# TRANSBOUNDARY WATERS

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*In 2018, toxic algae spread from Lake Okeechobee through the State of Florida, leading to a state of emergency and costing the state over $17 million. Similar toxic algal blooms have become an annual occurrence throughout the country and highlighted the pervasive issues with the U.S. water supply. Inadequate and incomplete monitoring data means that state and federal managers, as well as the public, know shockingly little about water quality in most of the waters in the United States despite the fact that the Clean Water Act requires extensive water quality monitoring and assessment. Academics have widely discussed failings of the Clean Water Act, but the impacts of these failings are only beginning to show their true extent.*

*This Article presents an empirical study on the effects of scientific inconsistency on regulatory classifications in the Clean Water Act's Total Maximum Daily Load program by looking at waters that span state boundaries, or transboundary waters. Transboundary waters are subject to the same federal legal regime, but two different states monitor and assess their water quality. When two states monitor the same transboundary water they should find water quality measurements that are roughly in agreement. This is not the case: Only 4% of transboundary waters nationally are regulated consistently on both sides of a state boundary, indicating a striking degree of scientific and regulatory inconsistency among states. This inconsistency undermines a key goal of the Clean Water Act: to encourage uniform state regulation of water bodies.*

*I place this finding in the landscape of proposed solutions to the Clean Water Act's failings. I argue that solutions that focus on changing the cooperative federalism relationships at the Clean Water Act's core ignore the scientific realities at the heart of the Act. Transboundary waters highlight that regulatory outcomes in the Clean Water Act are highly sensitive to small changes in scientific methodology. I explain how misconceptions of science when the Act was drafted led to this outcome and propose solutions to overcome these misconceptions.*

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## Introduction

Despite the explicit water monitoring requirements in the Clean Water Act ("CWA"),[1] we know very little about water quality in most of the waters in the United States. People swim, fish, and boat in these waters every day. In recent years, thousands have gotten sick nationwide from outbreaks of algae and bacteria caused by pollution in lakes and rivers.[2] Congress passed the CWA to remedy these very problems, but it has been over forty-five years and the problems, in large part, remain.

A widespread lack of monitoring has hidden the extent of our nation's water quality problems. The CWA mandates that states monitor their waters and report on them annually to Congress, but as of 2017, states have only been able to assess roughly 30% of the nation's rivers and streams.[3] This 30% has only been achieved after massive efforts from 2002 to 2008 by states and EPA to monitor the nation's waters.[4]

The lack of baseline information on water quality limits what states can do to fix pollution problems. This is particularly true in the case of nonpoint source pollution. Nonpoint sources, including runoff from agriculture, roads, logging and other industrial activities, contribute to the impairment of over 85% of the rivers in the United States that are currently classified as impaired.[5]

1. 33 U.S.C. §§ 1251–1387 (2018).
2. *See* Daniel S. Graciaa et al., *Outbreaks Associated with Untreated Recreational Water — United States, 2000–2014*, 67 Morbidity & Mortality Wkly. Rep. 701, 701 (2018), https://perma.cc/VT5R-YFMB; *see also, e.g.*, Tyler Treadway, *With Toxic Blue-Green Algae Bloom, Don't Eat Lake Okeechobee Fish, Audubon Biologist Says*, Treasure Coast Newspapers (June 10, 2019), https://perma.cc/UP3T-9BFL.
3. *See* EPA, EPA 841-R-16-011, National Water Quality Inventory: Report to Congress 8 (2017), https://perma.cc/9F7R-NEQP [hereinafter 2017 Water Quality Inventory] (stating there are 1,107,002 assessed of approximately 3.5 million rivers and streams nationwide).
4. *See* Oliver A. Houck, *The Clean Water Act Returns (Again): Part I, TMDLs and the Chesapeake Bay*, 41 Envtl. L. Rep. 10,208, 10,212 (2011) [hereinafter Houck, *Chesapeake Bay*].
5. *See* EPA, EPA 841-R-16-009, National Nonpoint Source Program—A Catalyst for Water Quality Improvements 4 (2016) [hereinafter Nonpoint Source Program], https://perma.cc/P2YG-CU6K.

Nonpoint source pollution has led to some of the nation's most dramatic water quality disasters, such as the loss of blue crabs and oysters in the Chesapeake Bay[6] and the spread of toxic blue-green algae from Lake Okeechobee throughout the waters of South Florida.[7] However, the widespread lack of baseline information on water quality means that many nonpoint source pollution problems go largely unnoticed.[8]

The CWA's measures targeting nonpoint source pollution have been strikingly difficult to implement.[9] A lack of monitoring data is one of the reasons for this.[10] Without accurate baseline information on water quality, it is impossible to make and then implement the CWA's pollution reduction goals, known as "total maximum daily loads" ("TMDLs").[11] What data do exist about national water quality are generally incomplete and opportunistic.[12] This lack of information has resulted in a patchy nonpoint source pollution control program that rests on questionable scientific grounds.[13]

The patchiness of this regime flies in the face of one of the stated goals of the CWA: to achieve baseline fishable, swimmable water quality across the nation.[14] One of Congress's main justifications for the cooperative federalism structure of the CWA, and of many prominent environmental statutes, was the importance of creating a consistent minimum baseline for water quality nationally.[15] The TMDL program governing nonpoint source pollution is not meet-

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6. *See* Houck, *Chesapeake Bay*, *supra* note 4, at 10,213.

7. *See* Treadway, *supra* note 2.

8. *See* U.S. Gen. Accounting Office, GAO-00-54, Water Quality: Key EPA and State Decisions Limited by Inconsistent and Incomplete Data 6 (2000).

9. *See* Houck, *supra* note 4, at 10,209–13 (describing the decades of attempts to implement TMDLs).

10. There are myriad other reasons, discussed in more detail below. *See, e.g.*, Mary E. Christopher, *Time to Bite the Bullet: A Look at State Implementation of Total Maximum Daily Loads (TMDLs) Under Section 303(d) of the Clean Water Act*, 40 Washburn L.J. 480 (2000) (addressing different state approaches to implementing TMDLs); Oliver A. Houck, *Cooperative Federalism, Nutrients, and the Clean Water Act: Three Cases Revisited*, 44 Envtl. L. Rep. 10,426 (2014) [hereinafter Houck, *Cooperative Federalism*] (discussing overall impediments to TMDL implementation); William V. Luneburg, *Where the Three Rivers Converge: Unassessed Waters and the Future of EPA's TMDL Program: A Case Study*, 24 J.L. & Com. 57 (2004) (discussing the reasons for the number of waters that remain unassessed).

11. *See* Luneburg, *supra* note 10, at 58.

12. *See* U.S. Gen. Accounting Office, *supra* note 8.

13. *See id.* at 5 (noting that required water quality reporting "does not accurately portray water quality conditions nationwide").

14. *See id.* at 6–7 (discussing the gaps in nonpoint source data); William L. Andreen, *The Evolution of Water Pollution Control in the United States—State, Local, and Federal Efforts, 1789–1972: Part II*, 22 Stan. Envtl. L.J. 215, 277 n.416 (2003) [hereinafter Andreen, *Water Pollution Control*] (discussing the CWA's fishable and swimmable water quality goal).

15. *See* Adam Babich, *The Supremacy Clause, Cooperative Federalism, and the Full Federal Regulatory Purpose*, 64 Admin. L. Rev. 1, 29–31 (2012).

ing these goals.[16] However, the extent of the shortfall is unclear. This Article addresses this, using an empirical analysis to establish the extent of scientific and regulatory inconsistency in water quality monitoring and nonpoint source pollution control.

Part I of this Article outlines the history of the CWA, looking specifically at the evolution of nonpoint source pollution controls and the role of science in establishing them. I highlight the considerable literature that has been devoted to the specific failures of the TMDL program, setting the stage for a broader analysis of the impacts of these failures.

In Part II, I use an empirical analysis to establish the extent of regulatory and scientific inconsistencies in water quality monitoring and TMDL implementation across the nation. I draw specifically on the natural experiment created by transboundary waters, waters that span state jurisdiction lines and that are monitored by two different states. In a well-operating system, two states monitoring the same lake or river should take water quality measures that are in relatively close agreement.[17] This is not the case. The differences in monitoring data (or lack of data) lead to significant differences in what regulatory categories waters are placed in. I show that only 4% of transboundary waters nationally are subject to the same TMDL regulatory regime on either side of a state boundary. This is a dramatic and worrying inconsistency.

In Parts III and IV, I build on this descriptive work to present a normative argument for reevaluating the role of science in CWA decisions. I evaluate transboundary inconsistency in light of ongoing debates over the ideal role of the states and the federal government in the CWA's cooperative federalism. Transboundary regulatory inconsistency will not be solved either by increasingly federalizing nonpoint source controls, which has been the tactic of EPA, or by giving more power to the states, a decentralization trend that has been a popular argument among academics. I explore the role of science in this debate, highlighting how a lack of resources and flexibility in scientific methodologies can defeat cooperative federalism and the attempts to fix TMDLs. I argue that the failure to understand these scientific realities is a major shortcoming of the CWA.

## I. Nonpoint Source Pollution and the CWA

Water pollution was a systemic problem in the decades before the 1970s. Rivers caught fire.[18] Thousands died every year from contaminated water.[19] In-

16. *See* Christopher, *supra* note 10, at 502 n.133.
17. These measurements should be in relatively close agreement when they are taken in close proximity and controlling for other biophysical variables, as discussed further in Part II.
18. *See, e.g.*, Theresa Opheim, *Fire on the Cuyahoga*, 19 EPA J. 44, 44 (1993); Editorial, *The Clean Water Act at 30*, N.Y. Times (Oct. 22, 2002), https://perma.cc/9RKS-HQ3M.
19. *See* Andreen, *Water Pollution Control*, *supra* note 14, at 217–18.

creasing public concern sparked political pressure to combat these problems, but efforts at the state level were patchy and ineffective at overcoming centuries of pollution.[20] While water pollution had traditionally been within the purview of the states, the stage was set for federal intervention in water quality controls.

In 1972, Congress passed the CWA.[21] This landmark piece of legislation set out an ambitious program of cooperative federalism: creating national pollution standards but leaving implementation of these standards to individual states. The goals of this cooperative approach included preserving state primacy while achieving consistent national water quality baselines.[22] Cooperative federalism could help to overcome bureaucratic inertia by giving states the flexibility to innovate and tailor how they implemented federal standards.

In the decades since, many have pointed to the CWA as a story of environmental success.[23] Water quality around the country has improved dramatically. Less than fifteen years after the Act passed, the CWA had led to major strides in addressing pollution, for instance, by reducing industrial and municipal biological oxygen demand loads by over 45% through point source controls.[24] Rivers and lakes that were once unusable became centers of public recreation.[25]

Yet this historical account does not tell the whole story of the CWA. From its enactment in 1972, the legislation reflected such ambitious regulatory goals that implementation has remained a challenge to this day.[26] In an effort "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," the CWA explicitly aimed, for instance, to eliminate *all* polluted discharges into U.S. waters by 1985.[27] To say that the CWA failed to meet this goal is an understatement. While the CWA led to environmental gains, particularly regarding point sources, thirty years after its target date many waters in the United States are still heavily polluted.[28]

The CWA's first thirty years focused on the regulation of pollution from point sources. The CWA set up a permitting program for point sources, the National Pollutant Discharge Elimination System ("NPDES"), that set uni-

20. *See id.* (describing the evolution of water pollution controls prior to the enactment of the CWA).

21. 33 U.S.C. §§ 1251–1387 (2018).

22. *See* Babich, *supra* note 15, at 29–31.

23. *See, e.g.*, Editorial, *supra* note 18.

24. James Boyd, *The New Face of the Clean Water Act: A Critical Review of the EPA's New TMDL Rules*, 11 DUKE ENVTL. L. & POL'Y F. 39, 42 (2000).

25. *See* Editorial, *supra* note 18.

26. *See* NAT'L RESEARCH COUNCIL, ASSESSING THE TMDL APPROACH TO WATER QUALITY MANAGEMENT 2 (2001) (stating that meeting TMDL requirements is the "most pressing and significant regulatory water quality challenge for the states since passage of the Clean Water Act").

27. 33 U.S.C. § 1251(a) (2018).

28. *See* 2017 WATER QUALITY INVENTORY, *supra* note 3, at 2 (noting that in 2017, 46% of assessed rivers and streams were in poor biological condition).

form national effluent discharge limits based on the use of Best Available Technology ("BAT").[29] Establishing BAT standards for each type of point source across the United States proved to be a massive regulatory task, one that EPA spent the large part of the CWA's first two decades implementing.[30] The results of this program were an initial success, with large improvements in water quality immediately after standards were implemented.[31] However, this trend plateaued and ultimately began to reverse in the 1990s as unregulated nonpoint sources such as the agriculture and timber industries continued to pollute national waters. While the CWA was generally successful in reducing point source pollution, addressing nonpoint source pollution remains problematic. EPA has recognized that nonpoint source pollution is a large contributor to current water body degradation, contributing to the degradation of 85% of assessed rivers and streams.[32] Nonpoint sources, such as runoff from agriculture, logging, roads, and infrastructure, also happen to be the most difficult to regulate due to the indirect and distributed nature of their pollution.

It was only on the heels of citizen suits in the 1990s that EPA turned its attention to a neglected portion of the CWA: ambient water quality standards and TMDLs.[33] Logistical difficulties in implementing this section coupled with a focus on establishing point source controls meant that section 303 went virtually ignored by both states and EPA until a flurry of litigation beginning in the late 1980s targeted EPA for noncompliance with this section.[34]

TMDLs serve as the second major regulatory piece of the CWA, intended to restore national waters to high water quality standards.[35] While the majority of the CWA is based on technology standards for industrial and municipal point sources, Congress recognized there could be some cases where waters remain polluted even after point source controls were used.[36] The ambient water quality regime set out in sections 303 and 305 of the CWA takes a water-body-specific approach, requiring states to determine whether their waters are

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29. BAT standards are numerical effluent limitations set by EPA through modeling what discharge levels would be attained by the best available technology economically achievable. 33 U.S.C. §§ 1317(a), 1342.

30. Houck, *Chesapeake Bay*, *supra* note 4, at 10,209.

31. Boyd, *supra* note 24, at 42–43.

32. Nonpoint Source Program, *supra* note 5, at 4.

33. *See* Nina Bell, *TMDLs at a Crossroads: Driven by Litigation, Derailed by Controversy?*, 22 Land & Resources L. Rev. 61, 63–64 (2001); Christopher, *supra* note 10, at 482–83; Houck, *Chesapeake Bay*, *supra* note 4, at 10,215.

34. Boyd, *supra* note 24, at 47.

35. While initially viewed as a "safety net" that would fill a temporary role where point source controls were not yet implemented or failed, the "the reality now is that the water quality safety net drives the regulatory program." Douglas R. Williams, *Toward Regional Governance in Environmental Law*, 46 Akron L. Rev. 1047, 1066 (2013).

36. Oliver A. Houck, *The Clean Water Act TMDL Program: Law, Policy and Implementation V: Aftershock and Prelude*, 32 Envtl. L. Rep. 10,405 (2002) [hereinafter Houck, *Aftershock and Prelude*].

attaining water quality standards necessary to support specific "beneficial uses."[37] States determine what these uses are, ranging from recreation to drinking water supplies to agriculture, for each water body in their state and enforce water quality standards that support these uses.[38] States monitor all the waters within their boundaries to determine whether they meet these standards and submit a list to EPA (and Congress) biannually that details the attainment status of all their waters.[39]

Under section 303(d), any waters that are listed by states as impaired (i.e., unable to meet water quality standards) are subject to TMDL regulation.[40] In these cases, section 303 requires that states develop TMDLs that place daily limits on the discharge of the pollutants that are specifically responsible for the water's noncompliance with quality standards. States create plans to achieve these loads that target both point and nonpoint sources.[41] TMDLs are developed by states but must be approved by EPA under the CWA's cooperative federalism mandate.[42]

The TMDL program has the potential to be extraordinarily powerful. Giving states an alternate avenue to enforce water quality goals opens up the range of actors subject to regulation from specific point sources to include a wide swath of industrial and commercial entities that may only indirectly impact water quality. TMDLs similarly expand the range of waters that are actively regulated under the CWA. While the CWA applies to all waters in the United States,[43] the NPDES controls that are central to the CWA only target the few waters where point sources are located. This is a small fraction of all the waters in the United States.[44] The TMDL program requires states to bring not just these waters but *all* the waters within their borders into compliance with water quality standards.

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37. 33 U.S.C. §§ 1313, 1315 (2018).

38. Kelly Seaburg, *Murky Waters: Courts Should Hold that the "Any-Progress-is-Sufficient-Progress" Approach to TMDL Development Under Section 303(d) of the Clean Water Act Is Arbitrary and Capricious*, 303 WASH. L. REV. 767, 767–68 (2007).

39. 33 U.S.C. §§ 1313, 1315.

40. *Id.* § 1313.

41. Section 303 does not explicitly apply to nonpoint sources, but EPA has consistently held that the TMDL program applies to both point and nonpoint source pollution even in the face of considerable industry pressure. *See* Robin Kundis Craig, *Local or National? The Increasing Federalization of Nonpoint Source Pollution Regulation*, 15 J. ENVTL. L. & LITIG. 179, 225 (2000).

42. Seaburg, *supra* note 38, at 772–74.

43. Defining what constitutes a water is a topic unto itself. *See, e.g.*, Robin Kundis Craig, *Beyond* SWANCC*: The New Federalism and Clean Water Act Jurisdiction*, 33 ENVTL. L. 113, 116–17 (2003).

44. Clifford Rechtschaffen, *Enforcing the Clean Water Act in the Twenty-First Century: Harnessing the Power of the Public Spotlight*, 55 ALA. L. REV. 775, 775 (2004) (noting that roughly 60,000 NPDES facilities have permits).

Despite this potential, the effectiveness of TMDLs as a regulatory tool is the subject of heated debate. Proponents emphasize that it is the only regulation that addresses nonpoint source pollution, while critics argue that TMDLs are in many ways toothless because they lack enforcement mechanisms.[45] Regardless, the impact of nonpoint sources on water quality nationally has driven increasing attention to TMDLs as an important regulatory tool, and EPA and states are scrambling to assess and list additional waters.[46]

The reach of TMDLs is massive. There are nearly 4 million miles of rivers and streams in the United States, 42 million acres of lakes, 108 million wetland acres, and over 87,000 square miles of bays and estuaries, all covered by the CWA.[47] Section 305(b) of the Act requires that states monitor all of the water bodies in their states and report on their attainment status biannually to Congress.[48] This is a huge monitoring task, and one that has yet to be fully achieved: As of 2008, only around 30% of waters were actively monitored by states.[49] Forty-five years after the CWA was enacted, the continuing inability of states to monitor their waters raises questions about if, and when, states will ever achieve these goals.

State problems in achieving section 305(b) monitoring requirements are in part due to the fact that determining whether waters are impaired and what TMDLs should be enacted is scientifically complex.[50] Considerable research has shown the flaws in the science underlying TMDLs.[51] A 2001 National Research Council report on the scientific basis for TMDL management found widespread inconsistencies in state methods for monitoring and listing waters as polluted.[52] Risk thresholds for contaminants such as dioxin varied by a factor of as much as 10,000 between states in the early days of TMDLs.[53] Variability in standards is also pervasive at the local level, leading to major issues with sharing data between municipalities to inform state-level models.[54] The National Research Council worried that these large data gaps were significantly

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45. *See* Seaburg, *supra* note 38.

46. *See generally* EPA, EPA 841-B-03-003, ELEMENTS OF A STATE WATER MONITORING AND ASSESSMENT PROGRAM (2003) [hereinafter STATE WATER MONITORING].

47. 2017 WATER QUALITY INVENTORY, *supra* note 3, at 8, 11, 14, 18.

48. 33 U.S.C. § 1315(b) (2018).

49. *See* Houck, *Chesapeake Bay*, *supra* note 4, at 10,212.

50. *See* David S. Caudill & Donald Curley, *Strategic Idealizations of Science to Oppose Environmental Regulation: A Case Study of Five TMDL Controversies*, 57 KAN. L. REV. 251, 257 (2009).

51. *See, e.g.*, U.S. GEN. ACCOUNTING OFFICE, *supra* note 8 (describing the challenges posed by incomplete data); Oliver A. Houck, *TMDLs IV: The Final Frontier*, 29 ENVTL. L. REP. 10,469 (1999) [hereinafter Houck, *Final Frontier*] (describing the limits of the TMDL program).

52. *See generally* NAT'L RESEARCH COUNCIL, *supra* note 26.

53. Oliver A. Houck, *The Regulation of Toxic Pollutants Under the Clean Water Act*, 21 ENVTL. L. REP. 10,528, 10,550–51 (1991) [hereinafter Houck, *Toxic Pollutants*].

54. Dianne K. Conway, *TMDL Litigation: So Now What?*, 17 VA. ENVTL. L.J. 83, 106 (1997).

hindering states' abilities to meet TMDL requirements and design "equitable and effective" regulatory and nonregulatory water quality solutions.[55] These data issues not only undermine the effectiveness of the CWA but have opened the door to challenging TMDL science as a method to prevent waters from being listed as impaired.[56]

Differences in scientific methodology have created significant variability in TMDL implementation between states.[57] While the National Research Council identified that inconsistency in the scientific foundations of the TMDL program between states could lead to regulatory inequity,[58] the extent and impact of this inequity remains to be parsed. This Article fills this gap, using an empirical analysis to establish that differences in the scientific underpinnings of TMDLs lead to major variability in TMDL implementation between states, impacting regulatory outcomes and creating inequity across state lines.

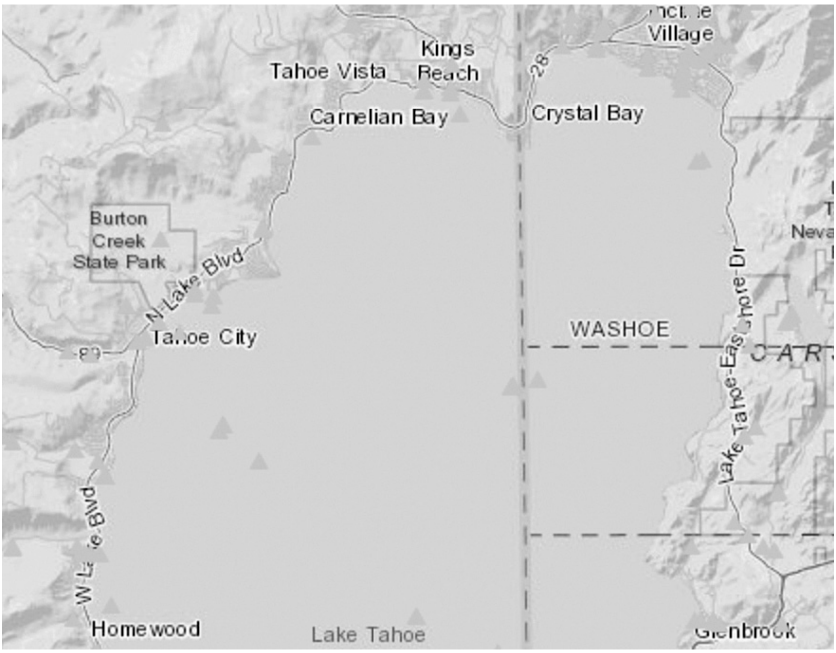
## II. Transboundary Waters

In this Part, I use waters that span state boundaries as a natural experiment to study the consistency of ambient water quality monitoring between states. Under the cooperative federalism of the CWA, each state is responsible for monitoring the water quality of its own water bodies. Transboundary waters offer a unique, and unexplored, opportunity to understand whether water quality measurements are consistent between states. Controlling for natural variables, including geophysical characteristics of water flow, when states monitor different sides of the same water body they should have water quality measurements that are in rough agreement with each other (particularly given that state monitoring stations are often located very close to one another).[59] When states

55. Nat'l Research Council, *supra* note 26, at 2–3.
56. *See* Caudill & Curley, *supra* note 50, at 257.
57. *See id.* at 259; Houck, *Final Frontier*, *supra* note 51, at 10,477–78.
58. Nat'l Research Council, *supra* note 26, at 2.
59. This research shows that, even in large waterbodies, sampling stations are generally close together. For example, in Lake Tahoe, several sampling stations closely straddle the state borders (stations represented by green triangles), as shown in the figure below.

agree on the designated uses for these waters,[60] consistent water quality measures should result in consistent regulatory classifications across state lines.[61] However, several scholars and EPA itself have recognized that inconsistency in TMDL classification across state boundaries is not uncommon.[62]

I analyze transboundary waters nationwide using the required state submissions under CWA section 305(b) to ascertain whether transboundary waters are assessed consistently across state lines. In the section 305(b) listings that states must make available, no exact water quality values are reported. Instead, state listings designate whether waters are "attaining" their designated uses or are "impaired," exceeding set pollution thresholds based on their designated uses.[63] Functionally, this means that this study is not sensitive to small varia-




60. This is largely the case: my analysis shows 1,149 transboundary waters where designated uses are consistent on both sides of a state boundary with only 347 where designated uses are inconsistent. Waters with inconsistent designated uses were not included in this study.

61. It is worth noting that states are left to determine the numerical thresholds for attainment, so it is possible that variation in regulatory classification will result simply from states setting different numerical thresholds. However, this is rarely the case. States largely turn to the EPA's water quality guidance to set their own thresholds. Variation between states in regulatory classification is instead largely the result of "variations in data collection, assessment methods, and relative representativeness of the available data." Luneburg, *supra* note 10, at 66 (quoting State Water Monitoring, *supra* note 46).

62. *See, e.g.*, State Water Monitoring, *supra* note 46, at 1; Luneburg, *supra* note 10.

63. *See* EPA, Water Quality Standards Handbook § 3.2.1 (2017) [hereinafter WQS Handbook] (detailing how states determine their own numerical water quality standards).

tions in data quality; it only maps larger variations that ultimately lead to classification differences. The significantly inconsistent results, discussed below, are even more striking in the face of this. It also means that the focus of my analysis is less on the underlying differences in scientific methodology, but on the regulatory classifications that these differences result in.

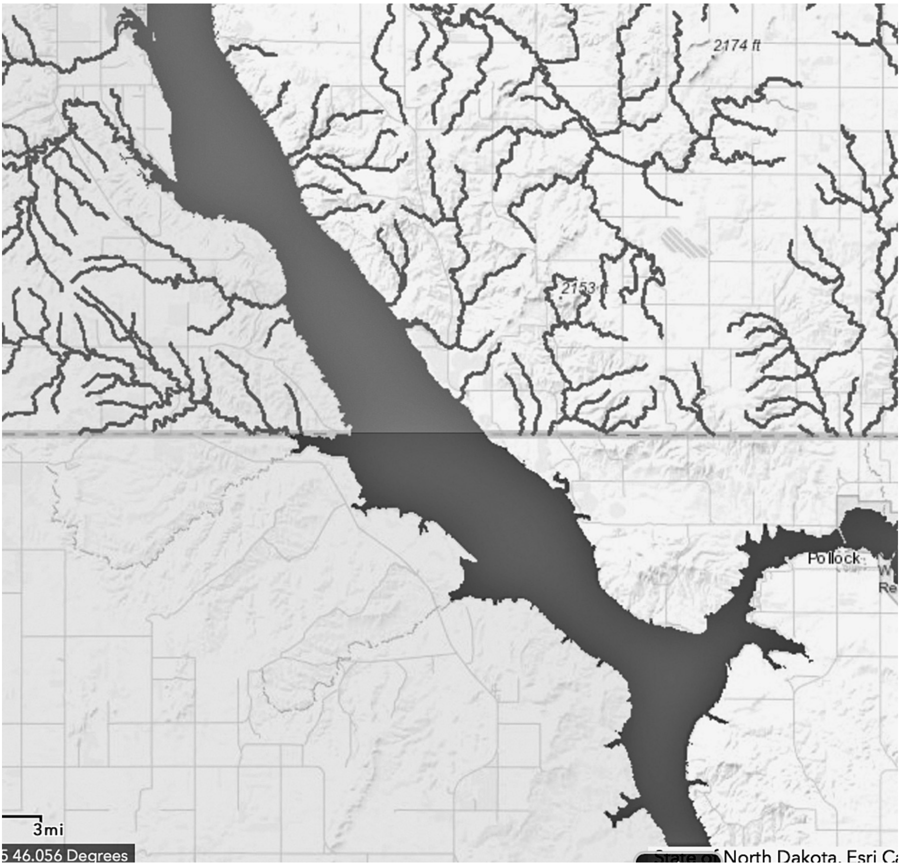



FIGURE 1: LAKE OAHE, A TRANSBOUNDARY WATER, WITH EPA MONITORING STATUS OVERLAID FOR THE YEAR 2012, BASED ON DATA FROM EPA'S WATERS GEOVIEWER. THE LAKE IS CLASSIFIED AS IMPAIRED ON THE SOUTH DAKOTA SIDE OF THE STATE BOUNDARY AND ATTAINING ON THE NORTH DAKOTA SIDE.

### *A. Methods*

The data for this study are from biannual state water quality submissions to EPA and Congress as part of the section 305(b) process. The data are available online in various formats in EPA's WATERS GeoViewer.[64] Data used were from the year 2012.

For this study, I used geographic information systems ("GIS") analysis owing to inconsistency between states both in water-body naming and in associated GPS coordinates. Because of these inconsistencies, the only way to accurately identify transboundary waters is through visual analysis of each individual water. Transboundary waters were visually identified using GIS and subsequently verified in detail in EPA's WATERS GeoViewer to ensure that waters crossed state lines and were monitored by the states on either side.

Only transboundary waters that were assessed by at least one state were included in this study. Waters that themselves served as the boundaries between states were excluded.[65] Transboundary waters that were assigned different designated uses by states were also excluded from this study, as comparison in these cases would be between entirely different regulatory standards. The majority of transboundary waters in the United States met study criteria and were assessed on at least one side and assigned the same designated uses by both monitoring states.

Transboundary waters meeting the study criteria were coded on both sides according to what designated uses they had been assigned and whether they were attaining these uses or were impaired. They were also coded based on whether TMDLs were needed or had been completed and what specific pollutants these TMDLs targeted, as well as on broad geophysical criteria.[66]

### *B. Results*

Under the CWA, water bodies are deemed "impaired," "attaining," or "unassessed."[67] This study looks first at these broad categories to determine consistency in monitoring between states using data from all transboundary waters in the United States that met study criteria (n=1,149). Only 29.2% of waters are placed into the same category (impaired or attaining) on both sides of state lines, while 14.4% of the time these waters are placed into different cate-

64. *WATERS GeoViewer Map Image Layer*, EPA (Nov. 2, 2017), https://perma.cc/G9EV-W3E4.

65. The Mississippi River, for example, forms the western border of many Midwest states. The cooperative agreements in monitoring these border waters are significantly different than for most transboundary waters and were not included here for that reason.

66. These criteria include the approximate distance of monitoring stations from state boundaries, upstream or downstream location of monitoring stations, and whether stations were located at the periphery or center of a waterbody.

67. 33 U.S.C. § 1313 (2018). EPA also recognizes a "threatened" category for waters that may be at risk of falling into the impaired category. 40 C.F.R. § 130.7(b)(5)(1) (2019). However, no waters designated as threatened were found in coding the over 1,000 waters addressed in this study, an interesting side note on state non-use of this category.

gories by each state carrying out monitoring.[68] Particularly interesting is the finding that over half of all waters (56.4%) were monitored on one side of state boundaries but unassessed on the other.

Looking just at waters that were monitored on both sides of a state line, 32.9% were classified as attaining on one side of a state line and impaired on the other. This result is particularly striking as it directly reflects the inconsistency of underlying scientific methodologies or numerical water quality standards.[69]

Once states designate a water as impaired, they are required to create TMDLs for that water. I next looked at just those transboundary waters where one or both sides were classified as impaired and subject to the strict regulatory control of TMDLs. TMDLs target the specific pollutants or conditions that are causing impairment. Thus, within the larger "impaired" category there are differences between water bodies in what pollutants are being targeted. Figure 2 addresses these differences, showing whether states are regulating the same pollutants through TMDLs across state boundaries. These data show even starker differences, with only 4% of waters subject to identical TMDL regulation on either side of a state boundary. Strikingly, over two-thirds of transboundary waters subject to TMDLs are subject to strict TMDL regulations on one side of a state line but not on the other (68.9%), either because the other state has not assessed their side of the water or because they have assessed it differently (either with different methodologies or different numerical standards).[70]

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68. An initial chi-square test showed that the differences in transboundary water attainment status were significant, $X^2$ (3, n = 1,149) = 788.8, p = 0.00.

69. The majority of states use consistent numerical criteria to determine these categories, revealing that differences in monitoring methods alone are impacting the regulatory outcome. *See generally* WQS HANDBOOK, *supra* note 63. In cases where states use different numerical criteria to determine whether designated uses are being met, this result also emphasizes how small scientific determinants can ultimately determine the monitoring outcome.

70. These results were significant using a chi-square test, $X^2$ (2, n = 829) = 521.9, p = 0.00.

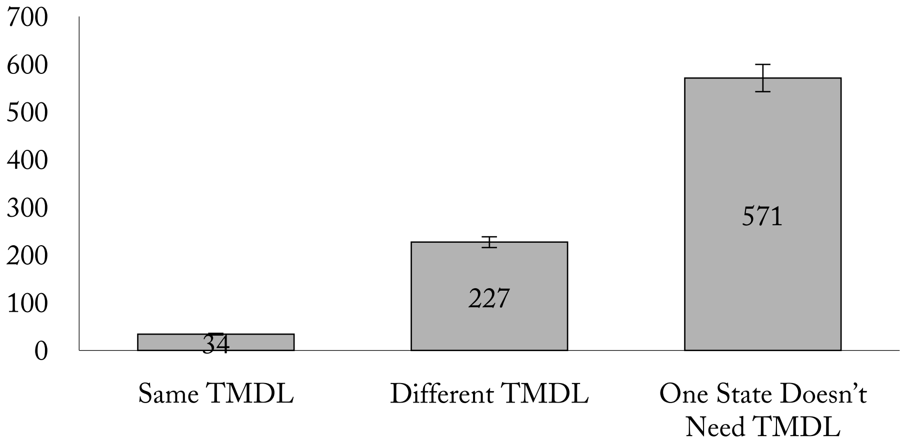


Figure 2: TMDL regulatory agreement in transboundary waters. In waters with the "Same TMDL," both states had determined that TMDLs were needed for the same pollutant. In waters with "Different TMDLs," both states agreed that a TMDL was needed but identified different pollutants to be regulated. Only transboundary waters that were listed as impaired on at least one state side are included here.

Most inconsistency in transboundary water classification is due to one side being unassessed. This is a significant finding, but does not illuminate what degree of difference in scientific outcomes exists between states. Looking specifically at waters that were assessed as impaired on *both* sides of state boundaries can show this. Table 1 analyzes how often being placed in the same broader category results in the same TMDL regulations. The majority of the time (86.6%), transboundary waters that are classified as impaired on both sides of state lines are ultimately subject to different TMDLs.

| **Impaired Transboundary Waters** | | |
|---|---|---|
| | n | Percent |
| Same TMDLs | 33 | 13.4% |
| Different TMDLs | 213 | 86.6% |
| Total | 246 | |

TABLE 1: TMDL CONSISTENCY IN IMPAIRED TRANSBOUNDARY WATERS.[71]

Drilling further into these data, Table 2 compares the resulting regulatory status of transboundary waters. States are required to create TMDLs for all waters that are designated as impaired. In practice, creating and implementing TMDL regulations can take years, and there is significant inconsistency between states in whether TMDLs have been fully implemented.[72] The results show that TMDLs are in place on both sides of state boundaries only 5.3% of the time, while more commonly TMDLs are in place on one side of a boundary and needed but not yet enacted on the other side (11.1%) or needed on both sides (11.9%). Consistent with the results from Table 2, the most likely case here is that one state does not require TMDLs while the other boundary state has TMDLs in place (21.8%) or needs to implement them (49.8%).

| **TMDL Status (%)** | | **State 2** | | |
|---|---|---|---|---|
| | | TMDL in place | TMDL needed | No TMDL required |
| **State 1** | TMDL in place | 5.3 | 11.1 | 21.8 |
| | TMDL needed | | 11.9 | 49.8 |

TABLE 2: TMDL STATUS FOR TRANSBOUNDARY WATERS, IN PERCENTAGES. THIS DATA SET (N=829) INCLUDES ONLY STATES WHERE TMDLS ARE NEEDED ON ONE OR BOTH SIDES OF A WATER.

Table 3 looks at the consistency of the regulatory regime currently by analyzing only those waters that have TMDLs in place, finding that variance from the expected outcome (same TMDL categories) was strongly significant.[73] Of

71. These results were significant using a chi-square test, $X^2$ (2, n = 247) = 317.3, p = 0.00.
72. These results were significant using a chi-square test, $X^2$ (4, n = 829) = 519.2, p = 0.00.
73. This result was significant, $X^2$ (3, n = 142) = 131.3, p = 0.00.

waters with TMDLs in place on at least one side, the vast majority of transboundary TMDLs are for different categories (89.4%). Only a small fraction of enacted TMDLs regulate pollutants in transboundary waters the same on either side of state boundaries (10.6%).

| | Different TMDL Category | | Same TMDL Category | |
|---|---|---|---|---|
| **TMDL Status** | n | Percent | n | Percent |
| Both in place | 36 | 25.5% | 5 | 3.5% |
| One in place, one needed | 90 | 63.8% | 10 | 7.1% |
| Total | 126 | 89.4% | 15 | 10.6% |

TABLE 3: CONSISTENCY IN ENACTED TMDLS. ONLY WATERS WITH TMDLS NEEDED ON BOTH SIDES OF A TRANSBOUNDARY WATER AND A TMDL ACTUALLY IMPLEMENTED ON AT LEAST ONE OF THOSE SIDES WERE INCLUDED IN THIS DATASET.

This study looks at the current regulatory picture under the CWA and does not seek to predict future trends, so regression analyses were not relied on to provide predictive data. Nonetheless, a multiple linear regression was used to see whether any key demographic indicators from each state (size, geographical location, population demographics, mean income, political party of governor, majority vote in last presidential election) accounted for the observed variability. Additionally, basic geographic variables, including whether state monitoring locations were upstream or downstream, were also included. None of these factors were significant at p=.05.

### *C. Causes of Inconsistency*

Overall, analysis of transboundary waters shows dramatic inconsistencies in how waters are classified under the CWA. Only 29% of transboundary waters included in this study were classified into the same categories across state boundaries, and of this 29%, the vast majority is ultimately subject to different TMDL regimes (86%): either different pollutants are regulated by state TMDLs or TMDLs are in different stages of implementation. In total then, only 4% of transboundary waters are subject to currently consistent TMDL regulation on either side of state boundaries.

The inconsistencies in TMDL implementation fly in the face of efforts by EPA in the last twenty years to provide more federal oversight for TMDL science.[74] EPA has given consistently stricter guidance to states in the face of attacks on TMDL science. Recently, EPA released extensive guidelines for states in *Elements of a State Water Quality Assessment Plan*.[75] This document lays out detailed procedures for water quality monitoring as well as numerical thresholds at which different types of ecosystems can be presumed degraded. These scientific thresholds in particular were lobbied for by states who were often too resource-poor to develop these guidelines themselves.[76] Outside interest groups saw federal mandates as a way to remedy some of the continuing issues with TMDL science.[77]

These mandates have not been as successful as many hoped. The current differences in regulatory classifications (impaired vs. attaining) are reflective of underlying differences in water quality measurements themselves and of different choices between states of where to prioritize monitoring resources. I turn here to some examples to understand these causes of regulatory inconsistency under the CWA.

### 1. *Unassessed Waters*

The most common difference in transboundary water classification occurs when one side of the water is unassessed and the other is assessed (56% of the time).[78] The resulting inconsistency is not due to errors in scientific measurement, but results from higher-level decisions about where a state is carrying out its sampling and how that fits into ecosystem models.

An example from the Idaho-Nevada border illustrates this well. Idaho employs a watershed-basin approach to assessing its waters, relying on dispersed sampling sites to create watershed models that allow the state to interpolate quality in areas that it may not have directly sampled.[79] Nevada meanwhile uses a more traditional method that relies on quantitative measurements from a given water to determine its impairment status.[80] This means that many more of the waters in Idaho are considered assessed than those in Nevada, as visually illustrated in Figure 3, as Idaho uses watershed modeling to extrapolate assessment status from limited sampling sites.

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74. Houck, *Cooperative Federalism*, *supra* note 10, at 10,428–29 (describing increasing federal control over TMDL implementation).
75. State Water Monitoring, *supra* note 46.
76. *See* Houck, *Cooperative Federalism*, *supra* note 10, at 10,435 ("[T]he Florida Wildlife Federation and other state environmental organizations filed suit against EPA to compel it to adopt numerical nutrient standards for state waters.").
77. *Id.*
78. *See supra* Part II.A.
79. *See* Hawk Stone, North and Middle Fork Owyhee River 7–8 (2009), https://perma.cc/KZ53-WWZX.
80. *See* Bureau of Water Quality Planning, Total Maximum Daily Loads for East Fork Owyhee River and Mill Creek (2005), https://perma.cc/X769-HXQQ.

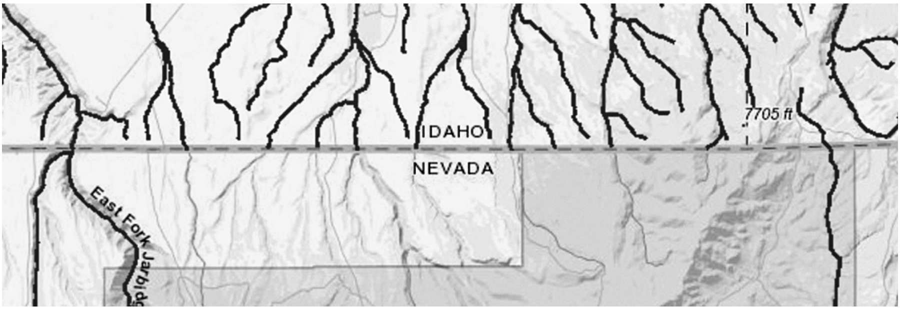


FIGURE 3. A MAP OF THE IDAHO-NEVADA BORDER ILLUSTRATES THE DIFFERENCES IN HOW MANY WATERS ARE ASSESSED IN EACH STATE. EACH ASSESSED WATER IS REPRESENTED BY A THICK LINE. MAP RETRIEVED FROM EPA'S WATERS GEOVIEWER.

The differences in classification that result when one side of a transboundary water is unassessed are a testament to the latitude that states have in implementing TMDLs.

*2. Different Water Sampling Methods*

Beyond differences in classification that arise from some waters being unassessed, there are differences in how states monitor water quality that leads to differences in TMDL classification. The Owyhee River, spanning the Idaho-Nevada border, provides a case study. The Owyhee River runs through northern Nevada and southwestern Idaho on its way to joining up with the Snake River in Oregon. In 2000, EPA approved a TMDL submitted by Idaho for the portion of the Owyhee next to the Nevada border for temperature exceedances.[81] In 2002, Nevada followed suit and listed the Owyhee stretching to the Idaho border on its section 303(d) list due to temperature exceedances.[82] The Owyhee is thus one of the rare transboundary waters that is not only assessed on both sides of the state boundary, but where the TMDLs on both sides are in agreement. Looking at this case provides some insight into the methodologies that each state is using to achieve this result.

Despite the Owyhee's consistent classification on either side of the state boundary, it also illustrates the impacts of variations in sampling methodology. Several sampling sites on the Nevada side of the Owyhee are on tribal land and so are sampled by the Shoshone-Paiute Tribes under slightly different protocols than those used by the Nevada Department of Environmental Protection

81. STONE, *supra* note 79, at 5.

82. BUREAU OF WATER QUALITY PLANNING, *supra* note 80, at 32.

("DEP").[83] Most notably, the tribes tend to sample in the morning, while the state samples in midafternoon when the temperature is higher.[84] As a result, the temperature at tribal sites rarely exceeds temperature standards, while the Nevada DEP nearly always finds temperature exceedances. The difference in sampling time determines whether or not the river will attain water quality standards.[85] Tribal data is not determinative of the final TMDL status but highlights the important point that even small changes in scientific methodology, such as what time of day the water body is sampled, could potentially impact the ultimate determination of the impairment status of the water.

Finally, even when underlying numerical water quality standards are different, the resulting regulatory classification may still agree. This type of flexibility was the intention of the CWA's monitoring program: enough flexibility to allow states to take into account what methodologies would work best for their own waters while still ensuring that they met consistent water quality baselines nationally. However, this is a rare case. Much more common is that this flexibility has led to dramatic differences in regulatory classification and ultimately undermined the CWA as an effective and equitable regulation.

### 3. *Intentionality*

Some commentators have suggested that variations in methodology are used by states to modify TMDL requirements to suit their own development or enforcement interests.[86] The choice of which waters to leave unassessed has particular potential in allowing a state to shape the TMDL program to their own interests. There is strong evidence to support this finding.

In 1999, a group of state water managers wrote a white paper concluding that "an unfortunate mix of politics, bureaucratic inertia and bad science means that conflicting, erroneous and manipulated sets of water quality data containing little accurate information on the actual condition of the nation's rivers and streams are routinely reported by states and dutifully compiled by EPA for presentation to Congress and the public."[87]

The incentives to find that waters are not impaired are strong. Uncertain science can allow managers to avoid political battles and strict federal TMDL

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83. *See id.* at 22, 24, 36.
84. *Compare id.* at A-1 to A-5, *with id.* at A-10.
85. In practice, the use of daily averages (like in Idaho) could overcome this, but this relies on temperature data from throughout the day. While temperature loggers can be put in place that track and record temperature data these are still rare and generally only one temperature datapoint is available each day.
86. *See* Houck, *Final Frontier*, *supra* note 51, at 10,478.
87. PUB. EMPS. FOR ENVTL. RESPONSIBILITY, PEER WHITE PAPER: MURKY WATERS: OFFICIAL WATER QUALITY REPORTS ARE ALL WET 2 (1999).

requirements.[88] Florida has been particularly successful at manipulating the scientific process to minimize the number of waters they list as impaired.[89] Of the waters it monitors, the state has classified 3,400 of its waters as impaired, while the remaining 54,111 are classified as "undeterminable" despite evidence that they were impaired in the past.[90]

Comparing these examples show how small differences in state methodology ultimately impact water quality regulation in the United States. State decisions both of what waters to actively monitor as well as when to monitor them can determine their impairment status.

### D. *Conclusions*

The most common type (69%) of inconsistent classification is when one side of a transboundary water is subject to TMDL regulation and the other is not. The implications of this are meaningful, with costly effects for businesses operating on the side of state boundaries with TMDLs in place. TMDLs are potentially one of the most powerful regulatory tools within EPA's authority because they provide EPA an avenue to strictly regulate nonpoint sources.[91] TMDLs can regulate *any* contribution of pollutants to a water body. This includes pollution from a variety of nonpoint sources (e.g., agriculture, logging) widely recognized for their contributions to water pollution that have historically escaped regulation because of the difficulties in determining their individual contributions. TMDLs allow this concern to be bypassed, not mandating that specific operations reduce their pollution by set amounts but instead capping the total amount of a pollutant that can be released into a water daily. Functionally, this makes TMDLs a uniquely strong environmental regulatory tool and one that has significant economic impacts on a wide variety of actors.[92] The current inconsistencies in TMDL regulation mean that businesses next to a river on one side of a state line may be subject to strict TMDL limitations on their discharge while a similar facility a short distance away but on the other side of a state line is not. Such regulatory differences do of course exist between

88. Wendy E. Wagner, *Stormy Regulation: The Problems that Result when Stormwater (and Other) Regulatory Programs Neglect to Account for Limitations in Scientific and Technical Information*, 9 Chap. L. Rev. 191, 229 (2005) ("Learning that a water body is polluted only increases conflicts between the environmentally-minded public and regulated parties—conflicts that elected officials are likely to dodge. Inept and nonexistent monitoring provides the recipe for keeping these bothersome water quality problems off the political radar.").

89. *See* Houck, *Cooperative Federalism*, *supra* note 10, at 10,435–39.

90. *Id.* at 10,439.

91. *See id.*

92. *See* Houck, *Cooperative Federalism*, *supra* note 10, at 10,212–13 (noting the costs to business could top $10 billion annually to mitigate agricultural runoff).

state laws, but these differences should not be exacerbated by a federal law whose whole purpose is to ensure water quality consistency nationwide.

The consequences are severe for states also: TMDLs are unlikely to be effective in transboundary waters if they are not implemented consistently on both sides. If one state does not put a TMDL in place, the other state can do all that is possible to restrict nonpoint source pollution only to have it thwarted if the other state continues to allow significant nonpoint source runoff. Nonpoint sources must be controlled by both states if TMDLs are to be effective in transboundary waters.

This result is particularly significant given that in recent years state agencies have received so much pushback on TMDL regulation that section 303(d) listings have dramatically fallen as states only list those waters they feel are unquestionably proven to be polluted.[93] The data analyzed here represent these downsized TMDL listings—the best of the best in terms of data quality. Given the discrepancies found, this is concerning.

Data quality under the CWA is a significant concern, with only 4% of transboundary waters assessed and regulated consistently across state lines. This phenomenon suggests vast and widespread inaccuracy in our current assessments of water quality in the United States, something that recent publicized failures like that of Flint, Michigan's water supply anecdotally support. The consequences of basing our water quality regulation on incorrect data will not just be felt by nonpoint sources that are subject to widely variable TMDL regimes but ultimately by members of the public who use these waters for water, food, and recreation. Future research will look at the full extent of these inaccuracies as well as the root cause for current regulatory inconsistencies.

## III. Cooperative Federalism and Transboundary Waters

The TMDL program in the CWA is not achieving its purpose. Rampant inconsistency in regulation between states is compounded by huge monitoring burdens that are unlikely ever to be fully met. Judged by the stated aims of the CWA to achieve consistent water quality baselines,[94] the Act's nonpoint source provisions have failed.

93. *See* Oliver A. Houck, The Clean Water Act TMDL Program: Law, Policy, and Implementation 138 (1999) [hereinafter Houck, TMDL Book] ("Farm and other nonpoint interests have persuaded states to reduce their submissions on impaired waters to the absolutely proven, with significant results. Incongruous as it may seem in the face of new EPA listing criteria designed to be all-inclusive, to err on the side of listing, and to facilitate the use of 'all relevant data,' many states have actually cut their [section] 303(d) lists in half since 1996, relegating hundreds of waters to such categories as 'further study,' 'insufficient information,' and only 'moderately impaired.'").

94. *See* Andreen, *Water Pollution Control*, *supra* note 14, at 237, 281 n.444.

More than that, the TMDL program has created extreme regulatory inconsistency across the United States. The same lake can be subject to a strict TMDL restriction on one side of a state boundary, while on the other side of a state boundary the water quality in the lake is not monitored at all. This has potentially significant economic impacts on industry actors.

The problems with the CWA are not new, or even newly discovered. Academics and regulators have proposed many solutions to the problems with the CWA oversight of nonpoint sources, largely framed in federalism terms. Arguments hinge on either increasing federal oversight or increasing state control as avenues to fix nonpoint source regulation, using the TMDL program as a larger pawn in the tensions between federal command-and-control regulations and increasing interest in decentralization. The vehemence of this debate largely overlooks the important role that science can play in reinforcing existing tensions in the cooperative federalism model.

I use transboundary waters as a way to explore the role of science in cooperative federalism, showing how it can either reinforce or undermine efforts to craft more effective nonpoint source pollution controls. I argue that given this role, the most promising avenues for nonpoint source regulation going forward are in regional approaches that rest on watersheds, an approach that will eliminate many of the scientific issues that have been the undoing of the current TMDL program.

### *A. Federalism Under the Clean Water Act*

The goals of cooperative federalism in environmental regulation are "to (1) attain national standards, (2) overcome bureaucratic inertia, and (3) preserve state primacy."[95] The CWA achieves these goals by requiring that states implement national water quality standards while providing some flexibility in how they do this. It attempts to achieve state primacy as part of a larger complex landscape of "water federalism."[96]

The CWA balances state and federal authority throughout. Section 402, the NPDES system, is a federally-driven program that gives EPA the authority to set technology-based numeric limitations for point sources.[97] On the other hand, regulation of nonpoint sources, including setting ambient water quality standards, was left in the hands of the states.[98]

Despite the initial grant of control to the states to deal with their own nonpoint source pollution, nonpoint source regulation has been steadily federal-

95. Adam Babich, *supra* note 15, at 22.

96. Robin Kundis Craig uses "water federalism" as a way to express the complex relationships between states, the federal government, and outside actors in water governance. *See* Robin Kundis Craig, *Adapting Water Federalism to Climate Change Impacts: Energy Policy, Food Security, and the Allocation of Water Resources*, 5 Env't & Energy L. & Pol'y J. 183 (2010).

97. 33 U.S.C. § 1311(b) (2018).

98. *Id.* § 1313(a), (d).

ized since 1972.[99] This began with the 1987 CWA amendments, which included, among other things, updates to how nonpoint source pollution was to be monitored and controlled.[100] These amendments strengthened the TMDL program through the addition of section 319.[101] This voluntary section offers grants to support TMDL implementation in return for several commitments from states. The first requirement is that states report to EPA annually the "navigable waters within the State which, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards."[102] This requirement is the source of a huge monitoring burden for states, as well as much of the data used in this paper. Once states identify these impaired waters, section 319 requires them to develop "best management practices and measures to control each category and subcategory of nonpoint sources."[103] While voluntary, the changes in the 1987 amendments moved regulation of nonpoint source pollution from being squarely in the hands of states to being subject to federal oversight.

The trend toward federalization was apparent in the 1990s with multiple attempts in Congress to add additional federal control over nonpoint sources, though ultimately no major changes were made in the face of larger concerns about the reach of the federal government.[104] Meanwhile, EPA had begun to move toward implementing TMDLs after a flurry of litigation in the late 1980s and spent the majority of the decade iterating on TMDL guidance.[105]

In 2000, EPA issued its final TMDL rule, strengthening the TMDL program.[106] EPA held firm on the controversial issue of whether nonpoint source pollutants should be subject to TMDLs at all,[107] reaffirming that nonpoint sources are covered by section 303(d) in the face of considerable lobbying by major nonpoint source polluters including big agriculture.[108] Beyond this, EPA set deadlines for the creation of TMDLs and mandated that states develop clear plans to achieve them.[109] These regulations proved extremely controversial

99. *See* Craig, *supra* note 41, at 181.

100. Water Quality Act of 1987, 33 U.S.C. § 1329(b) (1987).

101. For an overview of the history of this amendment, see Craig, *supra* note 41, at 189–91.

102. 33 U.S.C. § 1329(a)(1)(A).

103. *Id.* § 1329(a)(1)(C).

104. *See* Craig, *supra* note 41, at 198.

105. *See* Oliver A. Houck, *TMDLs III: A New Framework for the Clean Water Act's Ambient Standards Program*, 28 ENVTL. L. REP. 10,415, 10,419 (1998) [hereinafter Houck, *New Framework*].

106. Revisions to the Water Quality Planning and Management Regulation and Revisions to the NPDES Program, 65 Fed. Reg. 43,586 (July 13, 2000) (codified at 40 C.F.R. pts. 9, 122–24, 130, 132).

107. *See id.* at 43,588.

108. *See* Houck, *New Framework*, *supra* note 105, at 10,419.

109. 40 C.F.R. § 130.7 (2019).

and were narrowly approved, only to be put on a backburner during the Bush Administration.[110]

At the same time as these major changes, EPA expanded its role through numerous smaller documents. In the late 1990s, EPA produced technical guidance on major pollutants that set out region and water body type-specific criteria for states to employ.[111] In 2003, EPA released detailed guidance, including numerical standards for pollutant impairment, on how states should design and implement water quality monitoring plans.[112]

This complex, and increasingly federal, landscape of cooperative federalism is the one that most scholars have turned to in thinking about how solutions to CWA problems should be framed. The state/federal dichotomy that is the heart of the CWA has provided plenty of fodder for ongoing debates over what a better solution could look like. Transboundary waters provide new evidence to evaluate the potential effectiveness of these solutions.

### *B. Federal Solutions*

EPA has taken the stance that more federal oversight is the solution to the problems with nonpoint source regulation. Increasing federal oversight in the CWA has rendered state primacy, that stated aim of Congress, almost entirely eclipsed by the provisions of the Act.[113] However, some have noted that nonpoint source pollution is "the last *national* water pollution problem to solve,"[114] and thus may require a national solution.

Increasing the federal oversight of monitoring methods could move the system towards eliminating inconsistency in water classification. EPA has made moves in this direction, issuing detailed guidance to states on how they should monitor their waters and what numerical pollution limits are appropriate.[115] Taking this further and creating federally mandated monitoring programs, with additional guidance on exact monitoring tools, methods, and timelines, could overcome many of the scientific barriers to accurate TMDL science.

Moving TMDL and nonpoint source controls closer to the command-and-control model of environmental regulation elicits many criticisms, though. This level of oversight eliminates the chance for state innovation and flexibility, a benefit of cooperative federalism programs that is increasingly unrealized in the CWA. The TMDL program has already been called "obsessively methodological."[116] Adding additional methodological guidance on top of this would

110. *See* Houck, *Chesapeake Bay*, *supra* note 4, at 10,210.
111. *See* Houck, *Final Frontier*, *supra* note 51, at 10,478–79; WQS HANDBOOK, *supra* note 63.
112. STATE WATER MONITORING, *supra* note 46.
113. Houck, *Cooperative Federalism*, *supra* note 10, at 10,427.
114. *See* Craig, *supra* note 41, at 181.
115. Houck, *Cooperative Federalism*, *supra* note 10, at 10,428–29.
116. Wagner, *supra* note 88, at 225.

complicate an already overly complex regulatory system, potentially stifling any chance for state innovation.[117] Further concerns stem from the cost, bureaucratic nature, and lack of flexibility and accountability in these highly centralized federal regimes.[118]

Another model for federal control could come through making nonpoint source controls more enforceable.[119] EPA moved in this direction with the 2000 TMDL rule, requiring that states develop implementation plans for TMDLs in accordance with set deadlines.[120] This was a major advance for a previously state-based program, but these advances created a program that was still "information-based."[121] The requirement that states create plans that would with reasonable assurance achieve the required pollution reduction was not followed by any requirement that the states actually implement these plans.[122]

Moving nonpoint source regulation forward could start by simply giving teeth to the existing structure of EPA's TMDL program. Giving EPA the power to enforce state TMDL plans would go a long way toward achieving effective TMDL implementation.[123] At the same time, looking at transboundary waters shows that the TMDL plans that EPA approves are often based on flawed science. Creating better enforceability for flawed plans will do little to achieve water quality goals. And states would be threatened with massive enforcement actions from EPA for the many TMDL plans they have not made or implemented. In response to this, states would perhaps be more likely to turn to flawed science as a way to quickly appear to be meeting their obligations.[124]

Another avenue for better enforcement could come from citizens. Citizen suits against EPA were largely responsible for EPA's initial turn to begin implementing the nonpoint source controls of the CWA.[125] If Congress expanded the Act to allow citizen suits against nonpoint source polluters for noncompli-

117. *See id.* at 225–26.

118. For discussion of the full debate over command-and-control approaches to environmental law, which is beyond the scope of this paper, see Richard B. Stewart, *A New Generation of Environmental Regulation*, 29 CAP. U. L. REV. 21 (2001).

119. *See generally* Victor B. Flatt, *Spare the Rod and Spoil the Law: Why the Clean Water Act Has Never Grown Up*, 55 ALA. L. REV. 595 (2004).

120. Houck, *Aftershock and Prelude*, *supra* note 36, at 10,411–12.

121. Houck, *Chesapeake Bay*, *supra* note 4, at 10,210.

122. 40 C.F.R. § 130.6 (2019).

123. *See, e.g.*, Williams, *supra* note 35, at 1069 (noting that "the absence of effective authority to control non-point source pollution, remain[s] the greatest obstacle to achieving the legislation's goal.").

124. In fact, many states already appear to be doing this. *See, e.g.*, Houck, *supra* note 36, *Aftershock and Prelude*, at 10,404 (discussing Florida's use of scientific gray areas to avoid meeting CWA requirements).

125. Robin Kundis Craig & Anna M. Roberts, *When Will Governments Regulate Nonpoint Source Pollution? A Comparative Perspective*, 42 B.C. ENVTL. AFF. L. REV. 1, 10 (2015).

ance, it could have equally dramatic impacts on nonpoint source pollution. Citizen suit provisions have helped to spur action in other parts of the CWA.[126] Beyond citizen suits, shining a spotlight on the myriad ways in which the CWA is failing could help to harness public concern and motivate EPA action.[127]

The case of transboundary waters makes several things clear about the potential for increasing federalization to solve the problems of CWA monitoring. The first is that it will require extremely detailed oversight if EPA actually wishes states to meaningfully monitor their waters. If the time of day that monitoring is carried out is enough to dramatically vary the results, EPA's guidance will have to be hyper-specific to achieve these goals.

Furthermore, even if EPA is hyper-specific, states simply do not have the resources to carry out the monitoring needed under the CWA. This is apparent in the number of waters in the United States that remain completely unmonitored, and in the low number of data points (often in the range of three to five) expected to make a water quality determination.[128]

Taken together, these two realities mean that states are likely to continue to enjoy high degrees of flexibility in meeting their CWA requirements. EPA will never be able to be specific enough to ensure that states cannot alter monitoring methods to meet their own ends, and states are unlikely to have sufficient resources to monitor all the waters within their borders, leaving administrators with some element of choice.

Arguments for increasing the role of the federal government gloss over these scientific realities, assuming that nonpoint source pollution could be as easy to command and control as point sources. But it never will be. The scientific complexity of ambient water quality monitoring leads to a need for considerable flexibility for states that will prevent a federalized solution from ever achieving national consistency. Doubling down and increasing federal oversight could remedy some of the remaining problems with TMDL implementation, but more likely it will continue to exacerbate the "tendency of an elaborate but failed federal program to effectively preempt state innovation" and continue to fail at meeting water quality goals.[129]

### *C. Decentralized Solutions*

On the other side of the spectrum, many argue that returning control of nonpoint source pollution to the states could allow real gains. State primacy was

126. Michael Healy, *Still Dirty After Twenty-Five Years: Water Quality Standard Enforcement and the Availability of Citizen Suits*, 24 ECOLOGY L.Q. 393, 453–59 (arguing that citizen suits are beneficial to implementation of the NPDES program).

127. *See generally* Rechtschaffen, *supra* note 44.

128. U.S. GEN. ACCOUNTING OFFICE, *supra* note 8, at 43.

129. Wagner, *supra* note 88, at 225.

a central goal of Congress in the drafting of the CWA.[130] Not only would increased state control allow greater innovation and tailoring at the state level, it would also ensure that the federal government did not interfere in the traditional state domain of land-use regulation. In practice, even when the CWA was passed it did not meet these goals, though it remained truest to them in the provisions on nonpoint source pollution.

The initial state-first program set out by the CWA to address nonpoint source pollution was largely ineffective. A large part of this stemmed from two factors: First, in the decade after the CWA was passed, the focus of states and federal agencies was primarily on implementing the ambitious point source controls that were the CWA's central provisions.[131] Second, a lack of clarity around the ambient water quality provisions, such as whether nonpoint source pollution was even intended to be regulated under section 303, and lack of guidance from EPA meant that states fundamentally did not understand the key requirements of water quality monitoring and TMDLs.[132] Whether a program that puts states first would fail as spectacularly today is unclear.

Most of these solutions call for placing greater control in the hands of the state.[133] A wave of "second-generation" scholarship makes this case in theoretical detail, arguing that decentralized environmental regulation is better at meeting overall social welfare goals.[134] Some argue that water quality in rivers and lakes is an inherently local problem best addressed at the local level.[135] Others point to economic analyses of the costs of implementing TMDLs, arguing that these laws are overly prescriptive and increase the cost of compliance by reducing flexibility.[136]

Transboundary waters as a case study illuminate several flaws in shifting control over nonpoint source regulation to the states. Of these, the clearest is the divergence between the stated aims of Congress and the action of the states. Inconsistent regulatory classification between states results in a patchwork of

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130. Oliver A. Houck, *TMDLs: The Resurrection of Water Quality Standards-Based Regulation Under the Clean Water Act*, 27 ENVTL. L. REP. 10,329, 10,336 (1997).

131. HOUCK, TMDL BOOK, *supra* note 93, at 61–63.

132. *Id.*

133. William L. Andreen, *Water Quality Today - Has the Clean Water Act Been a Success?*, 55 ALA. L. REV. 537, 540 (2004) [hereinafter Andreen, *Water Quality Today*].

134. For an extensive overview of this literature, see Daniel C. Esty, *Revitalizing Environmental Federalism*, 95 MICH. L. REV. 570, 599–613 (1996).

135. *See, e.g.*, Henry N. Butler & Jonathan R. Macey, *Externalities and the Matching Principle: The Case for Reallocating Environmental Regulatory Authority*, 14 YALE L. & POL'Y REV. 23 (1996); Andrew P. Morriss, Bruce Yandle & Roger E. Meiners, *The Failure of EPA's Water Quality Reforms: From Environment-Enhancing Competition to Uniformity and Polluter Profits*, 20 UCLA J. ENVTL. L. & POL'Y 25 (2001).

136. *See* Keith Keplinger, *The Economics of Total Maximum Daily Loads*, 43 NAT. RESOURCES J. 1057, 1073 (2003).

water quality regulations that stray far from the initial intent of Congress.[137] Moving towards a decentralized system will only exacerbate the existing issues of transboundary inconsistency. Even when overarching standards are set by the federal government, small changes in how states interpret and implement these standards can lead to vast differences in the outcome, as demonstrated in the case of transboundary waters.

Placing greater control in the hands of the state also faces significant resource constraints. Most state agencies, even those in larger offices, fall far short of the staffing required to meaningfully implement and enforce environmental regulation.[138] The number of transboundary waters, over 70% nationally, that remain unassessed drives this point home.[139] Without federal resources in the form of funding through section 319 or scientific guidance, states would be much further behind in water quality monitoring than they are today.

Another challenge to vesting too much power for nonpoint source pollution control in the states is that pollution, and the waters it affects, are often transboundary. The transboundary nature of water pollution is one of the justifications for allowing Congress to regulate it under the CWA.[140] Under the Commerce Clause, regulation of transboundary problems like this are part of the powers of the federal government.[141] This stems from the recognition that action on an individual state level will not yield the desired outcomes for these cross-border issues.[142] This same reasoning brings into question an approach to nonpoint source pollution that relies too much on state control and creates further transboundary discrepancies in pollution levels.

The transboundary waters example begins to refute the argument that decentralized environmental regulation is more effective than federal command and control, at least in the case of water quality regulation. Allowing states to

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137. Whether or not nationally uniform water quality should be the goal is a separate question, one addressed to some extent by the CWA's determinations of beneficial uses. Giving states the power to determine what each water's intended use is subsequently dictates the water quality standards it will be held to. So, the "uniformity" of water quality is not exactly uniform and can vary greatly depending on what uses states report. For more on the vices and virtues of uniform standards, see James E. Krier, *On the Topology of Uniform Environmental Standards in a Federal System—and Why It Matters*, 54 MD. L. REV. 1226 (1995).

138. *See, e.g.*, Clifford Rechtschaffen & David L. Markell, *Improving State Environmental Enforcement Performance Through Enhanced Government Accountability and Other Strategies*, 33 ENVTL. L. REP. 10,559, 10,570 (2003) (describing insufficient staffing for air quality enforcement in Ohio and water quality enforcement in Los Angeles).

139. *See supra* Part II.

140. Craig, *supra* note 41, at 215.

141. *Cf.* Hodel v. Va. Surface Mining & Reclamation Ass'n, 452 U.S. 264, 278–80 (1981) (holding that the commerce clause permits regulation of the interstate effects of surface mining, including water pollution).

142. Further Commerce Clause interpretation supports federal environmental regulation to prevent a "race to the bottom." Kirsten H. Engel, *State Environmental Standard-Setting: Is There a "Race" and Is It "To the Bottom"?*, 48 HASTINGS L.J. 271, 280–82 (1997).

determine how they implement environmental regulations creates a more shadowy version of the race to the bottom. If small changes in even the time of day that samples are taken can change regulatory outcomes, states can restructure data to render federal mandates essentially irrelevant, intentionally or unintentionally. The outsize impact of small changes in water quality assessment methodology provides an alternative avenue for states to exert their own preferences in CWA implementation.

Several scholars have argued that giving states more power could pave the way for regulatory reforms such as tradable permits and reforms based on property rights.[143] Rights-based environmental management is being used effectively in other common-pool resources, such as fisheries.[144] The extension of these regimes to water quality management has the potential to economically achieve water quality goals.[145]

### *D. Regional Partnerships*

A third option exists beyond the traditional state-federal dichotomy that has been central to Clean Water Act debates: regional governance. Regional governance, particularly when it is tied to watersheds, has the potential to solve many of the thorniest issues in nonpoint source regulation.[146] Regional partnerships can be used to overcome the danger of a race to the bottom while at the same time promoting innovation and regional tailoring.[147]

Many of the most successful cases of TMDL implementation rely on regional partnerships to tackle the complex landscape of nonpoint source pollution and regulation. The most prominent of these may be the Chesapeake Bay, where states, commercial fishers, nonprofits, and EPA worked together to push through perhaps the nation's most contentious and ambitious TMDL.[148] The decades-long battle to implement this TMDL has paid off, with steady progress toward halting the Bay's decline.[149]

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143. *See, e.g.*, Stewart, *supra* note 118.

144. *See, e.g.*, Jane Lubchenco et al., *The Right Incentives Enable Ocean Sustainability Successes and Provide Hope for the Future*, 113 Proc. Nat'l Acad. Sci. 14,507–10 (2016) (describing the success of rights-based management to align incentives and achieve environmental outcomes in ocean ecosystems).

145. *See* Morriss et al., *supra* note 135, at 59–65 (arguing for property rights-based approaches to water quality management).

146. *See* Williams, *supra* note 35, at 1082.

147. *See* Engel, *supra* note 142, at 371.

148. For an account of how the Chesapeake Bay TMDL came to be, see Houck, *Chesapeake Bay*, *supra* note 4.

149. Houck, *Cooperative Federalism*, *supra* note 10, at 10,440–41.

Regional governance based around watershed boundaries can overcome many of the problems of purely state or federal solutions.[150] Coordinating monitoring and regulation between states eliminates problems of inconsistent classification.

However, regional plans rely on extensive cooperation between states, industry, and other interested parties. The resulting complex systems may be unrealistic to implement for every watershed in the United States. Cooperation in the Chesapeake Bay, for example, took over a decade to finalize.[151] In high-profile areas with major water quality problems, watershed-based cooperation is likely the only way of achieving water quality goals. But this approach is unlikely to be worth the cost of coordination in other circumstances.

Scientific gaps and inconsistencies will continue to undermine the CWA's effectiveness. The focus on restructuring the balance of power in the CWA's cooperative federalism regime ignores these constraints. Transboundary waters show us that the problems with current nonpoint source regulation under the CWA will not be solved through theoretical tools alone. The resource-intensity and scientific complexity of effective water quality monitoring spells similar problems for attempts to centralize or decentralize the TMDL program. Neither vesting additional control in the federal government nor in the hands of states is likely to solve the nonpoint source pollution conundrum.[152] Fixing TMDLs will not be achieved by restructuring EPA's cooperative federalism but by fixing the scientific underpinnings of the CWA.

## IV. Overcoming Scientific Misconceptions

The scientific foundations of the CWA are crumbling. And the way that they are crumbling exacerbates existing tensions in cooperative federalism. Effective implementation of the CWA's nonpoint source controls requires understanding the misconceptions of science that were built into the Act from the beginning.

Many of the problems with the nonpoint source pollution program ultimately result from bad water quality science. The patchiness of the regulation that has frustrated many stems from the fact that only 30% of waters in the United States are assessed. It can take years before TMDLs can be finalized for waters that are impaired, due both to complex modeling and to arguments over

150. This approach has also been successful in Florida. *See* Christine A. Klein, Mary Jane Angelo & Richard Hamann, *Modernizing Water Law: The Example of Florida*, 61 Fla. L. Rev. 403, 422 (2009) ("[The] regional/watershed-based aspect of water management is critical to the protection of water resources.").

151. Houck, *Chesapeake Bay*, *supra* note 4, at 10,213–25.

152. As noted by Oliver Houck when discussing how far the nation has yet to go to meet water quality goals, "Cooperative federalism will help the nation get there. As we have seen, the opposite is also true." Houck, *Cooperative Federalism*, *supra* note 10, at 10,442.

uncertain science.[153] States exploit the scientific vagueness of the CWA for their own political ends. Eliminating the scientific weakness in water quality data nationally would go a long way toward improving nonpoint source pollution control. Many have recognized that these failures are stumbling blocks not just of the CWA, but of all environmental regulations that require ambient monitoring.[154]

Improving monitoring could remedy the failings of other sections of the CWA, including the provisions on stormwater discharge.[155] Solutions include putting forward quantitative instead of qualitative standards,[156] or creating new agencies focused entirely on monitoring.[157] These solutions recognize the scientific constraints inherent in ambient water quality monitoring: that science does not deal well with flexible systems, qualitative goals, or sporadic resource commitments.

In this Part, I point to two misconceptions of science that account for the majority of inconsistency in CWA monitoring: misconceptions of what is scientifically possible and misconceptions of scientific validity and uncertainty. Overestimating what is scientifically possible led Congress to create a law where only 30% of monitoring requirements are being even superficially met after fifty years. Underestimating the importance of scientific uncertainty undermines implementation efforts as states attempt to place naturally varying ecosystems into clear categories of polluted or not polluted. I propose solutions to overcome these misconceptions.

### *A. Misconceptions of Scientific Feasibility*

When Congress drafted the CWA, the core monitoring provisions of the Act were effectively unachievable. Monitoring ambient water quality in the millions of miles of waters in the United States was simply beyond the technical feasibility of states and the federal government.[158] The CWA was built on the premise that scientific gaps that existed in the 1970s could be filled.[159] Little attention was paid by Congress to how states would monitor water quality or to the complexity of the resources and guidance this would entail. The result was that states ended up with a monitoring burden that was vast and effectively impossible to meet. In other environmental regulation, Congress can create incentives to fill known scientific gaps. These technology-forcing regulations use

153. *See, e.g.*, Houck, *Chesapeake Bay*, *supra* note 4, 10,208–23 (discussing the lengthy process of implementing the Chesapeake Bay TMDL).

154. *See, e.g.*, Eric Biber, *The Problem of Environmental Monitoring*, 83 U. Colo. L. Rev. 1 (2011).

155. Wagner, *supra* note 88.

156. Houck, *Cooperative Federalism*, *supra* note 10, at 10,431.

157. Biber, *supra* note 154, at 66.

158. Houck, *Final Frontier*, *supra* 51, at 10,474–75.

159. Wagner, *supra* note 88.

regulatory incentives to spur technological innovation towards filling scientific and technical gaps that exist when a regulation is passed.[160] For example, the Clean Air Act contains such technology forcing provisions.[161] In the CWA's ambient water quality monitoring provisions, however, Congress did not create any of these incentives. Instead, Congress passed the CWA with no recognition of the scientific limitations to widespread water quality monitoring nor with any consideration of the incentives that might be needed to fill these gaps. It should be no surprise that forty years later, these scientific issues remain largely unaddressed.

The scientific failures of the CWA are apparent in how few waters are actively monitored by states and how many inconsistencies there are in the transboundary waters that span state borders. Even when states are doing their best to achieve water quality monitoring goals, small changes as granular as what hour of the day they monitor can have large impacts on the resulting data. This may be a failing of the states to engage in methodologically perfect scientific monitoring, but it is even more a failure in how the CWA was designed. The scientific constraints of ambient water quality monitoring are not compatible with the requirements of the CWA and the resources available to states to monitor it.

Creating ambitious policy goals without a thorough understanding of what scientific gaps and limitations exist yields regulations that are neither effective nor achievable.[162] In the case of the CWA, Congress failed to fully consider the lack of existing water quality data and the difficulties in carrying out monitoring at a nationwide scale. The result is an ambient water quality program that has been impossible to effectively implement.[163]

It is possible that Congress was aware of the unachievable scientific mandate it was creating in the CWA. Building unrealistic scientific goals into otherwise strong regulation could be a way for Congress to soften regulatory requirements and introduce flexibility for regulated parties.[164]

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160. *See generally* David Gerard & Lester B. Lave, *Implementing Technology-Forcing Policies: The 1970 Clean Air Act Amendments and the Introduction of Advanced Automotive Emissions Controls in the United States*, 72 TECH. FORECASTING & SOC. CHANGE 761, 762 (2005).

161. *See* 42 U.S.C. § 1311 (2018).

162. For an argument that scientific and technical limitations should be taken into account at the early stages of regulatory drafting, see Wagner, *supra* note 88, at 193 ("We cannot decide, for example, that we want all waters fishable and swimmable or the air safe for all persons and then figure out how science can get us there. Instead, competent regulatory design requires an assessment of what science and other sources of technical information can and cannot offer—at the front end of regulatory design. Limits in available information should inform both the ends and the means of how we choose to regulate.").

163. Houck, *Cooperative Federalism*, *supra* note 10, at 10,426.

164. Framing political decisions as scientific ones can allow lawmakers to avoid confronting tricky ethical questions, like what levels of risk to human health are acceptable. These "trans-scientific" questions ultimately cannot be answered by science, but are nonetheless often asked to

But whether Congress intended it or not, the result of the CWA's monitoring requirements is a scientific program that is only partially achievable for states. Only roughly one-third of the waters in the United States are monitored at all today, and even those that are monitored are often monitored so infrequently that the results are almost meaningless.[165] Attempts to meet the CWA's requirements mean states spread their resources thin to cover wider geographic areas and as a result waters are monitored so infrequently that the data are highly uncertain.[166]

The scientific underpinnings of the CWA were flawed from the beginning. But these flaws have often been sidelined as scientific or technical details that are only minor contributors in the broader landscape of the CWA. This is an oversight. The scientific failures of the CWA have fundamentally undermined its effectiveness.[167] The impacts of this flawed scientific understanding are only now becoming fully clear: most of the waters in the United States remain unmonitored, while in those that are monitored divergent regulatory classification has undercut the credibility of existing TMDL efforts.

Several solutions may help to overcome the existing problems with achieving the CWA's ambient monitoring requirements. Specifically, resource prioritization strategies that effectively incorporate lower quality data sources coupled with new technology-forcing mechanisms can help achieve the scientific monitoring goals of the Act.

*1. Prioritizing Monitoring Needs*

The single largest factor leading to inconsistency in transboundary water classification is the number of waters that remain completely unmonitored. Even in cases where waters are monitored, spatially and temporally limited data leads to inconsistent pollution determinations.[168] States have a great deal of flexibility determining where to focus their limited monitoring resources, introducing additional inconsistency into the system.

States should create systems that better prioritize where monitoring resources are focused. Current practices vary by state and are often haphazard, with some states focusing on trying to monitor as many waters as possible (often generating useless results in the process as they only monitor many waters once or twice a year) while others focus on socially important waters that are heavily used or near to large or affluent population centers.[169] These pro-

scientists as part of regulation. *See* Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613, 1619–22 (2013).

165. *See* U.S. GEN. ACCOUNTING OFFICE, *supra* note 8.

166. *See id.*

167. *See id.*

168. *See supra* Part II.B.

169. U.S. GEN. ACCOUNTING OFFICE, *supra* note 8, at 5–6.

grams would be strengthened by taking a more systematic approach that incorporates not just social but scientific information to understand where monitoring is most needed.

Some states have had success using tiered monitoring plans to prioritize monitoring. In Florida, for example, basins are monitored on a rotating basis for water quality status and trends.[170] Any waters that show evidence of impairment are then subject to more intensive monitoring.[171] This allows the state to focus resources effectively on waters that are most likely to be polluted.

Coupling these tiered monitoring plans with existing technology resources could create robust, systematic water quality monitoring nationally. While Florida's tiered monitoring plans rely on traditional water quality monitoring as step one of their monitoring, adding an additional preliminary screening step that takes advantage of existing but potentially lower-quality data sources would increase the robustness of these plans. Specifically, remote sensing and volunteer monitoring data can both provide valuable information in identifying potential problem areas and trends despite often lacking the scientific rigor to be included in final water classifications.[172] States should use these sources as a first step to understand where additional monitoring resources should be deployed. Satellite data is a low-cost source of data on important indicators of water quality, including temperature and water color.[173] Using satellite data to observe large-scale trends can indicate when potential problems arise that need more detailed monitoring. Likewise, volunteer monitoring groups have been an important source of data in the CWA.[174] However, using data collected by volunteers is often limited by concerns over data quality.[175] States should focus on using this to identify problem areas for follow-up monitoring by trained scientists; this overcomes these data quality concerns while helping states to prioritize where monitoring resources should be focused.

Coupling scientific methods for identifying areas of highest concern with existing social considerations can help states to better prioritize limited monitoring resources. Tiered systems that use lower-quality data to understand where monitoring resources should be deployed are particularly promising. These systems should be coupled with the understanding that monitoring more waters is not always better: Sacrificing the robustness of water quality data by

170. Letter from Gregory P. DeAngelo, Deputy Dir., Div. of Envtl. Assessment and Restoration, Fla. Dep't of Envtl. Prot., to Gracy Danois, Chief, Assessment, Listing and TMDL Section, Fla. Dep't of Envtl. Prot. 2 (Sept. 1, 2015) (on file with author).

171. *Id.*

172. *See* Annie Brett, *Putting the Public on Trial: Can Citizen Science Data Be Used in Litigation and Regulation?*, 28 VILL. ENVTL. L.J. 163, 181 (2017).

173. Matthew R.V. Ross et al., *AquaSat: A Data Set to Enable Remote Sensing of Water Quality for Inland Waters*, 55 WATER RESOURCES RES. 10,012, 10,012 (2019).

174. *See* Brett, *supra* note 172, at 182.

175. *Id.* at 181.

monitoring only once or twice a year leads to inconsistent and indefensible regulatory outcomes. By more systematically choosing where to focus monitoring resources, states can ensure that problem areas are being effectively identified while at the same time ensuring that water quality monitoring data is valid enough to support regulatory decisions.

### *2. Technology-Forcing Mechanisms*

The CWA did not create the mechanisms needed to encourage technological innovation in ambient water quality monitoring. While the kind of economically unachievable burden created by the CWA's monitoring provisions is a hallmark of technology forcing regulations, effective technology-forcing regulations also require the belief that regulators will enforce the provisions if the standards are not met.[176] This is far from the reality in the CWA. The monitoring requirements of the Act are not enforced in any meaningful way and as a result there are no incentives for states to develop better ways of carrying out water quality monitoring.

Creating these incentives is relatively straightforward: enforce the CWA's monitoring provisions. If Congress or EPA held states accountable for falling short of the CWA's mandated monitoring there would be strong incentives to implement more accurate, lower-cost solutions. In practice, this accountability may be difficult to achieve, as neither Congress nor EPA has shown any movement towards enforcing these provisions. Increasing transparency could also force technological innovation if the public begins to hold states accountable for insufficient and invalid water quality reporting.

## *B. Misconceptions of Scientific Uncertainty*

Natural variation in ecosystem conditions makes it difficult to place waters into clearly defined, black and white categories of polluted or not polluted. When natural variation is coupled with variation in scientific methodologies and motivations, the result is scientific data that does not always reflect true ecosystem conditions.

Uncertainty and variation are inherent in science. Good environmental regulation should recognize scientific uncertainty and create mechanisms to ensure that regulatory outcomes are insulated from small changes in scientific inputs. Transboundary waters show what can happen when regulatory outcomes are instead highly sensitive to variation in the underlying science. In the case of TMDLs, small changes between states in numerical water quality standards and methodologies often dictate whether a water is classified as impaired or

176. Technology forcing regulations generally focus on creating currently unattainable targets for regulated industry, not state agencies. *See* Gerard & Lave, *supra* note 160, at 762.

not. These minor variations result in major differences in regulatory outcomes and TMDL implementation.

A more robust version of the CWA would create regulation that is informed by science but not at the mercy of it. This would help to overcome the existing problem of inconsistent classification in transboundary waters.

Interestingly, the EPA has created a clear avenue to address potential scientific uncertainty by including a threatened category of waters.[177] This category recognizes that waters may fall into a threshold category where they are not clearly polluted but show evidence of being threatened and may become impaired in the future. Waters in the threatened category are reported to Congress as part of section 303(d) reporting requirements, but are not subject to TMDLs.[178]

The threatened category is rarely used by states. In transboundary waters, only four waters (out of 1,153 total) were classified as threatened by at least one state. This is a missed opportunity. Classifying waters as threatened gives states a clear avenue for the seemingly many threshold cases where the attainment water status of a water is uncertain. In the case of transboundary waters, states should list waters as threatened when the data is insufficient to make a valid determination of whether a water is polluted. For instance, when determinations are based on limited temporal and geographic data, listing threshold cases as threatened or attaining will lead to better scientific outcomes. This also allows for better prioritization, as discussed above, as once waters are listed as threatened more monitoring resources can be devoted to ensuring they are accurately categorized in the future.

Many states have their own multilevel systems for water categorization based on pollutant levels that contain similar categories to the federal threatened category. Florida, for example, has eleven separate status categories indicating various levels of attainment and uncertainty.[179] However, these categorical distinctions often do not translate in the mandated federal CWA reporting process and many states still do not use them. States should increase the use of the threatened category to accurately reflect the uncertainty of water quality monitoring data.

## Conclusion

In 2004, commenters wrote that "we need to determine as accurately as possible what has worked and what has failed" about the CWA before we pro-

177. *See* 40 C.F.R. § 130.7 (2019).

178. *Id.*; *see also* 33 U.S.C. § 1313(d) (2018).

179. *Watershed Assessment Section*, Fla. Dep't of Envtl. Protection, https://perma.cc/ZFG8-Y9BZ.

pose reforms.[180] In the fifteen years since, it is increasingly clear where the CWA has failed: on nonpoint source pollution. Evaluating transboundary waters shows the extent of this problem, with only 4% of transboundary waters subject to the same regulatory classifications on either side of a state boundary.

Many have sought to solve the regulatory patchwork that is the TMDL program by advocating alternately for greater federal or state control over water quality monitoring. But scientific realities—in the form of resource shortages, methodologies that can be tweaked to support state political goals, and the sensitivity of impairment classifications to even the smallest changes in monitoring protocols—undermine many of these federalism solutions.

Congress should recognize and design regulation around scientific realities instead of hoping that states will, somehow, after decades of failure, figure out how to fill massive scientific gaps. In the case of the CWA nonpoint source pollution program, major gains could be made by focusing on the scientific underpinnings: by effectively prioritizing monitoring resources, encouraging the use of technological innovation in water monitoring, and recognizing scientific uncertainty.

180. Andreen, *Water Quality Today*, *supra* note 133, at 542.