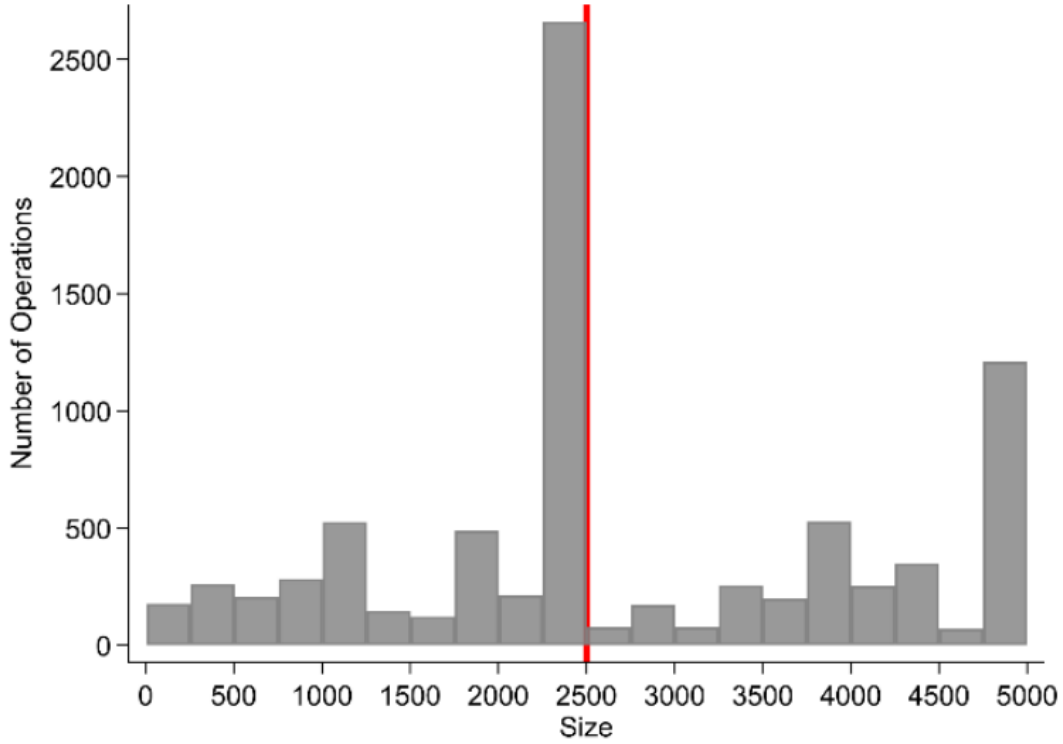
Source: "Lagoons of Pig Waste Are Overflowing After Florence." NYT.

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:

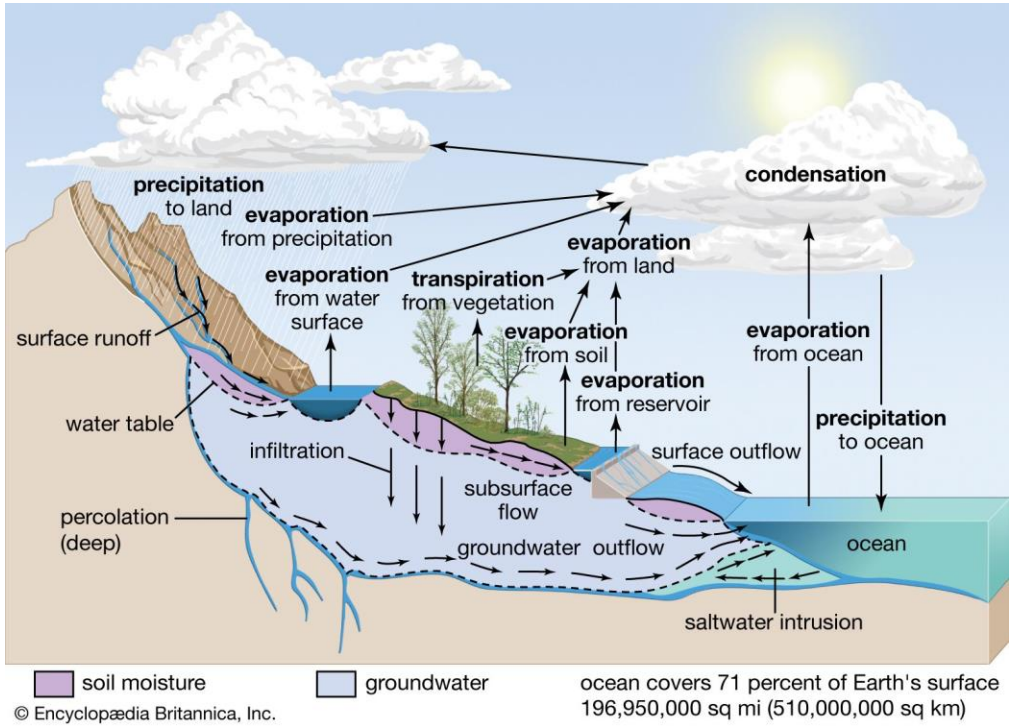
- Navigable rivers and lakes
- Interstate waters
- Territorial seas up to 200 miles

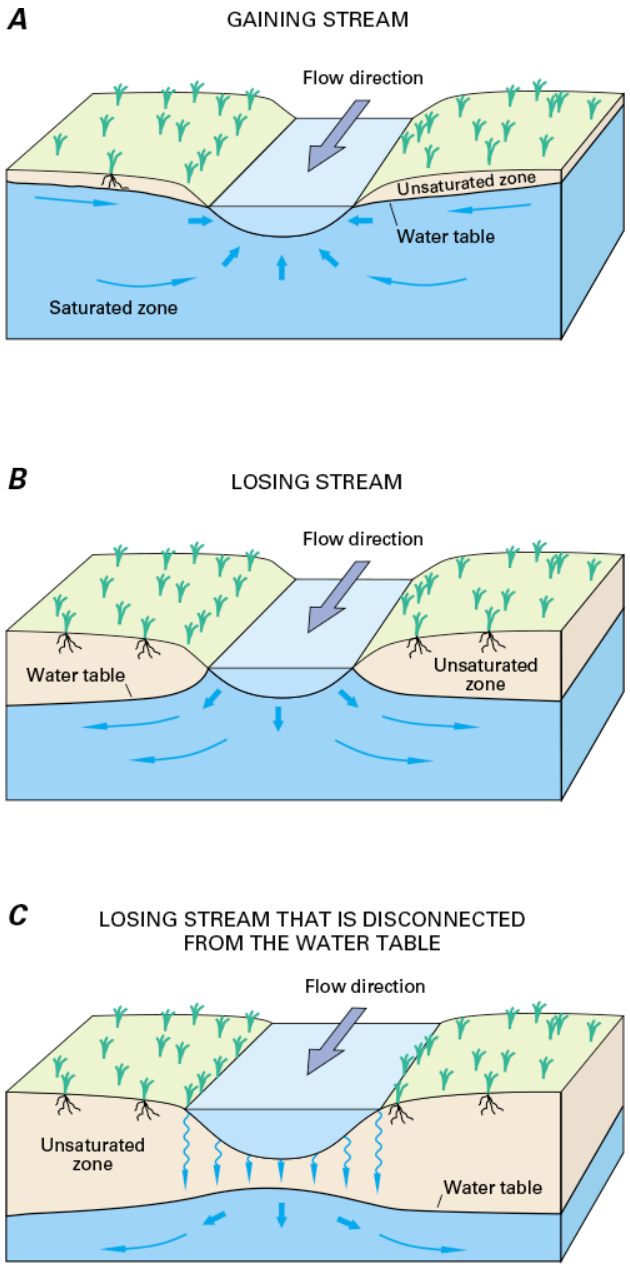
Somewhat ambiguous:

- 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:

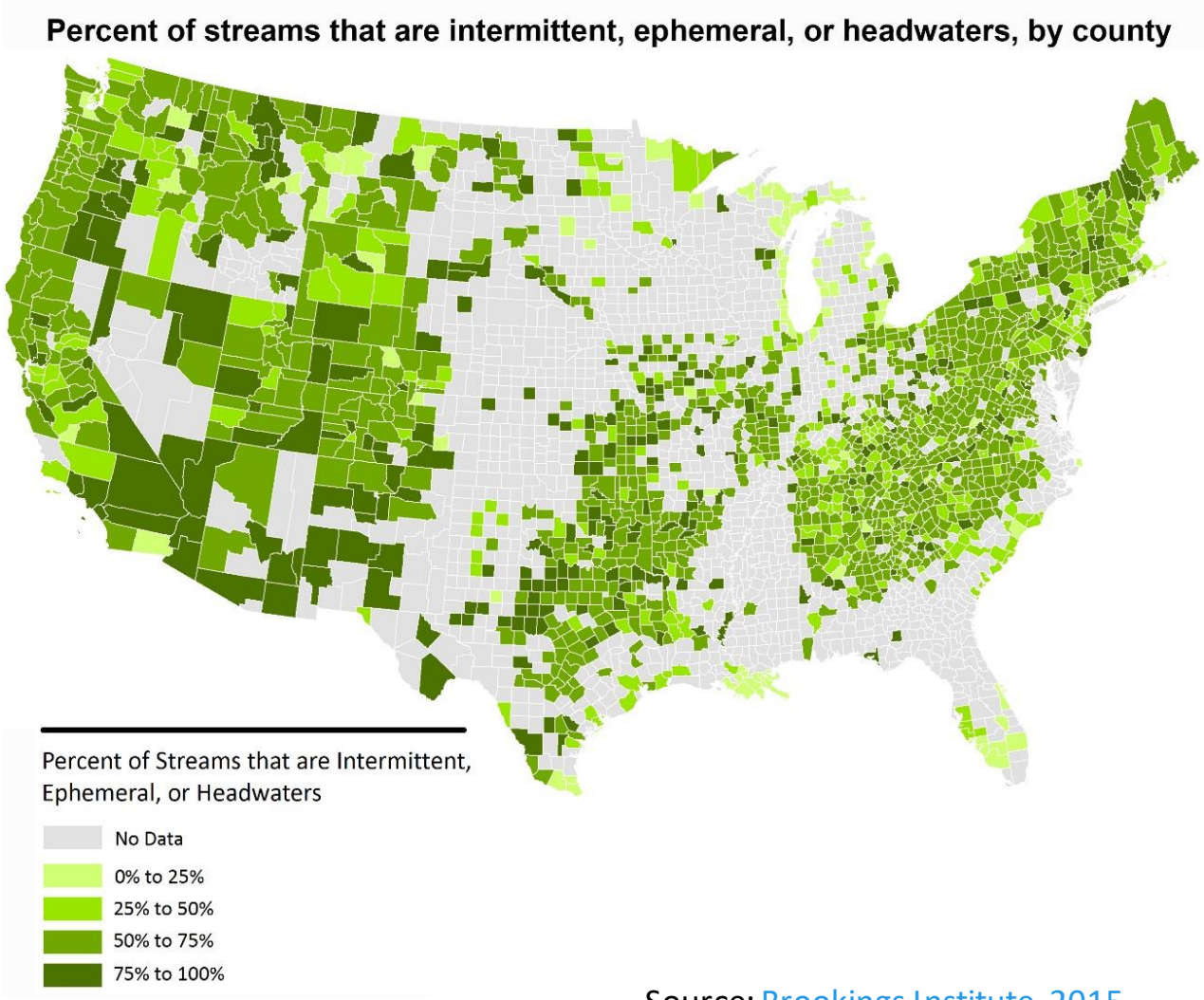
1) **Scalia test:** jurisdiction extends to relatively permanent bodies of water, including wetlands, that are connected to navigable waters.
2) **Kennedy test:** jurisdiction extends to any waters, including wetlands, acting as a **significant nexus** for traditional navigable waters.
    - Significant 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 built on the connections inherent to hydrogeologic systems, using the **significant nexus** test 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 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 (26.4m wetland acres)
- All ephemeral streams and an estimated 70% of all streams (600,000 stream miles)

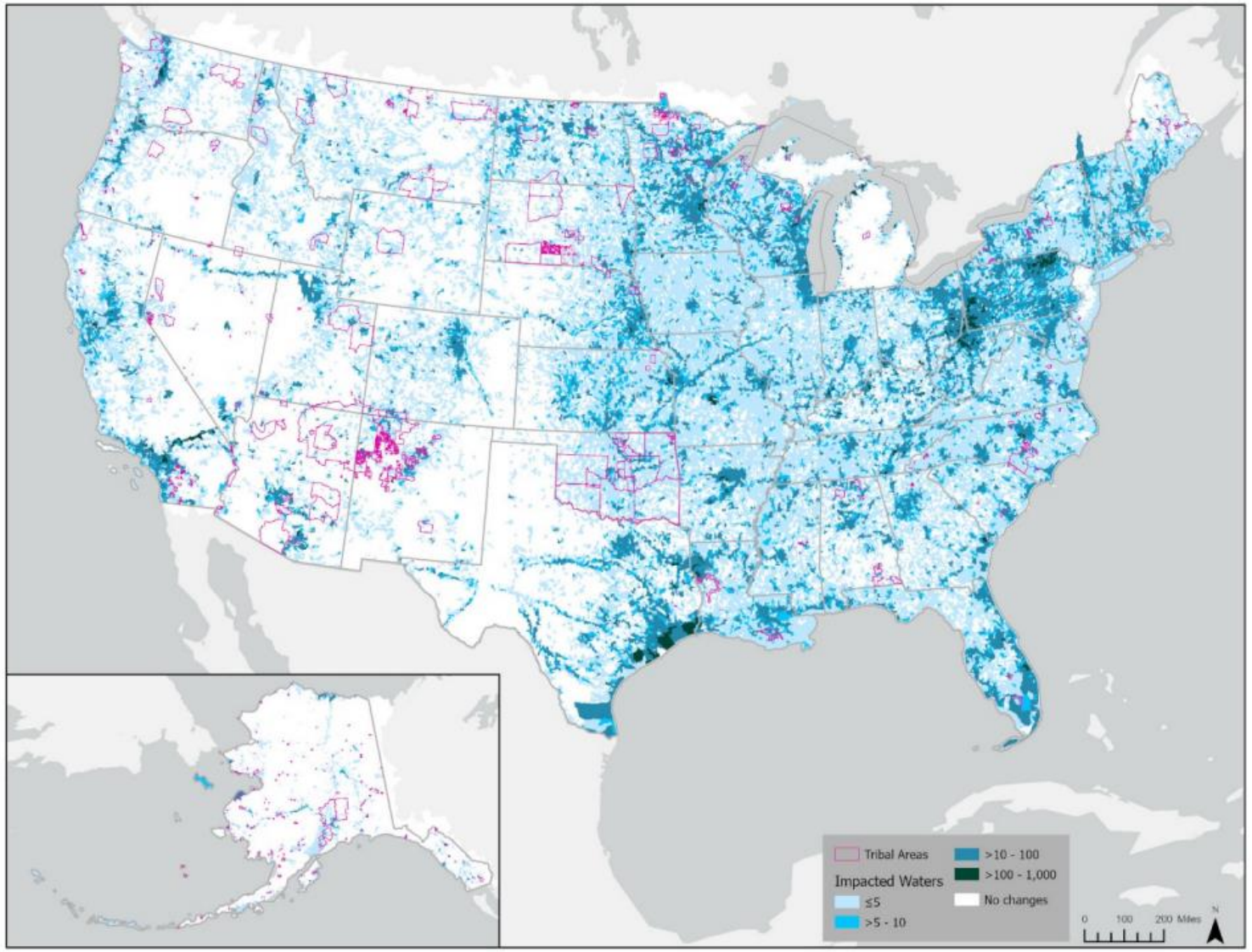
It also excluded categories of WOTUS established by precedent:

- 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.]

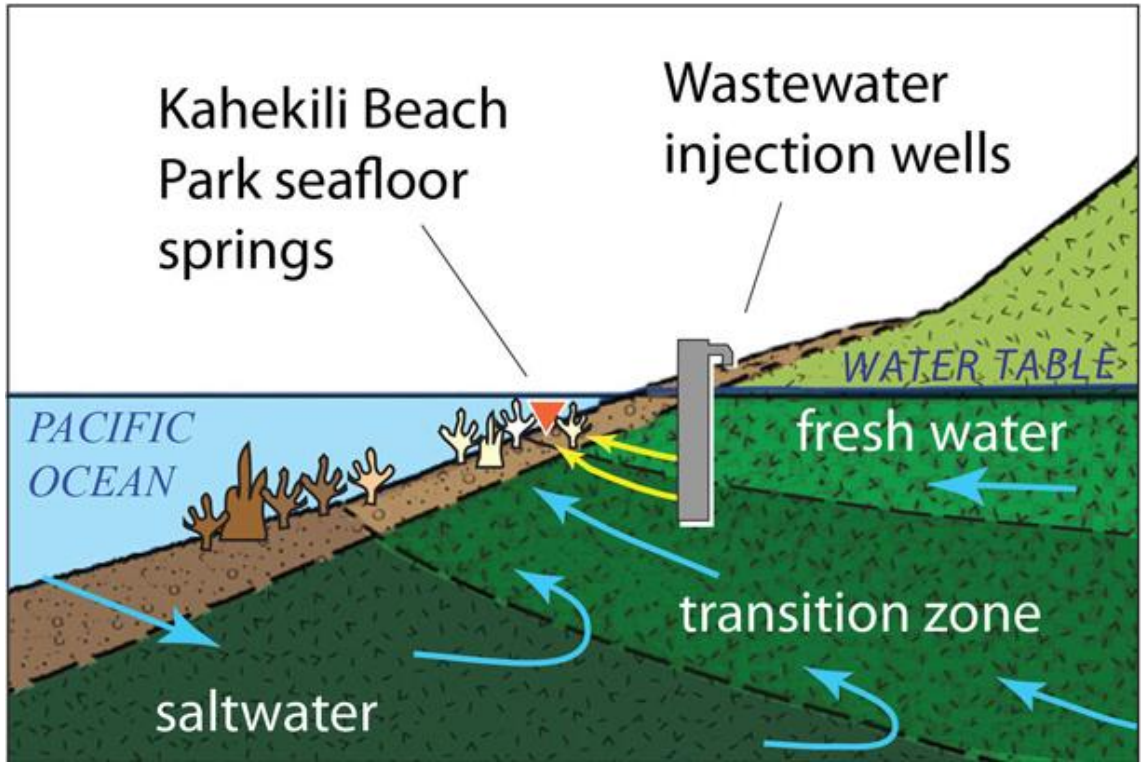


Source: Economic Analysis for the Revised WOTUS (2021).

County of Maui v. Hawaii Wildlife Fund (2020)

Recent supreme court developments

- 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.



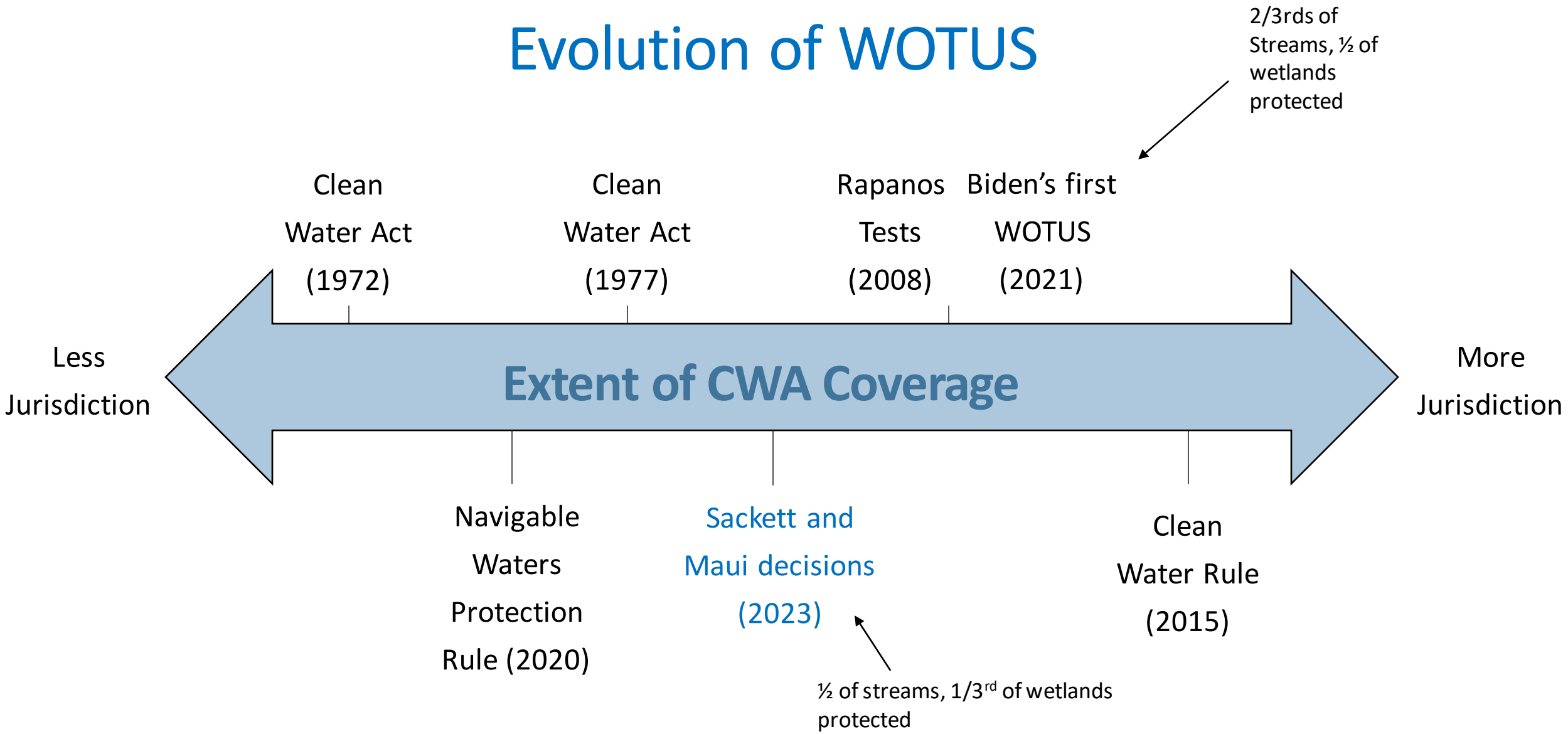
Source: USGS.

Sackett vs. EPA (2023)

- Sackett vs. EPA
  - WOTUS are relatively permanent, standing or continuously flowing streams, oceans, rivers, and lakes
  - WOTUS must have a continuous surface connection to rivers and lakes forming WOTUS
  - Read a great article about Sackett by the NRDC.

Source: EarthJustice.

Evolution of WOTUS



Continuing Challenges

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

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

Part 4: Economics and the Clean Water Act

A Puzzle for BCA in Water Rules

Recent retrospective analyses show that the median benefit-cost ratio of CWA regulations is 0.37.

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.

Keiser and Shapiro (2019)

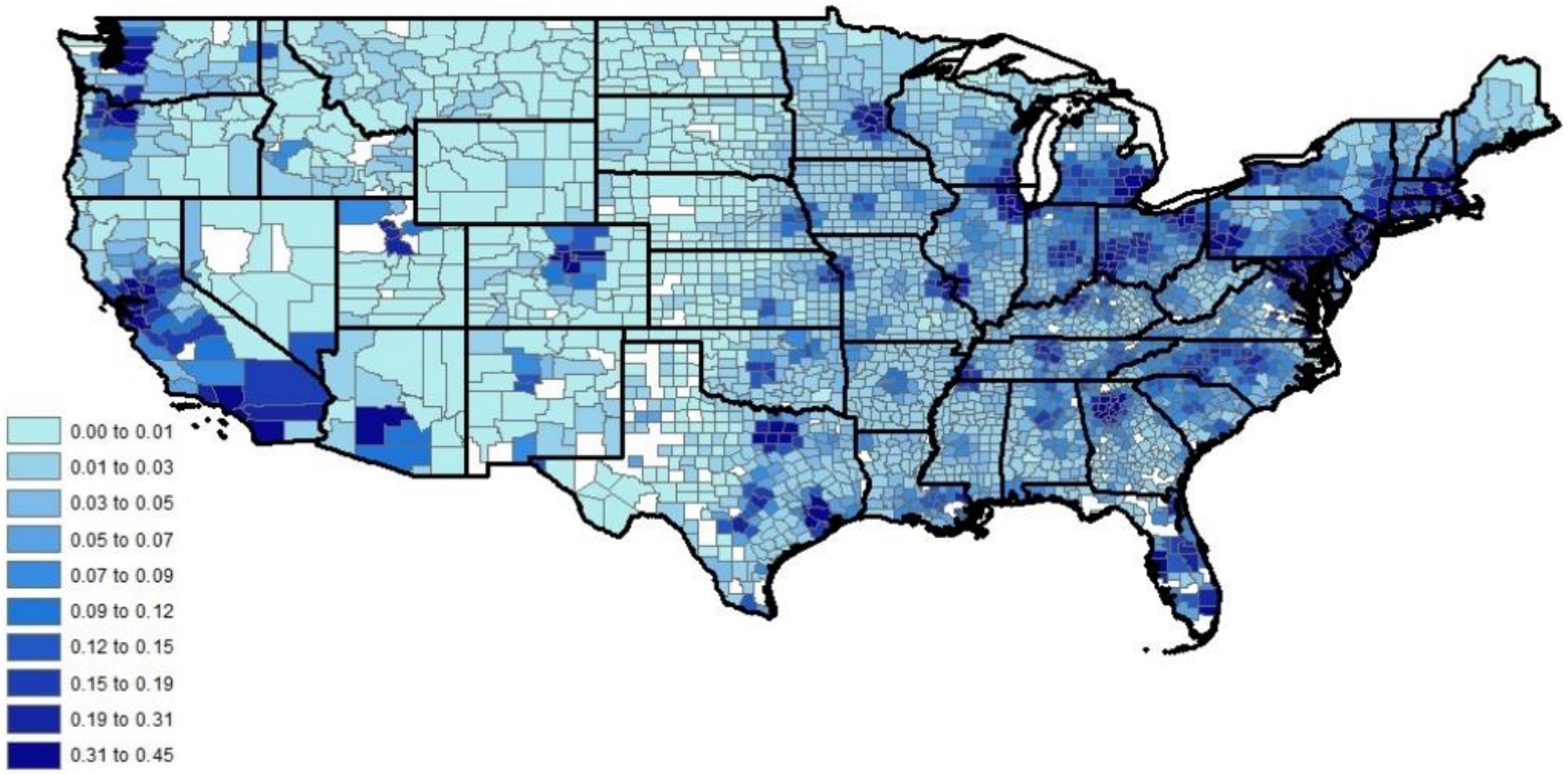
In a related paper on the costs and benefits of the grants program portion of the CWA, Keiser and Shapiro (2019) ask:

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)

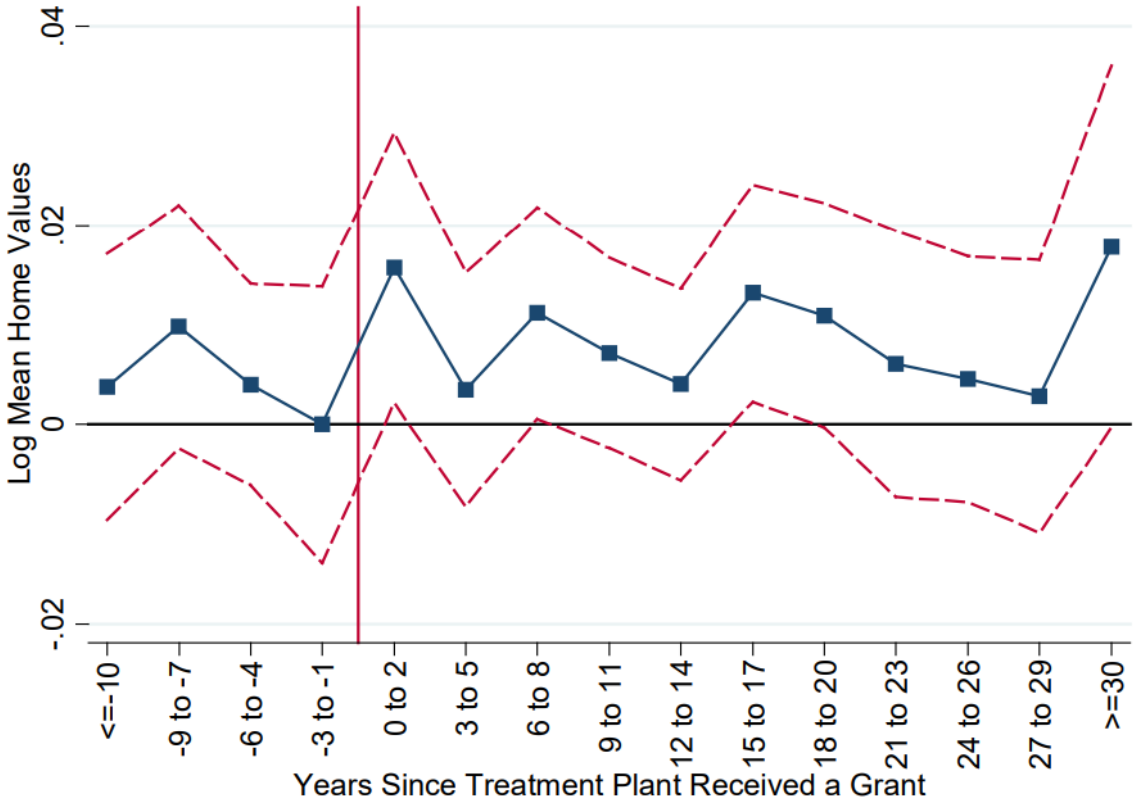
Hedonic results on home values:

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

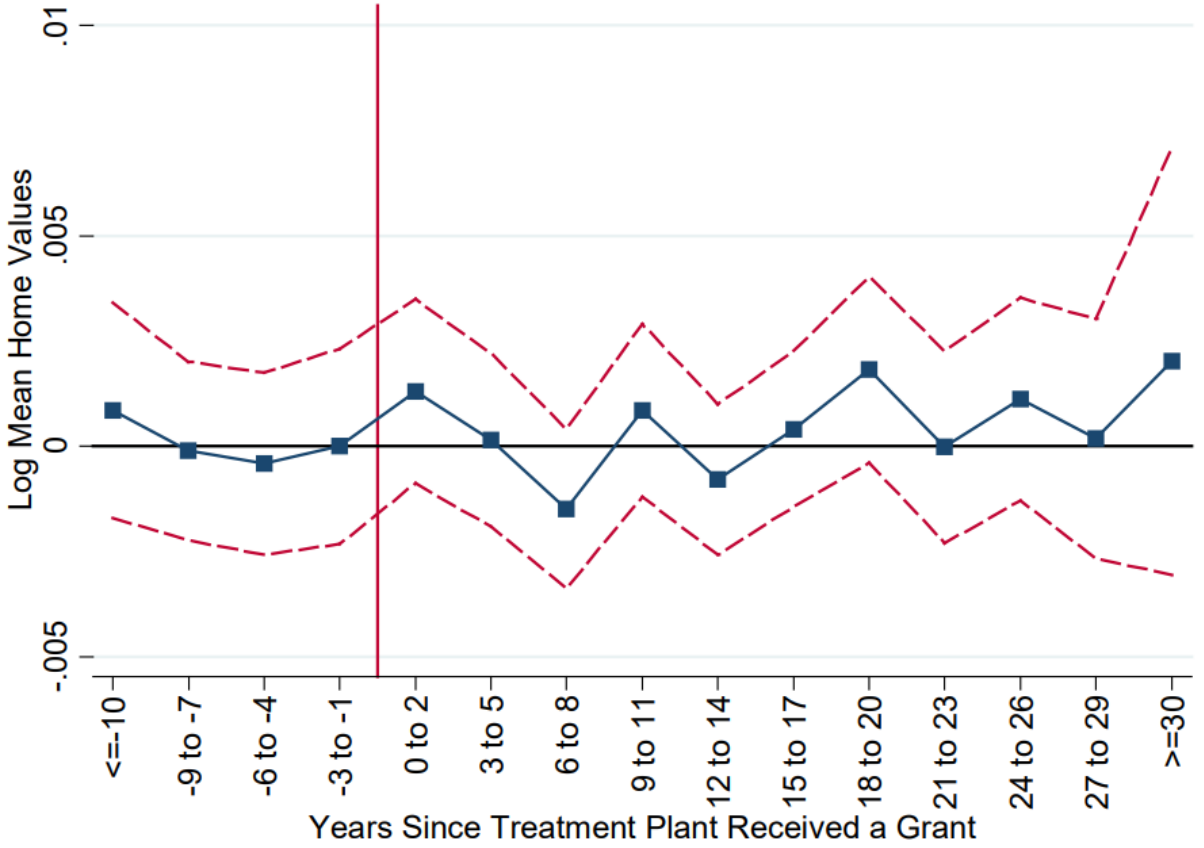


Keiser and Shapiro (2019)

Home values within 0.25 miles.



Home values within 25 miles



Keiser and Shapiro (2019)

Why might hedonic estimates of grant impacts undercount true benefits?

- Hedonic model mainly counts amenity value of being on the body of water, not all recreation.
- Health impacts are not included but may be substantial (Flynn and Marcus, 2022).
- Existence and non-use values.
  - Exxon Valdez SP WTP was 1000x revealed preference (Kling et al., 2012).

A Puzzle for BCA in Water Rules

Do the costs of US water quality regulations not exceed their benefits, or do existing analyses substantially understate true benefits?

- Older stated preference studies did not necessarily incorporate frontier methods with respect to consequentiality and incentive compatibility.
- Measurement error biases recreation demand estimates to zero.
- Incomplete information by households biases hedonic estimates.
- Many unquantified benefits including:
  - Health benefits
  - Existence values.
  - Non-standard pollutants.

A Puzzle for BCA in Water Rules

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

- Intrinsic value of ecosystem food webs are complex and not generally known to survey respondents.
- Cultural values associated with the existence of species, habitats, and specific features are difficult to transfer across sites.
- Iconic bodies of water require specific stated preference studies.

Next class

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

- Two readings for Wednesday:
  - Allaire et al. (2018)
  - Fedinick et al. (2022)
  - (*optional*) Keiser et al. (2023)