An overview of the evolving jurisdictional scope of the U.S. Clean Water Act for hydrologists

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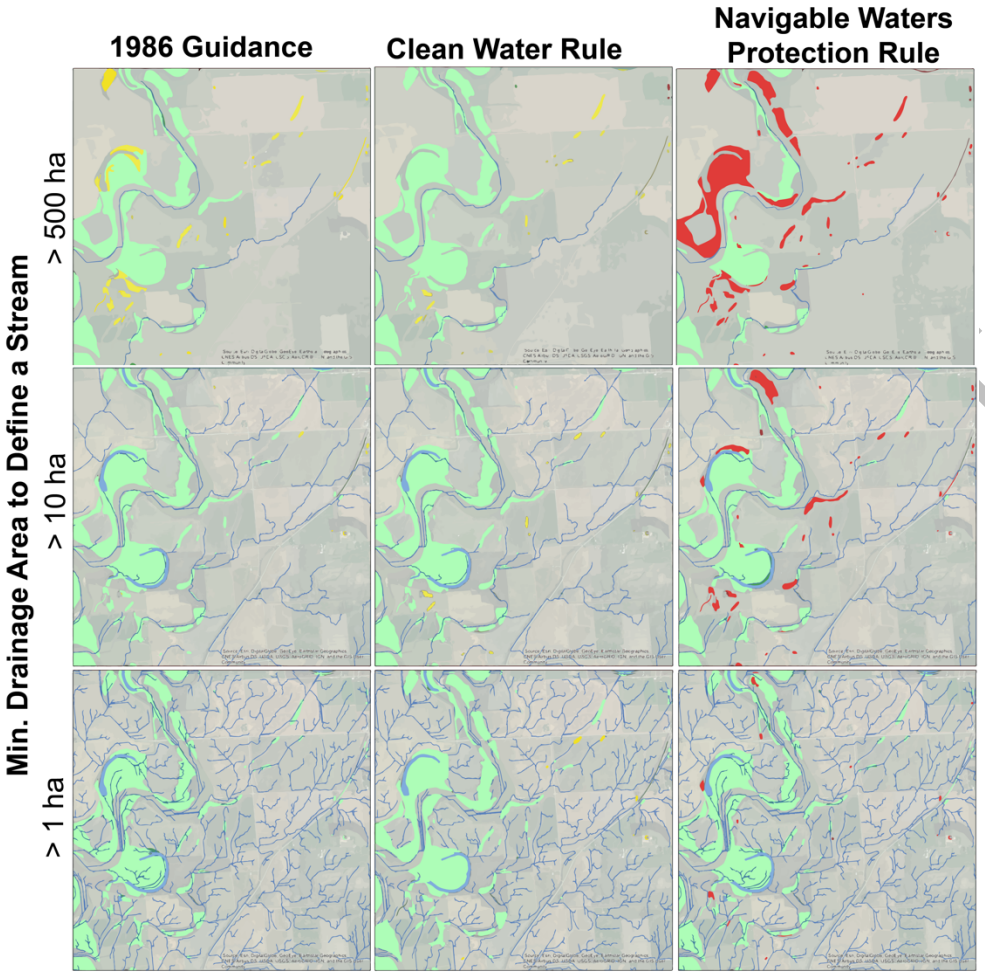
Abstract

The Clean Water Act (CWA) is the primary federal mechanism by which the physical, chemical, and biological integrity of streams, lakes, and wetlands are protected in the U.S. The CWA has evolved considerably since its initial passage in 1948, including explicit expansions and contractions of jurisdictional scope through a series of legislative actions, court decisions, and agency rules. Here, we provide a practical summary of the CWA's evolution, detailing the major updates or revisions and their circumstances. Additionally, we identify the jurisdictional scope of the law for rivers and streams, lakes, and wetlands based on the language used and implementation by the agencies during the same time period. While the rulemaking process commonly uses language that will be abstract to many hydrologists, understanding the on-the-ground implications, quantifying regulatory (un)certainties, and assessing the magnitude of changes through time is important to understanding the implications of environmental regulation development, litigation, and enforcement. Thus, we translate the enforcement norms and definitions into quantitative estimates for Clean Water Act scope in the Wabash River Basin (IL, IN, & OH, USA) as a demonstration of the spatial consequences of changing regulatory language.

Graphical/Visual Abstract and Caption



Variability in the regulatory stream network extent (rows) and changing regulations through time (columns) result in different suites of federal protection for wetlands (green indicating protected, yellow indicating uncertainty, red indicating not protected). In the above, columns represent regulatory language as of 1986, 2015, and 2020, while rows consider more contracted (top) and generous (bottom) definitions of the regulatory stream network. (modified with permission from (Walsh & Ward, 2019)).

1. INTRODUCTION

Interpretation and enforcement of the Clean Water Act has evolved since its origin as the 1948 Federal Water Pollution Control Act. A series of Supreme Court cases, federal guidance, and rulemaking have sought to answer the fundamental issue of which waters are federally protected. Debate about which streams, lakes, and wetlands are regulatory (hereafter the "Waters of the United States", or WOTUS) has regularly arisen since the term WOTUS was included in the 1972 amendments to the Federal Water Pollution Control Act (commonly the Clean Water Act, CWA) (Federal Water Pollution Control Act Amendments of 1972, 1972). Federal protections provided via the Clean Water Act (e.g., permit requirements to dredge, fill, or discharge pollutants) extend only to those waters classified as WOTUS, making it essential to understand the geographical extent of federal protections. Despite the clear importance of understanding which waters are federally regulated, numerous court decisions and agency recommendations have not produced a robust and consistent definition required for proactive and efficient regulation. Moreover, while several comprehensive reviews discuss the evolving legal definition of WOTUS (e.g., Copeland, 2016; Mihelcic & Rains, 2020; Mulligan, 2019), these do not translate to a practical assessment of how the scope of the Clean Water Act is changing on the landscape.

Our objective in this study is to document the evolving spatial protections afforded to U.S waters from 1948 to 2021, taking the Wabash River Basin as a case study to demonstrate the on-the-ground consequences of these changing definitions, rules, and norms. We examined how the implementation of the Clean Water Act has evolved through a series of amendments, Supreme Court cases, executive orders, and agency rules during its history. Based on the evolution of the regulatory process, we quantified the impact of these changes in the Wabash River Basin, where a prior case study has established data sets and methods [1], linking historical changes to that modern analysis. We highlight key decision-points and their on-the-ground consequences, and use our scientific understanding to attribute quantitative bounds to the vague and uncertain terminology. This quantitative history of WOTUS is the first of its kind and serves to document the co-evolution of enforcement, rulemaking, and legislation with our understanding of hydrological systems, detail trends in regulatory scope, and provide historical context for ongoing legal cases surrounding the enforcement of the Clean Water Act (*Conservation Law Foundation, et al. v. Andrew Wheeler, et al.*, 2020; *South Carolina Coastal Conservation League, et al. v. Andrew Wheeler, et al.*, n.d.; *State of California, et al. v. Andrew Wheeler, et al.*, n.d.). Finally, we note that federal regulations provide a functional 'floor' for protection of water resources, where some states and local governments can elect to provide independent protections of the same waters and/or protections that are above and beyond those at the federal level (*Environmental Law Institute,* 2013).

Four periods in the evolving enforcement of the Clean Water Act

The jurisdictional history of what we commonly call the Clean Water Act can be subdivided into four distinct time periods, each marked by different challenges and legal objectives. From 1948 to 1972 the act targeted water pollution without a meaningful threat of enforcement. A series of amendments strengthened the regulation, paving the way for the critical 1972 amendments. The decade following the 1972 amendments saw the newly formed Environmental Protection Agency in disagreement with the US Army Corps of Engineers, with both agencies seeking to draw jurisdictional lines to best satisfy their own missions and goals. The agencies came into agreement in 1982, and jointly refined jurisdictional boundaries in response to a series of Supreme Court decisions, concluding with Rapanos v. United States in 2006. In the present era, the agencies strive to best interpret Rapanos, and new rules have been established aimed at resolving uncertainty produced by broad judicial language and having rules represent the best available science (US EPA, 2015).

2. A BRIEF HISTORY OF THE CWA AND ITS EVOLUTION

2.1 Pre-Clean Water Act (1948-1972)

The Federal Water Pollution Control Act became law in 1948 (Federal Water Pollution Control Act of 1948, 1948) and was the first law that aimed to protect human health by requiring the abatement of pollution to waterways. Only "interstate waters" were regulated at this time, and only that pollution which "endanger[ed] the health or welfare of persons in a State other than that in which the discharge originate[d]" was subject to provisions of the law. Given the difficulty of confidently attributing illnesses

to a specific polluter, no legal action was witnessed under this initial version of what we now call the Clean Water Act (Barry, 1970).

Amendments in 1961 expanded these protections to intrastate waters (*Federal Water Pollution Control Act Amendments of 1961*, 1961), and in 1965 the first water quality criteria were established (*Water Quality Act of 1965*, 1965). These criteria required states to develop federally approved water quality standards for interstate waterways, and abate any pollution exceeding those thresholds (Barry, 1970). Jurisdiction was guided solely by the legislature, with no clear definitions of which waters were regulatory. For a water to fall under the act's purview, damage to human health or failure to meet water quality criteria in select waterways needed to be evidenced.

2.2 Learning Agency Teamwork (1972-1982)

The Federal Water Pollution Control Act (Federal Water Pollution Control Act of 1948, 1948) provided the foundation for water protections in the United States, laying the groundwork for stronger legislation. It was entirely rewritten in 1972 in an amendment that rebranded the legislation as the Clean Water Act (CWA) (Federal Water Pollution Control Act Amendments of 1972, 1972). The amendment laid out several ambitious goals for US waters, including the elimination of pollutant discharge to navigable waterways by 1985 ("Water Pollution Control Act," 1948), a goal which still has not been realized (USEPA 2017), the consequences of which are visible at a national level (USEPA, 2020; USEPA, 2006). While providing more concrete federal rules, the newly written CWA also emphasized autonomy of the states, asserting an intent to ensure that states maintain the right to "prevent, reduce, and eliminate pollution" (Federal Water Pollution Control Act Amendments of 1972, 1972). The amendment, which came on the heels of the Cuyahoga River fire, had strong bipartisan support. When President Nixon vetoed the amendment due to its "unconscionable $24 billion price tag" (Nixon, 1972), both Congressional Democrats and Republicans united to override the veto and pass the legislation (House Vote No. 459; Senate Vote No. 571, both in 1972).

The CWA expanded upon the regulatory framework pioneered in 1965, implementing more comprehensive water quality standards. The act required permitting of point source discharges to navigable waters and provided the federal government the power to set effluent limitations for point sources in cases where discharges would "interfere with the attainment or maintenance of […] water quality" (Federal Water Pollution Control Act Amendments of 1972, 1972). Critically, the CWA takes water quality as an integrated result of the physical, chemical, and biological integrity or health of the resource.

As written, the CWA has jurisdiction over "navigable waters," which are defined as "waters of the United States including the territorial seas" (commonly WOTUS). The introduction of this vague legislative definition intentionally left room for interpretation by the U.S. Army Corps of Engineers (USACE) and the newly formed U.S. Environmental Protection Agency (USEPA). Notably, this marked a shift away from complete legislative control, with a transfer of autonomy and decision-making to the executive branch agencies.

In 1973, the USEPA proposed a refined definition of WOTUS to define which waters were subject to Clean Water Act regulations (USEPA, 1973). Their definition included navigable waters, stream tributaries to navigable waters, and interstate waters. Additionally, waters meeting certain criteria also received protections, including waterways utilized for recreation and industrial purposes, and those from which fish and shellfish are taken and sold. These conditions applied to streams and lakes, but wetlands were not regulated by the USEPA at this time.

In contrast and coincident in time, the USACE argued that "navigable waters" were all waters "subject to the ebb and flow of the tide" and those that are presently, have been historically, or may be in the future utilized for interstate commerce (Permits for Activities in Navigable Waters or Ocean Waters, 1974). These conflicting agency definitions increased the confusion surrounding WOTUS and enforcement. Following Natural Resources Defense Council v. Callaway (*Natural Resources Defense Council, Inc. v. Callaway*, 1975), the USACE expanded its definition of which streams and lakes were regulated, and considered certain wetlands a type of jurisdictional water for the first time (USDOD, 1975, 1977).

In 1980, the USEPA authored a revision to their rule (USEPA, 1980), which the USACE signed onto two years later . This harmonized definition of WOTUS borrowed from each agency's previous rule. At this time, WOTUS was understood to include waters used for commerce, recreation, fishing and industry, tributaries to those waters, and wetlands adjacent to regulated lakes and streams.

2.3 Wetlands and the Supreme Court (1982-2005)

The agencies' decision to consider wetlands as WOTUS prompted a series of Supreme Court cases aimed at determining if and to what extent the legislature intended wetlands to fall under CWA jurisdiction. Wetlands are not commonly considered navigable bodies of water and tend to offer less recreational opportunity than rivers and lakes. However, research was increasingly demonstrating the importance of wetlands to critical services supporting water quality and ecosystems traditionally regulated under the CWA (e.g., Johnston, 1990, 1991).

In 1985 the Supreme Court ruled that wetlands play a crucial role in maintaining water quality and are "inseparably bound up with" jurisdictional waters (*United States v. Riverside Bayview Homes*, 1985). On this basis, the Supreme Court maintained that all wetlands adjacent to a jurisdictional water should be considered WOTUS. Consequently, the agencies updated their rules in 1986 to clarify protections for streams and wetlands (USDOD, 1986). For the first time, the agencies defined regulated streams as those bearing a defined bed, banks, and ordinary high water mark (USDOD, 1986). Importantly, an ordinary high water mark is a field indicator that could include several types of evidence of flow, including geomorphic shelving, debris, and visible moisture. Under the 1986 rule, an ordinary high water mark indicated the presence of water at a significant enough duration to merit classification as a stream, even if the streambed in question was dry at the time of investigation. All wetlands "adjacent" to regulated streams and lakes were also included in the definition of WOTUS, with adjacency further defined to include "bordering, continuous, or neighboring" (USDOD, 1986).

In 2001, WOTUS issues were once again before the Supreme Court, this time to determine the legality of the agencies' "Migratory Bird Rule," which categorized the movement of migratory birds across state boundaries as interstate commerce (USDOD, 1986). This rule effectively brought all waters used by migratory birds (e.g., waterfowl) under CWA protection via the Commerce Clause, regardless of their adjacency to traditionally regulated waters. In Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers (commonly 'SWANCC'), the Supreme Court ruled that migratory bird use could not be the sole reason that a waterway was considered jurisdictional under the CWA, striking down the rule (*Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 2001). It was reasoned that in cases where agency legal interpretation stretches Congressional authority, it needs to be clear that those legal actions were originally intended by Congress (*Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 2001). It was decided that the language of the CWA did not indicate that isolated wetlands and waterways with no obvious outlet to WOTUS should be considered jurisdictional based solely on migratory bird use. This exertion of judicial power over agency decisions placed clear limits on the extent of CWA protections for the first time.

In 2006, the Supreme Court revisited wetland jurisdiction once again. Rapanos v. United States (*Rapanos v. United States*, 2006) involved a developer who filled three wetlands adjacent to manmade ditches that flowed intermittently and ultimately drained into a jurisdictional stream. Since the wetlands themselves were not immediately adjacent to WOTUS but were connected via an intermittently flowing and manmade ditch, federal protection under the CWA was not clearly established. In a 4-1-4 decision, the Supreme Court did not reach a majority decision about whether the wetlands in question were WOTUS. Despite this, 5 of the 9 justices agreed to overturn the ruling of the lower court, sending back the case for reevaluation. As a result, despite differing jurisdictional interpretations, opinions authored by both Justice Kennedy and Justice Scalia set legal precedent.

Justice Scalia was joined by three other justices in defining WOTUS as "relatively permanent" bodies of standing or flowing water normally called "streams, oceans, rivers, [and] lakes". "Ephemeral streams," which only flow during rain events, were excluded. Scalia posited that wetlands adjacent to

WOTUS should also be WOTUS if a “continuous surface connection” exists. Lacking a surface connection, he argued, wetlands should not be regulated.

Justice Kennedy authored an independent opinion that wetlands are WOTUS if they possess a “significant nexus,” -- or meaningful connection -- to waters that are navigable or can be made so. This decision set the stage for connectivity being an essential basis for determination of CWA scope, a cornerstone of subsequent rulemaking (e.g., US EPA, 2015). Kennedy also emphasized that wetlands should not be examined in isolation, but in the context of the surrounding landscape. He argued that wetlands should be considered jurisdictional if they impact the quality of navigable waterways either “alone or in combination with similarly situated lands in the region”. For example, if a network of wetlands improves downstream water quality, none of those wetlands should be removed, even if the elimination or degradation of one in isolation does not produce a noticeable change.

Ultimately Rapanos v. United States marked the end of an era that tested the unified rules promulgated by the agencies and disputed in the courts. Power shifted to the judicial branch as agency rules were successfully challenged and found contrary to the legislature’s intent. In his Rapanos v. United States concurring opinion, Justice Roberts lamented the fact that “the Corps and the EPA would have enjoyed plenty of room to operate in developing some notion of an outer bound to the reach of their authority” following SWANCC, further stating that the case could have been readily avoided (*Rapanos v. United States*, 2006). This era closes with the judiciary tasking the agencies to develop strategies for implementation and refined definitions of upper jurisdictional bounds, and creating the need for “significant nexus” and “continuous surface connection” tests.

2.4 The Post-Rapanos Era (2006-Present)

Rapanos v. United States led to confusion amongst regulators and the regulated community about which wetlands should be considered WOTUS. Lacking one unified rule, the agencies released a guidance document in 2008 which aimed to clarify the ruling (US EPA & US DoD, 2008). The agencies indicated any wetland with a significant nexus to navigable waters should be considered jurisdictional, at any distance from the receiving water.

In 2015, with the support of the Obama administration and building upon a comprehensive assessment of the science (US EPA, 2015), the agencies finalized the Clean Water Rule. This rule set clear, quantitative standards outlining when significant nexus tests needed to be performed. Lakes and wetlands were considered jurisdictional if they were within 100 feet of WOTUS, within the 100-year floodplain and 1,500 feet of WOTUS, or within 1,500 feet of “traditionally navigable” waters (US DoD & EPA, 2015). Significant nexus tests were required for other lakes and wetlands within the 100-year floodplain of traditionally navigable WOTUS, or within 4,000 feet of WOTUS and interstate waters. Any waterbodies falling outside these criteria were exempt from permitting and no significant nexus test would be required.

The Clean Water Rule immediately faced litigation and was stayed nationwide by the Sixth Circuit Court of Appeals less than two months after its promulgation (*State of Ohio, et al. v. U.S. Army Corps of Engineers, et al.*, 2015). This reverted the most recent agency regulation back to their 1986 rules and 2008 guidance. Three years later, however, a Supreme Court case determined that the Court of Appeals did not have authority to stay the Clean Water Rule in the first place, restoring its implementation (*National Association of Manufacturers v. Department of Defense et al.*, 2018).

The agencies, now guided by the Trump administration, quickly responded to this ruling by suspending the Clean Water Rule for two years (USDOD & USEPA, 2017). However, later that year the South Carolina District Court placed an injunction on the agencies’ delay (*South Carolina Coastal Conservation League, et al. v. Andrew Wheeler, et al.*, n.d.). The injunction revived the Clean Water Rule in 26 states, resulting in a patchwork of regulation where 24 states operated under the 2008 guidance and the other 26 operated under the Clean Water Rule. In several cases, a single agency district was responsible for simultaneously enforcing both rules across different regions. After years of back-and-forth, the rule was formally repealed in 2019 (USDOD & USEPA, 2019).

In response to an executive order (Trump, 2017), the agencies finalized a new rule in 2020 entitled the Navigable Waters Protection Rule (NWPR) (USDOD & USEPA, 2020). Much like the Clean Water Rule, the stated goal of this rule was to increase predictability and clarify the scope of WOTUS. In a departure from the longstanding 1986 precedent (US DoD, 1986), the NWPR redefined jurisdictional streams as those with perennial or intermittent flow, explicitly excluding those with ephemeral flow. Since 1986, streams with bed, banks, and evidence of flow had been considered jurisdictional irrespective of observed flow frequency. The rule also determined that only lakes and wetlands immediately adjacent to and with a surficial flow connection to WOTUS should be considered WOTUS themselves, again departing from 1986 precedent allowing for a wider jurisdictional buffer to define adjacency. Notably, this rule received much criticism for its departure from the best available science (Honeycutt & Board, 2019; Mazeika et al., 2019; Mihelcic & Rains, 2020; Sullivan et al., 2020; USEPA Science Advisory Board, 2020; Ward & Walsh, 2020).

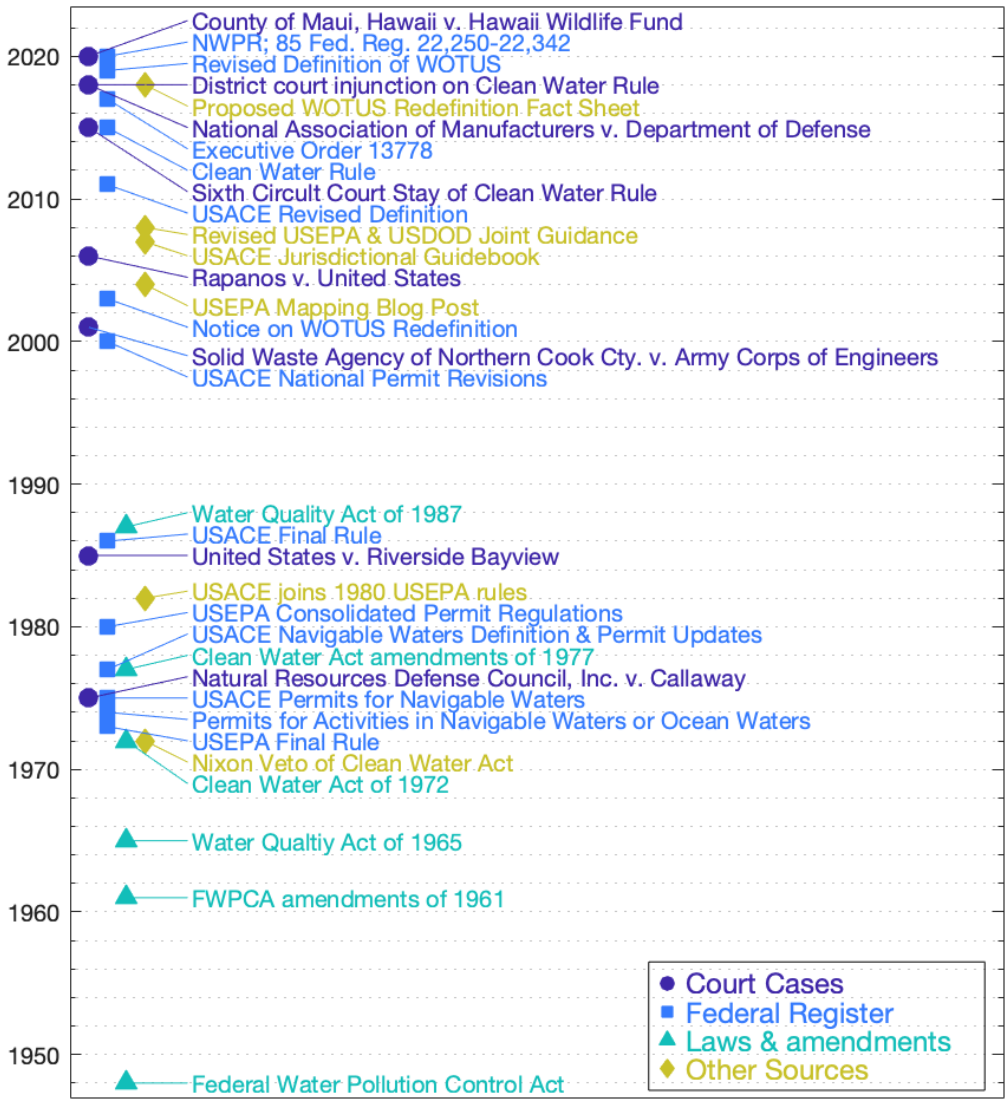


Fig. 1. Timeline of court cases, publications in the Federal Register and Code of Federal Regulations, legislation and amendments, and complementary documentation germane to the evolving definition of the jurisdictional scope of the Clean Water Act. Taken together, these events, decisions, and

documents define the Waters of the U.S. and form the basis upon which waters receive federal protections. Note the documents and decisions above are a fraction of the available literature that was reviewed, but provide an overview of significant events that have defined the evolving scope of the Clean Water Act.

3. THE EVOLVING JURISDICTIONAL SCOPE OF THE CLEAN WATER ACT

3.1 Changing regulatory definitions and their translation to geographical definitions

To quantify the changes in jurisdictional scope since the Federal Water Pollution Control Act was passed in 1948 (Federal Water Pollution Control Act of 1948, 1948), we systematically reviewed the language in agency rules and guidance, executive orders, Supreme Court cases, legislation, and studies about CWA jurisdiction from 1948 to present (Fig. 1; *COUNTY OF MAUI, HAWAII v. HAWAII WILDLIFE FUND ET AL.*, n.d.; *Federal Water Pollution Control Act Amendments of 1961*, 1961; *Water Quality Act of 1965*, 1965; *Water Quality Act of 1987*, 1987; Federal Water Pollution Control Act Amendments of 1972, 1972; Federal Water Pollution Control Act of 1948, 1948; *National Association of Manufacturers v. Department of Defense et al.*, 2018; *Natural Resources Defense Council, Inc. v. Callaway*, 1975; *Rapanos v. United States*, 2006; *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 2001; *State of Ohio, et al. v. U.S. Army Corps of Engineers, et al.*, 2015; *United States v. Riverside Bayview Homes*, 1985; Permits for Activities in Navigable Waters or Ocean Waters, 1974; Grumbles & Woodley, Jr., 2007a, 2007b; Nixon, 1972; Riley, 2008; Trump, 2017; US DoD, 1986; US EPA, 2015; USACE, n.d.; USACE & USEPA, 2007; USDOD, 1975, 1977, 2000, 2007b, 2007a, 2011c, 2011b; USDOD & USEPA, 2003, 2015, 2020; USEPA, 1973, 1980, 2014; USEPA & USDOD, 2007a, 2007c, 2007b, 2008b, 2008a, 2018, 2020a, 2020f, 2020g, 2020d, 2020b, 2020h, 2020i, 2020c, 2020e). During this review we noted any qualitative and quantitative descriptors that were used to define the scope of which waters were jurisdictional (Supplemental Table 1). Notably, we tracked the various characteristics of lakes, rivers, and wetlands that pertain to their jurisdictional status (e.g., inter- vs. intrastate, perennial vs. ephemeral, natural vs. man-made) and the associated legislation, rule, guidance, or decision (Ward & Walsh, 2021). On this basis, we classified jurisdictional waters as either “definitively,” “possibly,” “conditionally,” or “not” jurisdictional. “Definitively” jurisdictional waters included those explicitly specified as jurisdictional. For example, traditionally navigable rivers were classified as “definitively” jurisdictional because this is explicitly articulated in the original legislation. Similarly, “not” jurisdictional waters included all waters explicitly excluded by a rule or decision. For example, when the Clean Water Rule was enacted, all waters that failed to fall under the definition of WOTUS or to require a significant nexus test were considered “not” jurisdictional. For waters that we expect would be determined jurisdictional based on the decision rule, we defined the classification of “possibly” jurisdictional waters. This typically reflects a generous reading of the language, defining a maximum geographic scope of regulations (in contrast to “definitively” jurisdictional waters, which are a more geographically conservative lower boundary). For example, decades of WOTUS definitions have considered streams with a bed, banks, and ordinary high water mark jurisdictional. Since this demarcation is subject to individual interpretation in the field, it cannot be easily quantified at the scale of entire river networks (i.e., in this study and past efforts). In this and other situations, scientific judgement, GIS analysis, and literature review informed a conservative upper and lower bound, yielding a category of “possibly protected” waters (Walsh & Ward, 2019). In short, the category of “possibly” protected encompasses the uncertainty in classifications or case-by-case determinations that would require field studies or specific site effort during the permitting process. Additionally, we identified several “conditionally” jurisdictional waters. These waters were considered WOTUS if specific criteria were met. For example, waters that would be jurisdictional only if they passed a significant nexus test were included in this category.

Finally, to translate evolving definitions and legal bases into their on-the-ground implications, we applied these definitions across the Wabash River Basin in Illinois, Indiana, and Ohio, USA. This basin was selected because it has been previously used to demonstrate the spatial impact of regulatory changes on CWA jurisdiction. Briefly, the basin drains approximately 33,000 mi^2, including primarily agricultural land use in the northern half of the basin (Wisconsin glaciation) transitioning to more forested land use in the southern half of the basin (Illinoian advance and older). Prior studies identified 229,202 acres of lakes, up to 410,082 miles of streams (drainage area greater than 1 ha),

and 614,981 acres of wetlands in the basin (Walsh & Ward, 2019). Detailed descriptions of the data and decisions are provided in the prior study (Walsh & Ward, 2019) and the data associated with this manuscript (Ward & Walsh, 2021). We underscore that the analysis presented here is not intended to provide specific decisions for any individual waterbody and does not represent any agency determination or decision. Instead, the analysis is undertaken with the objective of assessing uncertainty and changing geographic scope of CWA jurisdiction through time. Additionally, this basin is for illustrative purposes. While the regulations and their applications are national in scale, results here present a tangible demonstration of their application in a particular basin. We note these results should be considered particular to the Wabash River Basin and are not generalizable to all basins.

In this study, we add a more granular temporal dimension to an existing case study that has been used to document the impact of regulatory decisions on CWA enforcement (Walsh & Ward, 2019). While the underlying data sets and GIS analyses presented here are identical to those previously published, this study adds a historical dimension, providing a more granular resolution of how changes to language in legislation, rules, guidance, and decisions are related to decisions of jurisdictional scope of the Clean Water Act. Decision rules used to translate legal documents into decisions for this analysis are detailed in Supplemental Table 1. Three broad approaches were used in this interpretation. First, in cases where quantifiable definitions were explicit in regulations, these were implemented directly. For example, the 2015 Clean Water Rule defined quantitative buffer areas around regulated streams. Other rules, such as those promulgated by the USACE in 1975 (USDOD, 1975), regulated water bodies that could easily be identified using attribute data, like impoundments. We also used the 100-yr floodplain defined by the National Flood Hazard Layer for cases where regulatory decisions were conditioned on this floodplain extent. Second, in cases where vague language could not be easily quantified, proxies were used. For example, several iterations of the WOTUS definition regulate buffers around “navigable waters” that are, have been, or could be used for interstate or foreign commerce. Section 10 of the Rivers and Harbors Act also regulates those waters (USDOD, 2011a), so agency lists of Section 10 waters were used as a conservative lower limit if no further agency guidance was provided. While perennial or intermittent streams should be regulated under the 2020 rule, we used the same high and low estimations for where an ordinary high water mark might be observed to ensure a conservative estimate of the change, and as a result, data reflected here may overestimate actual protections (Walsh & Ward, 2019). Importantly, the area-threshold approach has been previously used to identify intermittent and ephemeral streams (Fritz et al., 2008; Villines et al., 2015; Walsh & Ward, 2019), but is a surrogate for the more complex, in-the-field determinations required for agency decisions. Finally, some cases require interpretation of proximity or adjacency. For wetlands, the regulatory term “Adjacent” was assumed to only apply to those wetlands and lakes actually intersecting regulated waters unless otherwise specified in the regulation, with no formal consideration of surface connectivity for non-adjacent wetlands (as in the NWPR framework). When adjacency was defined as “bordering, continuous, or neighboring” in 1986 (USDOD, 1986), we implemented a buffer around regulatory streams and rivers. Although different buffers have been used across different agency districts, we used the 500-ft buffer suggested by a U.S. Government Accountability Office review of agency practices (USGAO, 2004) to define waters that were possibly jurisdictional.

3.2 Temporal evolution of jurisdictional scope

The changing definitions for WOTUS since 1948 have overall expanded protections for rivers, lakes, and wetlands in the Wabash River Basin (Fig. 2-4; Supplemental Table 1), but uncertainty remains and some recent legislation (e.g., NWPR) would contract protections. From 1948 to 1972 waters were only conditionally or not regulated since pollution had to be linked to a negative human health impact and even then, only across interstate waters. Jurisdiction and uncertainty both increased immediately following passage of the 1972 CWA. Almost all waters could be protected under the act if certain conditions were met because the broad definition of WOTUS placed no clear limit on jurisdiction, necessarily encompassing all different agency interpretations past that point.

Uncertainty in interpretation is pronounced after 1986 due to the qualitative “ordinary high water mark” determination used to identify the upward limit of jurisdiction in the headwaters. Over 89% of global stream miles are headwaters (Allen et al., 2018; Downing et al., 2012), with the USEPA reporting 53% of US stream-miles as headwaters and 60% of US stream miles as intermittently flowing (USEPA,

n.d.). Some of these may have been identified as WOTUS depending upon field interpretations. Even though most stream miles are headwater streams, these waterways are the ones where regulatory uncertainty is highest and where existing mapping efforts are known to fall short (Brooks & Colburn, 2011; Lang et al., 2012). Thus, we find high uncertainty since we do not know precisely where agency staff might place the upward limit of the ordinary high water mark in the headwaters. Lake and wetland jurisdiction are heavily influenced by how far into the headwaters WOTUS extend, so uncertainty in stream jurisdiction is propagated forward into lake and wetland jurisdiction (Walsh & Ward, 2019).

Compared to large fluctuations between 1948 to 1986, the miles and acres of WOTUS in the Wabash River Basin remain relatively constant from 1986 to present day (Fig. 2-4). Neither the 2015 Clean Water Rule nor the 2020 NWPR impacted the miles of regulated streams for the purposes of this analysis. Both rules also successfully reduced regulatory uncertainty over which lakes and wetlands are considered WOTUS through different strategies. The 2015 Clean Water Rule expanded protections and slightly increased the acres of non-jurisdictional wetlands, thereby reducing the total acreage in possibly and conditionally jurisdictional lakes and wetlands. The 2020 NWPR contracted protections to only those lakes and wetlands with a continuous surface connection to streams or rivers in a typical year, in contrast to the Clean Water Rule, which assigned a buffer based on the best available science (US EPA, 2015). Consequently, the NWPR increased the acres of non-jurisdictional lakes and wetlands (Fig. 3-4), eliminating all conditionally jurisdictional waters which would be subject to a significant nexus test under previous rules.

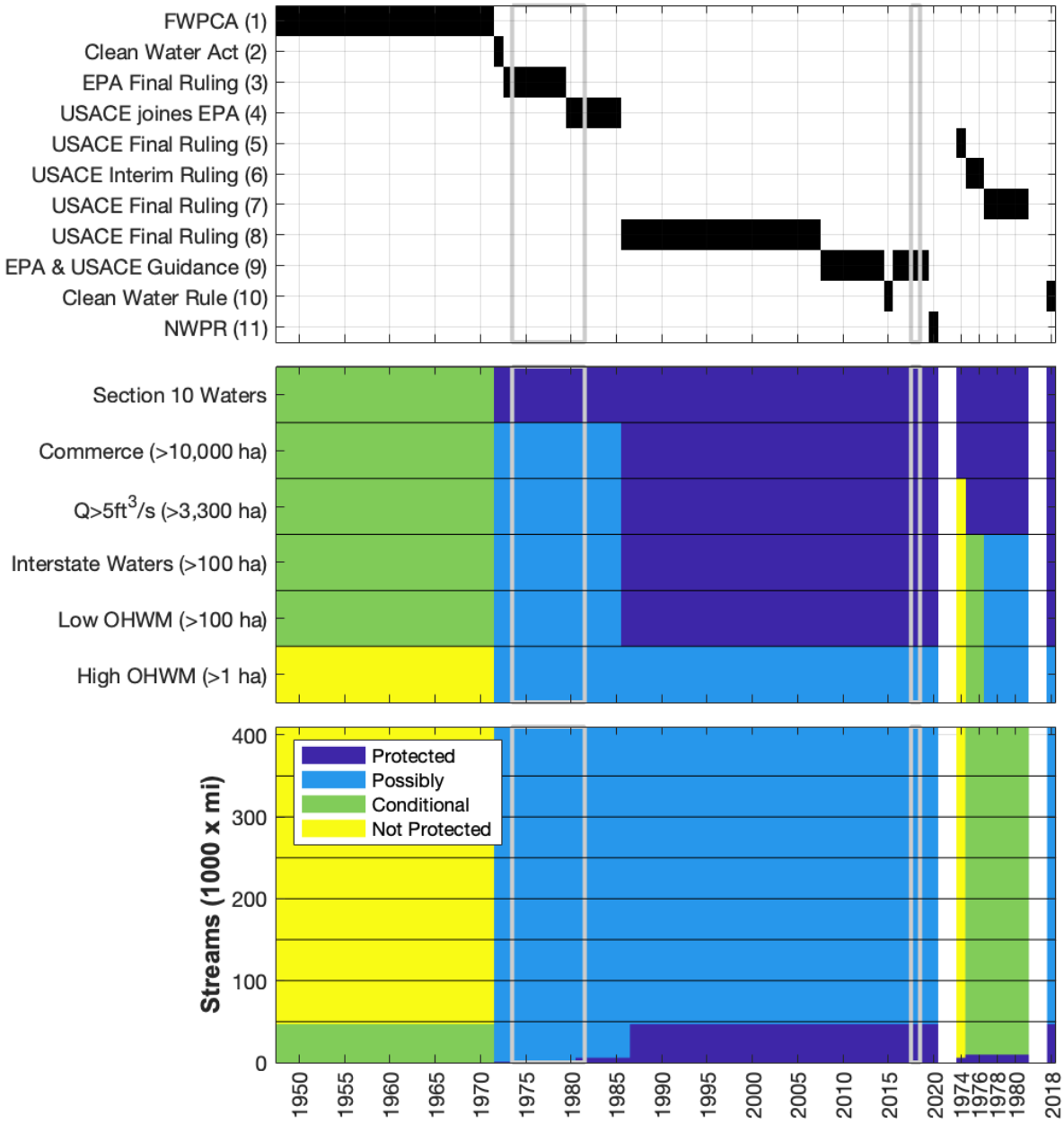


Fig. 2. Timeseries of actively enforced regulations and/or guidance (top), definitions used to designate jurisdictional status for streams (middle), and 1000s of miles of jurisdictional streams within the Wabash River Basin. Colors panels denote the jurisdictional status as a function of applicable definitions (middle) and the spatial extent of waters in each category (bottom). The separated sets bars on the right (1974-1980 and 2018) represent time periods where multiple rules or sets of guidance were being enforced; the grey boxes denote these same time periods in the main timeline. Rows in the top panel correspond to the prevailing rules being enforced through time as documented in:

(1) Federal Water Pollution Control Act (1948) & Amendments (1961, 1965)
(2) Clean Water Act (1972)
(3) USEPA Regulation (38 Fed. Reg. 13,528-13,540; 1973)
(4) USEPA Final regulation (45 Fed. Reg. 33,290-33,513, 1980), joined by USACE in 1982
(5) USACE Regulation (33 CFR §209, 1974)
(6) USACE Interim regulation post-Callaway (40 Fed. Reg. 31,320-31,343, 1975)
(7) USACE Final regulation (42 Fed. Reg. 37,122-37,164, 1977)
(8) USACE Final regulation (51 Fed. Reg. 41,206-41,260, 1986)

(9) USEPA and USACE Joint Guidance Memo post-Rapanos (2008)
(10) Clean Water Rule (80 Fed. Reg. 37,054-37,127, 2015)
(11) Navigable Waters Protection Rule (85 Fed. Reg. 22,250-22,342, 2020)

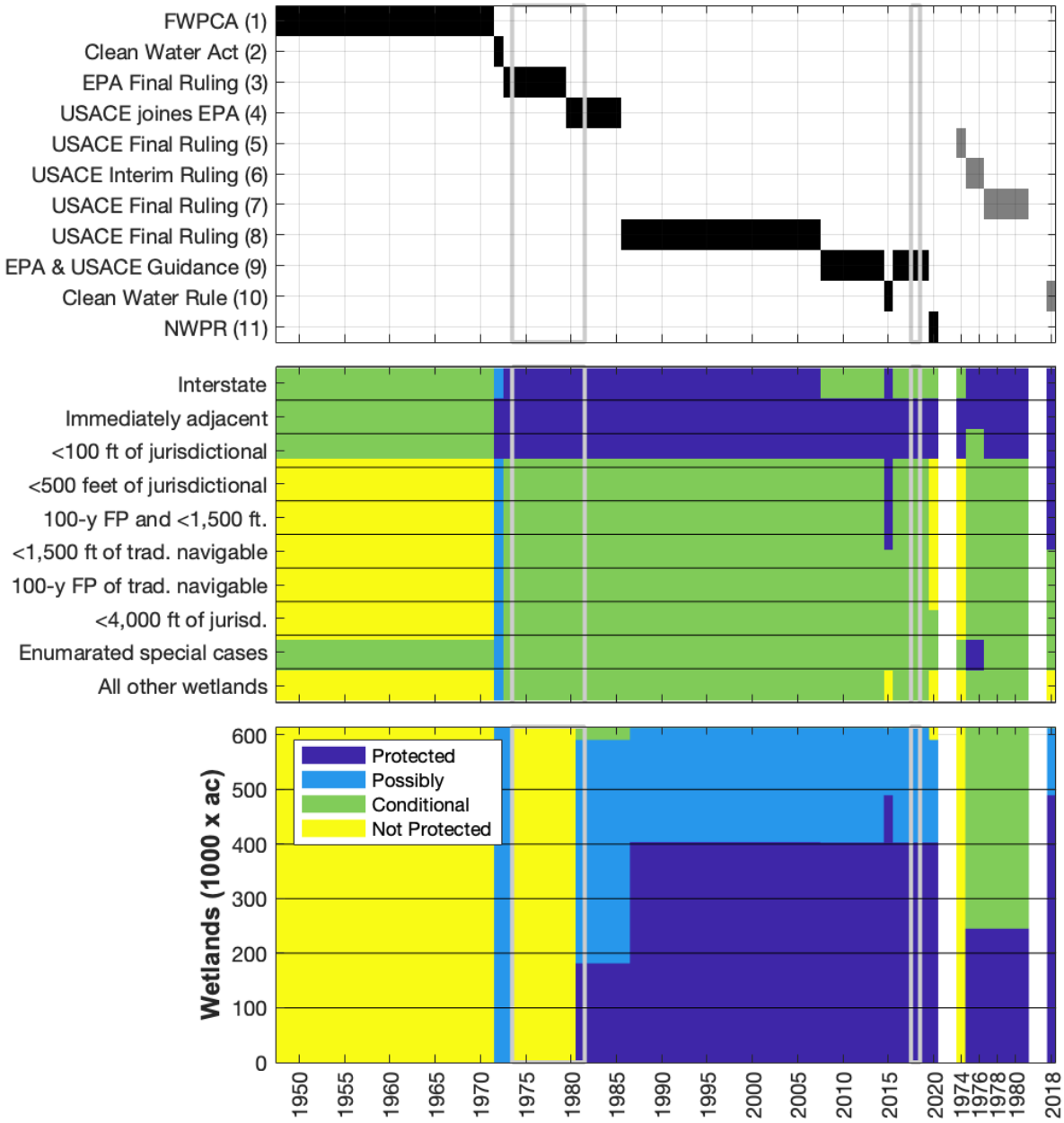


Fig. 3. Timeseries of actively enforced regulations and/or guidance (top), definitions used to designate jurisdictional status for wetlands (middle), and 1000s of acres of jurisdictional wetlands within the Wabash River Basin. Colors panels denote the jurisdictional status as a function of applicable definitions (middle) and the spatial extent of waters in each category (bottom). The separated sets bars on the right (1974-1980 and 2018) represent time periods where multiple rules or sets of guidance were being enforced; the grey boxes denote these same time periods in the main timeline. Rows in the top panel correspond to the prevailing rules being enforced through time, see Fig. 2 caption.

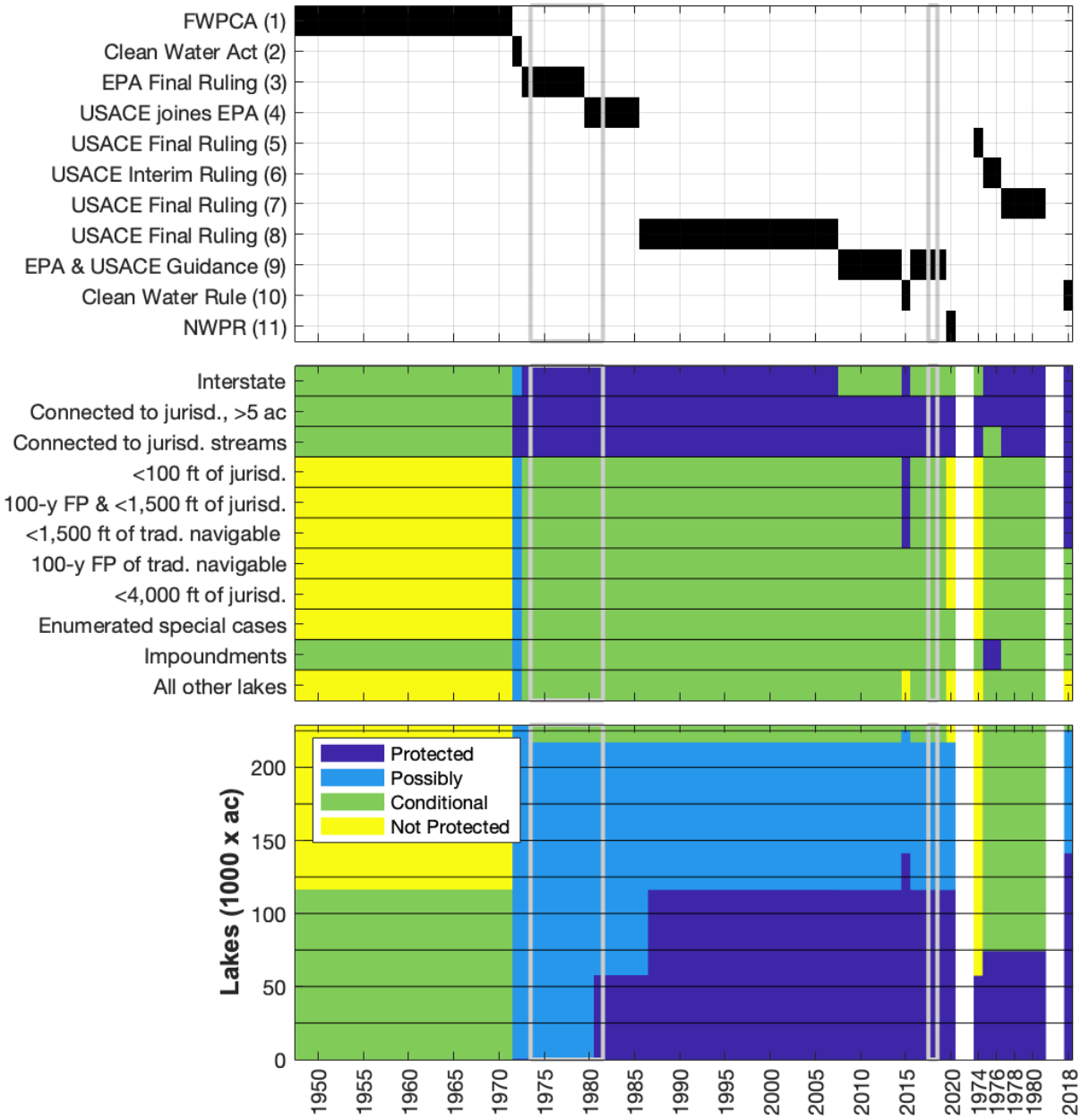


Fig. 4. Timeseries of actively enforced regulations and/or guidance (top), definitions used to designate jurisdictional status for lakes (middle), and 1000s of acres of jurisdictional lakes within the Wabash River Basin. Colors panels denote the jurisdictional status as a function of applicable definitions (middle) and the spatial extent of waters in each category (bottom). The separated sets bars on the right (1974-1980 and 2018) represent time periods where multiple rules or sets of guidance were being enforced; the grey boxes denote these same time periods in the main timeline. Rows in the top panel correspond to the prevailing rules being enforced through time, see Fig. 2 caption.

3.3 Uncertainty due to competing regulatory programs

From 1973 to 1982 the USEPA and USACE independently asserted competing jurisdictional definitions, contributing to the uncertainty already present in their definitions. Up until 1980, the USEPA definition resulted in nearly all streams and lakes falling into the possibly or conditionally jurisdictional categories, since their broad regulatory language could potentially capture all waters. In contrast, the USACE developed a more quantitative definition following *Natural Resources Defense Council v. Callaway* (*Natural Resources Defense Council, Inc. v. Callaway*, 1975). This definition included quantitative limits such as protections for all waters with discharge of 5 ft^3/s, and adjacent lakes greater than five acres (USDOD, 1975). The specificity of the USACE definition resulted in greater definitively and fewer possibly jurisdictional streams and lakes during this time.

While the USEPA did not consider wetlands jurisdictional until 1980, the USACE began regulating wetlands "contiguous" to WOTUS in 1975. All other wetlands could be conditionally regulated if decided by the District Engineer, resulting in a large conditionally jurisdictional category. The 1977 USACE definition resulted in the movement of most of these wetlands from the conditionally to the possibly jurisdictional category, and this definition was closely matched by the USEPA in 1980.

In 2018, definitions diverged once again when the Clean Water Rule was restored across 26 states. This change did not impact the miles of regulated streams since ordinary high water mark was used to make jurisdictional determinations under both rules in this study. This analysis shows, however that in states where the Clean Water Rule was enforced, more lakes and wetlands were definitively jurisdictional and more wetlands were not jurisdictional (Figs. 3-4).

4. SYNTHESIS & CONCLUSIONS

4.1 Uncertainty in jurisdiction has not been eliminated in 70+ years of regulation

While the geographic scope of WOTUS has expanded since 1948, uncertainty in exactly which waters are jurisdictional has remained high. Most streams, about half of lakes, and about one third of wetlands in the Wabash River Basin have consistently fallen into the possibly or conditionally jurisdictional categories since 1986 (Fig. 2-4). Supreme Court cases and agency rules aimed at clarifying one part of the WOTUS definition often shifted uncertainty and debate to another part, answering some regulatory questions while raising others. For example, while the significant nexus test was newly introduced in response to the *Rapanos v. United States* (*Rapanos v. United States*, 2006) decision and subsequent agency guidance (USEPA & USDOD, 2008a), it does not influence the acres of conditionally jurisdictional wetlands at that point in time. The guidance removed conditional protections over all waters, "the use, degradation or destruction of which could affect interstate or foreign commerce," (USDOD, 1986) but replaced that with conditional protections over waters with a "significant nexus" to WOTUS. The result was that, for the purposes of this analysis, the same area of water received conditional protections under either of these rules. The specific test to be applied in determining jurisdiction was the significant change, not the jurisdictional scope nor certainty.

Some shifts in uncertainty cannot be quantified using our approach. In the most recent attempt to reduce uncertainty, the 2020 NWPR shifts some uncertainty from wetlands to streams (Ward & Walsh, 2020), though clear tests for a continuous surface connection and definitions of 'typical year' were lacking. The rule scaled back regulated wetlands to those immediately adjacent to WOTUS, sharing a continuous surface water connection. Streams, however, receive more complicated treatment. It is difficult to determine a quantitative range for waters that flow perennially or intermittently, as outlined in this rule. This analysis shows that most uncertainty arises from the definition of which streams are regulated, and that uncertainty in the stream network transfers to uncertainty over which lakes and wetlands are regulated. The NWPR may increase this range farther, since intermittent flow is left unquantified. Furthermore, the NWPR describes that these flow designations should be made in context of a "rolling 30-year window" (USDOD & USEPA, 2020). This prospect further increases uncertainty, since climate change is currently altering stream networks and flow patterns across the country (Walsh & Ward, 2019; Ward & Walsh, 2020).

4.2 Historic changes to WOTUS provide context for modern rulemaking

Modern changes to CWA jurisdiction, such as the NWPR and Clean Water Rule, have had relatively small impacts on jurisdictional scope and certainty in the Wabash River Basin compared to evolution since the inception of the 1948 Federal Water Pollution Control Act. For example, wetlands have only been explicitly excluded from WOTUS twice since 1986. Under the 2015 Clean Water Rule, 2,410 acres in our study basin were determined to be not jurisdictional. However, 86,460 acres were also added to the definitively jurisdictional category, shrinking uncertainty from both directions and potentially increasingly efficient enforcement of regulations. While the 2020 NWPR also reduces uncertainty, it achieves this by removing at least 24,180 acres of wetland from federal protection, making it the largest exclusion since it was determined that wetlands could be WOTUS. Understanding this history provides context for modern changes and the associated political and legal divisiveness that accompany major environmental legislation.

4.3 The agencies' role is to produce clear regulatory language and reduce uncertainty

The vague definition of WOTUS in the 1972 CWA gave autonomy to the agencies to clarify which waters should be regulated. It is the agencies' role to reduce uncertainty in the administration of the act by implementing the law as informed by specialized topical knowledge (Bach et al., 2012). Reduced uncertainty can simplify jurisdictional determinations, saving agency time and money. Field visits can be shorter, less clarifying communication with the permittee may be required, and there is a lower likelihood that the agency will have to defend a decision in the courts if precedent is firmly established. In our analysis, the 2015 Clean Water Rule was the most successful attempt to reduce regulatory uncertainty in the modern era, but was not implemented for long enough to realize these efficiencies. It is important to note that such regulations should still be buttressed by the best available science at the time of their writing and implementation. Put plainly, regulatory efficiency cannot be achieved at the cost of ignoring science in the rulemaking process or reducing protections for critical resources.

Maintaining some uncertainty can also be beneficial, as it leaves more power to district staff and state agencies to adapt the law to their jurisdictions. Federal environmental laws provide blanket protection across a geographically and climatologically diverse country. Much like the agencies are assumed to have more detailed environmental knowledge than the legislature, state and local agencies might have better localized knowledge over the areas they regulate. Uncertainty left in the federal WOTUS definition allows states the freedom to adopt rules that best suit their environmental and political needs, though it is not a given that states will proactively fill any gaps created at the federal level (Keiser et al., 2021; USEPA & USDOD, 2020a). Sometimes patchwork regulations are difficult for corporations and the federal government to follow, however, and there have been attempts to unify the state implementation strategies (USGAO, 2004).

Ultimately, vague language may be an intentional mechanism to grant authority to the states in some cases, but in others it may be an expensive way to try for a different court ruling. If the agencies continue to diverge from established court decisions and fail to develop clear, quantifiable rules, then we expect to continue seeing WOTUS litigation in the courts (e.g., *Conservation Law Foundation, et al. v. Andrew Wheeler, et al.*, 2020; *South Carolina Coastal Conservation League, et al. v. Andrew Wheeler, et al.*, n.d.; *State of California, et al. v. Andrew Wheeler, et al.*, n.d.).

4.4 Regionalization and transferability of results

Our analysis of the Wabash River Basin provides new insight into historical changes in Midwest WOTUS, but may not accurately represent changes across the country. Many region-specific features would have impacted the analysis if it were performed in a different basin, but the general approach of defining qualitative and quantitative limits and mapping jurisdictional scope can be replicated. For example, stream flow frequency and magnitude vary across the country, with flow patterns in mountainous and arid regions differing drastically from those found in the Midwest, especially for intermittently and ephemerally flowing waters and their distribution on the landscape (Hammond et al., 2021; Zipper et al., 2021). In response, the agencies allow for region-specific guides for identifying ordinary high water marks. Under the NWPR, new challenges will arise, since perennial flows are less

common in arid regions, which may cause loss of protections for streams, lakes, and wetlands (USEPA Science Advisory Board, 2020)

Other regions bear unique features that may have influenced the analysis if included. For example, the Clean Water Rule included conditional protections for Carolina and Delmarva bays, coastal prairie wetlands, prairie potholes, pocosins, and western vernal pools (USDOD & USEPA, 2015). In regions with these features, the Clean Water Rule may have increased protections more than in our study basin where such features are not present. As a result, there may have been more conditionally or not jurisdictional waters seen during other time periods.

4.5 On the role of geospatial analysis to evaluate policy implications

This study is, to our knowledge, the first to consider the geographical scope of evolving laws, regulations, and court decisions in assessment of protections for streams, lakes, and wetlands in the U.S. (though at least one other has considered the rule change for stream length (Fesenmyer et al., 2021)). While agencies have repeatedly declined to quantify the effect of modern rulemaking, citing uncertainty and data limitations (*Letter from Nancy Stoner, Acting Assistant Adm'r, EPA Office of Water, to Lamar Smith, Chairman, Comm. on Science, Space, and Tech., U.S. House of Representatives (July 28, 2014)*, 2014; USEPA, 2014; USEPA & USDOD, 2020c), we demonstrate here that quantitative estimates are plausible and informative. However, we underscore that these mapping exercises provide only a preliminary assessment and actual permit decisions will require field studies in many cases. Moreover, we extend these analyses from modern estimates (Walsh & Ward, 2019) to provide context in terms of the temporal evolution of jurisdiction and the source(s) of uncertainty. In reviewing the evolving regulatory landscape, it is clear that the series of laws, decisions, and rules reflect a persistent need for specificity in language and objective bases for enforcement. Notably, the regulatory landscape around the CWA continues to evolve with new rulemaking efforts (e.g., Biden, 2021; USDOD, & USEPA. 2021) and legal cases (e.g., Sackett v. USEPA, 2022) at the time of publication. Finally, while our focus has been the U.S. Clean Water Act, the approach of translating polices to the on-the-ground implications is one that would be readily transferred to assess existing or proposed changes (e.g., for the European Water Framework).

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Conflict of Interest

The authors have declared no conflicts of interest for this article.

Author Contributions

Walsh completed the initial literature review, data analysis, and drafted the first version of the manuscript. Ward conceptualized the project, secured funding for the research, and collaborated on data analysis. The authors contributed equally in writing the final version of the manuscript.

Data Availability

The spatial data sets generated from *Walsh and Ward's* original analysis (Walsh & Ward, 2019), a tabular summary of the information presented in Figs. 2-4, and a summary of methods are available online in CUAHSI's HydroShare (Ward & Walsh, 2021). ***Note to reviewers: After this article is assigned a DOI, the metadata for the data set will be updated and the data link will become https://doi.org/10.4211/hs.11f5d423318e47858bac5639af5be9de***

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Methods Supplement for

An overview of the evolving jurisdictional scope of the U.S. Clean Water Act for hydrologists

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The methods for this study closely follow those presented by Walsh and Ward (2019), which are presented in detail in the supplement to that study. Briefly, we outline the methods here but refer readers to additional detail in Walsh and Ward (2019). Note that all analyses were conducted for the Wabash River Basin.

1. Data acquisition (following exactly Walsh and Ward, 2019)

Data for analysis were sourced from:

- the National Elevation Dataset (NED) for topography
- the National Hydrography Dataset (NHD) for lake and wetland boundaries
- the National Wetlands Inventory (NWI) for additional wetland boundaries
- the FEMA National Flood Hazard Layer (NFHL) the 100-yr floodplain
- the National Watershed Boundary Dataset (NWBD) for the boundary of the Wabash River basin

To ensure that wetlands data were not redundant with NHD data, NHD lakes classified as "SwampMarsh" were removed Wetlands classified as "Riverine" or "Lake" in the NWI were removed because NWI riverine wetlands were captured in the NHD. Wetlands classified as "Lake" in the NWI were removed, with lakes interpreted from the NHD. Overlap between wetland and lake data that persisted after these decisions were removed, with wetland-lake overlap assigned to 'lake' (i.e., priority given to NHD definition).

2. Definition of Stream Networks (following exactly Walsh and Ward, 2019)

Stream network definition was based on analysis of topographic data using a drainage area accumulation algorithm in GIS, Villines et al. [2014]. Are thresholds of 1 ha, 100 ha, and 10,000 ha were used to define the stream network associated with the most generous interpretation of stream network extent, a conservative estimate of perennial stream extent, and the extent of traditionally navigable waters (after Walsh and Ward, 2019). For locations where stream lines overlapped with lakes, that stream distance was removed to avoid 'double counting' of waters as both a lake and stream.

3. Classification of water bodies and their Clean Water Act protections

In summary, the Wabash River Basin was found to contain 229,202 acres of lakes, up to 410,082 miles of streams (drainage area greater than 1 ha), and 614,981 acres of wetlands. These totals are used as a basis to subdivide which waters receive which protections in subsequent analyses.

Ward and Walsh (2019) detailed their decisions for three key regulatory periods: (1) The 1986 rules developed after the Bayview Homes case, (2) the 2015 Clean Water Rule, and (3) The Navigable Waters Protection Rule, which was proposed and not finalized at the time of their publication. Here, we extend their analysis to consider a longer time period and a more granular accounting of changes as evolving executive, legislative, and judicial branch actions clarified the jurisdictional scope of the Clean Water Act.

Critically, we do not deviate in this analysis from the data set nor decisions in Walsh and Ward (2019). This is a more granular-in-time presentation of the data, but we have been faithful to their definitions soas not to introduce new bias or uncertainty in our analyses. All waters were classified into one of four categories:

1. **Definitively Protected** ("protected"). Waters that are explicitly protected by the language of legislation, rules, guidance, or decisions, representing a conservative lower bound in protections. For example, traditionally navigable rivers are considered 'protected' after 1972 as they have been explicitly included in unchanged legislative language.
2. **Possibly Protected.** Waters that are expected to be protected, but for which explicit definitions could not be identified. For example, non-navigable tributaries to traditionally navigable waters have been classified at 'possibly protected' since 1986. While these waters were broadly accepted as protected, there is not definitive language to clarify their protections. These represent waters that would likely be considered jurisdictional.
3. **Conditionally Protected.** Waters that are only protected if they meet a field-based determination or satisfy a specific requirement are classified in this study as conditionally protected. This represents a maximum plausible extent of regulatory language. For example, waters that require a significant nexus test (post-Rapanos decision) would be conditionally protected, as their protections are subject to the interpretation of this text.
4. **Not protected.** Waters that are explicitly not protected by rule are classified as not protected. For example, under the Clean Water Rule a class of waters was defined that did not require a significant nexus test and were not considered WOTUS, exempting them from protections.

Table 1 presents a summary of key jurisdictional time periods, definitions associated with each time period (e.g., updates or changes in the legislation, guidance, rules, or decisions), and our interpretation as to which waters are protected. All quantitative assessments of the location, size, floodplain status, and buffer that are used for our decisions were presented in Walsh and Ward (2019). Table 1, then, presents the mapping of those quantitative metrics to the language used to define the jurisdictional scope of the Clean Water Act.

Table 1: Summary of regulatory time periods, the relevant definitions or guidance, and the basis for determination of an individual waterbody as Protected, Conditionally Protected, Possibly Protected, or Not Protected in the Wabash River Basin. Note that all definitions from 1986 onward are identical to the previously published work of *Walsh and Ward* (2019)

Time Period	Streams	Lakes	Wetlands
1948-1961 Federal Water Pollution Control Act	"Interstate waters" (defined as "all rivers, lakes, and other waters that flow across, or form part of, State boundaries") and "their tributaries" when pollution crossed a state boundary and could be proven to endanger human health.	"interstate waters" and "their tributaries" if discharge could be proven to endanger human health	n/a
	Protected: none Conditionally Protected: none Possibly Protected: all perennial waters (drainage area >100 ha, Walsh and Ward) that drain to a boundary between states Not Protected: all other streams	Protected: none Conditionally Protected: none Possibly Protected: all lakes intersecting a state border, and all lakes intersecting "possibly protected" streams Not Protected: all other lakes	Protected: none Conditionally Protected: none Possibly Protected: none Not Protected: all wetlands (wetlands are not yet part of the discussion of waters)
1961-1965 Federal Water Pollution Control Act Amendments	"The pollution of interstate or navigable waters in or adjacent to any State or States (whether the matter causing or contributing to such pollution is discharged directly into such waters or reaches such waters after discharge into a tributary of such waters), which endangers the health or welfare of any persons, shall be subject to abatement as provided in this Act."	interstate or navigable waters and their tributaries when discharge could be proven to endanger human health	n/a
	Protected: none Conditionally Protected: none Possibly Protected: all perennial waters (Drainage Area greater than 100 ha, after Walsh and Ward)	Protected: none Conditionally Protected: none Possibly Protected: all lakes intersecting a state border and all	Protected: none Conditionally Protected: none Possibly Protected: none

	Not Protected: all other streams	lakes intersecting "possibly" streams Not Protected: all other lakes	Not Protected: all wetlands (wetlands are not yet part of the discussion of waters)
1965-1972 Water Quality Act	Same language as 1961 plus: "The discharge of matter into such interstate waters or portions thereof, which reduces the quality of such waters below the water quality standards established under this subsection (whether the matter causing or contributing to such reduction is discharged directly into such waters or reaches such waters after discharge into tributaries of such waters), is subject to abatement." (Water quality standards only for interstate waters, not navigable intrastate waters where pollution still had to endanger the health or welfare of persons within the state)	interstate or navigable waters and their tributaries	n/a
	Protected: same as prior period Conditionally Protected: same as prior period Possibly Protected: same as prior period Not Protected: same as prior period	Protected: same as prior period Conditionally Protected: same as prior period Possibly Protected: same as prior period Not Protected: same as prior period	Protected: same as prior period Conditionally Protected: same as prior period Possibly Protected: same as prior period Not Protected: same as prior period
1972 Clean Water Act	"Navigable waters" regulated, defined as WOTUS	"Navigable waters" regulated, defined as WOTUS	n/a
	Protected: Section 10 waters (traditionally navigable, taken as drainage area greater than 37.9 mi^2), after Walsh and Ward)	Protected: all lakes intersecting "protected" streams Conditionally Protected: all other lakes Possibly Protected: none	Protected: none Conditionally Protected: all wetlands (the potential must exist, since wetlands are

	Conditionally Protected: all other streams Possibly Protected: none Not Protected: none	Not Protected: none	jurisdictional based on this language later in time) Possibly Protected: none Not Protected: none
1973-1980 *EPA* rules	(1) All navigable WOTUS (they do not define navigability or say that it is connected to commerce); (2) Tributaries of navigable waters of the United States; (3) Interstate waters; (4) Intrastate lakes, rivers, and streams which are utilized by interstate travelers for recreational or other purposes; (5) Intrastate lakes, rivers, and streams from which fish or shellfish are taken and sold in interstate commerce; (6) Intrastate lakes, rivers, and streams which are utilized for industrial purposes by industries in interstate commerce	"Navigable waters" regulated, defined as WOTUS	n/a
	Protected: Section 10 waters (same as prior) Conditionally Protected: all other waters Possibly Protected: none (because uncertainty in tributary definition makes all other waters fit into the "maybe" category) Not Protected: none	Protected: all lakes intersecting a state border, and all lakes intersecting "protected" streams Conditionally Protected: all lakes intersecting a state border, and all lakes intersecting "maybe" streams Possibly Protected: all other lakes Not Protected: none	Protected: none Conditionally Protected: none (no mention of wetlands anywhere in rule, and no room for their inclusion in language) Possibly Protected: none Not Protected: all wetlands
1974-1975 *Corps* rules	WOTUS which are subject to the ebb and flow of the tide, and/or are presently, or have been in the past, or may be in the future susceptible for use for purposes of interstate or foreign commerce (rules further specify that these were only traditionally navigable		Wetlands inside the OHWM of lakes are considered jurisdictional, but would be captured in 'lakes' used in this study

	waters, and specifically uses logs as an example) (term "OHWM" appears for the first time, but only determines where jurisdiction stops across stream width, not distance into headwaters)		
	Protected: Section 10 and traditionally navigable waters Conditionally Protected: none Possibly Protected: none Not Protected: all other waters	Protected: all lakes intersecting "protected" streams Conditionally Protected: none Possibly Protected: none Not Protected: all other lakes	Protected: none Conditionally Protected: none Possibly Protected: none Not Protected: all wetlands
1975-1977 *Corps* interim rules post-Callaway	"(c) Rivers, lakes, streams, and artificial water bodies that are navigable waters of the United States up to their headwaters and landward to their ordinary high water mark; *(d)* All artificially created channels and canals used for recreational or other navigational purposes that are connected to other navigable waters, landward to their ordinary high water mark; *(e)* All tributaries of navigable waters of the United States up to their headwaters and landward to their ordinary high water mark; *(f)* Interstate waters landward to their ordinary high water mark (width, not upstream distance) and up to their headwaters; *(g)* Intrastate lakes, rivers and streams landward to their ordinary high water mark and up to their headwaters -that are utilized: *(1)* By interstate travelers for water related recreational purposes; *(2)* For the removal of fish that are sold in interstate commerce; *(3)* For	*"'Lakes'* means natural bodies of water greater than five acres in surface area and all bodies of standing water created by the impounding of navigable waters identified in paragraphs (a) -(h),"	Freshwater wetlands Including marshes, shallows, swamps and, similar areas that are contiguous or adjacent to other navigable waters and that support freshwater vegetation "Freshwater wetlands" means those areas that are periodically inundated and that are normally characterized by the prevalence of vegetation that requires saturated soil and (i) Those other waters which the District Engineer determines necessitate regulation for the protection of water quality as expressed in the guidelines (40 CFR 230). For example, in the case of intermittent rivers, streams, tributaries, and perched wetlands that are not contiguous or adjacent to navigable waters identified in paragraphs (a)-(h), a

	industrial purposes by industries in interstate commerce; or (4) In the production of agricultural commodities sold or transported in Interstate commerce; *(h)* Freshwater wetlands Including marshes, shallows, swamps and, similar areas that are contiguous or adjacent to other navigable waters and that support freshwater vegetation "Freshwater wetlands" means those areas that are periodically inundated and that are normally characterized by the prevalence of vegetation that requires saturated soil and (i) Those other waters which the District Engineer determines necessitate regulation for the protection of water quality as expressed in the guidelines (40 CFR 230). For example, in the case of intermittent rivers, streams, tributaries, and perched wetlands that are not contiguous or adjacent to navigable waters identified in paragraphs (a)-(h), a decision on jurisdiction shall be made by the District Engineer." 'Headwaters' was defined as 'the point on the stream above which the flow is normally less than 5 cubic feet per second.'" (based on average annual or median discharge)		decision on jurisdiction shall be made by the District Engineer."
	Protected: all waters with average or median discharge >5 ft^3/sec Conditionally Protected: none	Protected: all lakes intersecting a state border, and all lakes intersecting "protected" streams	Protected: all wetlands intersecting a state border, and

	Possibly Protected: all other waters Not Protected: none	that are greater than 5 acres, and all impoundments (all features with "reservoir" NHD code) Conditionally Protected: none Possibly Protected: all other lakes Not Protected: none	all wetlands intersecting "protected" streams and lakes Conditionally Protected: none Possibly Protected: all other wetlands Not Protected: none
1977 *Corps* rules	"(a) The term "waters of the United States" means: (1) The territorial seas with respect to the discharge of fill material. (2) Coastal and inland waters, lakes, rivers, and streams that are navigable waters of the United States, including adjacent wetlands; (3) Tributaries to navigable waters of the United States, including adjacent wetlands (manmade nontidal drainage and irrigation ditches excavated on dry land are not considered waters of the United States under this definition). (4) Interstate waters and their tributaries, including adjacent wetlands; and (5) All other waters of the United States not identified in paragraphs (1)-(4) above, such as isolated wetlands and lakes, intermittent streams, prairie potholes, and other waters that-are not part of a tributary system-to interstate waters or to navigable waters of the United States, the degradation or destruction of which could affect interstate commerce.'"	…and all other waters, "the degradation or destruction of which could affect interstate commerce"	Wetlands adjacent to interstate and navigable waters and their tributaries ("The term 'adjacent' means bordering, contiguous, or neighboring.") All other waters, "the degradation or destruction of which could affect interstate commerce"
	Protected: Section 10 and traditionally navigable waters Conditionally Protected: all other waters	Protected: all lakes intersecting a state border, and all lakes intersecting "protected" streams	Protected: all wetlands intersecting a state border, and all wetlands immediately

	Possibly Protected: none Not Protected: none	Conditionally Protected: all lakes intersecting a state border, and all lakes intersecting "conditionally protected" streams Possibly Protected: all other lakes Not Protected: none	intersecting all "protected" streams and lakes Conditionally Protected: all wetlands intersecting a state border, and all wetlands within a 500 foot buffer of "conditionally protected" streams and lakes Possibly Protected: all other wetlands Not Protected: none
1980 EPA rules. Joined by Army Corps in 1982	WOTUS: "(a) All waters which are currently used, were used in the past, or maybe susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; (b) All interstate waters, including interstate "wetlands;" - (c) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters: (1) Which are or could be used by interstate or foreign travelers for recreational or other purposes; (2) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (3) Which are used or could be used for industrial purposes by industries in interstate commerce; - (d) All	"All interstate waters" and "All impoundments of waters otherwise defined as waters of the United States under this definition"	"All interstate waters, including interstate 'wetlands'" and all "'Wetlands' adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a)- (f) of this definition" *(Adjacency not defined in this rule, so assume it means what we typically think of as "adjacent")

	impoundments of waters otherwise defined as waters of the United States under this definition; (e) Tributaries of Waters identified in paragraphs (1)-(4) of this definition; (f) The territorial sea; and (g) "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a)-(f) of this definition"		
	Protected: Protected: Section 10 and traditionally navigable waters Conditionally Protected: all other waters Possibly Protected: none Not Protected: none	Protected: all lakes intersecting a state border, and all lakes intersecting "protected" streams Conditionally Protected: all lakes intersecting a state border, and all lakes intersecting "conditionally protected" streams Possibly Protected: all other lakes Not Protected: none	Protected: all wetlands intersecting a state border, and all wetlands intersecting "protected" streams and lakes Conditionally Protected: all wetlands intersecting a state border, and all wetlands intersecting "conditionally protected" streams and lakes Possibly Protected: all other wetlands Not Protected: none
1985 US v. Riverside Bayview Homes	No change	No change	Confirmed that adjacent wetlands considered WOTUS (does not influence definition of adjacency)
	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior
1986 Army Corps rules	(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters	Migratory bird rule (from EPA memo, which clarified migratory birds represent interstate commerce).	Migratory bird rule

	which are subject to the ebb and flow of the tide; (2) All interstate waters including interstate wetlands; (3) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters: (i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or (ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (iii) Which are used or could be used for industrial purpose by industries in interstate commerce; (4) All impoundments of waters otherwise defined as waters of the United States under the definition; (5) Tributaries of waters identified in paragraphs (a) (1)-(4) of this section; (6) The territorial seas; (7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) (1)-(6) of this section. (tributaries = OHWM)		("adjacent" defined as "bordering, continuous, or neighboring")
	Protected: lowest estimate of OHWM (100 ha, after Walsh and Ward)	Protected: all lakes intersecting a state boundary, and all lakes intersecting "protected" streams	Protected: all wetlands intersecting a state boundary, and all wetlands intersecting "protected" streams and lakes

	Conditionally Protected: highest estimate of OHWM (1 ha, after Walsh and Ward) Possibly Protected: none (after Walsh and Ward) Not Protected: none	Conditionally Protected: all lakes intersecting a state boundary, and all lakes intersecting "conditionally protected" streams Possibly Protected: all other lakes Not Protected: none	Conditionally Protected: all wetlands intersecting a state boundary, and all wetlands intersecting "conditionally protected" streams and lakes with a 500 ft buffer (after Walsh and Ward) Possibly Protected: all other wetlands Not Protected: none
2001 Solid Waste Agency of Northern Cook County v. US Army Corps of Engineers	No change	Migratory bird rule no longer in effect	Migratory bird rule no longer in effect. Adjacent wetlands ("adjacent" defined as "bordering, continuous, or neighboring")
	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior
2006 Rapanos v. US	No change	Can be all waters with a significant nexus (same results as prior for different definitional reason)	Can be all waters with a significant nexus (same results for different definitional reason)
	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior
2008 EPA and Army Corps Guidance Memorandum	(1) Traditionally navigable waters and their adjacent wetlands; 2. Relatively Permanent Non-navigable Tributaries of Traditional Navigable Waters and Wetlands with a Continuous Surface	all waters and adjacent wetlands with a significant nexus	"adjacent" can mean "bordering, contiguous, or neighboring"

	Connection with Such Tributaries (perennial and intermittent waters); (3) all waters and adjacent wetlands with a significant nexus		
	Protected: lowest estimate of OHWM (100 ha, after Walsh and Ward) Conditionally Protected: highest estimate of OHWM (1 ha, after Walsh and Ward) Possibly Protected: none Not Protected: none	Protected: all lakes intersecting "protected" streams Conditionally Protected: all lakes intersecting "conditionally protected" streams Possibly Protected: all other lakes Not Protected: none	Protected: all wetlands intersecting "protected" streams and lakes Conditionally Protected: all wetlands intersecting "conditionally protected" streams and lakes with a 500 ft buffer Possibly Protected: all other wetlands Not Protected: none
2015 Clean Water Rule	No change	Rules detailed below	Rules detailed below
	Protected: lowest estimate of OHWM (100 ha, after Walsh and Ward) Conditionally Protected: highest estimate of OHWM (1 ha, after Walsh and Ward) Possibly Protected: none Not Protected: none	Protected: Interstate lakes, lakes intersecting "protected" streams, lakes within 100 ft of those lakes and streams, lakes within 100 yr floodplain and 1,500 feet of those lakes and streams, lakes within 1,500 ft of traditionally navigable waters (Sec. 10 streams and lakes) Conditionally Protected: Interstate lakes, lakes intersecting "maybe" streams, lakes within 100 ft of those lakes and streams, lakes within 100 yr floodplain and 1,500 feet of those lakes and streams, lakes within 1,500 ft of traditionally navigable waters (log accommodating streams and lakes)	Protected: Interstate wetlands, wetlands w/in 100 ft of "in" streams or lakes connected to those streams; wetlands w/i 100yr floodplain and 1,500 ft of "in" streams or lakes connected to those streams; and wetlands w/in 1,500 ft of trad. nav. (Sec. 10) streams and connected lakes Conditionally Protected: Interstate wetlands, wetlands w/in 100 ft of "maybe" streams or lakes connected to those streams; wetlands w/i 100yr floodplain and 1,500 ft of "in" streams or lakes connected to those streams; and wetlands

		Possibly Protected: 5 special cases (prairie potholes, etc.) subject to significant nexus test. Lakes w/in 100yr floodplain of trad. nav. (log accommodating) streams or their connected lakes. Lakes w/in 4,000 ft of "maybe" streams, connected lakes, or interstate waters Not Protected: all other lakes	w/in 1,500 ft of trad. nav. (log accommodating) streams and connected lakes Possibly Protected: Wetlands w/in 100yr floodplain of trad. nav. streams (log accommodating) or their connected lakes. Wetland w/in 4,000 ft of "maybe" streams and connected lakes, or interstate waters. Not Protected: all other wetlands
2018 National Association of Manufacturers v. Department of Defense et al. (and District Court injunction, so both rules viable)	Division of both 1986 and 2015 rules (Streams are the same between both)	Both 1986 and 2015 rules enforced depending upon state	Both 1986 and 2015 rules enforced depending upon state
	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior	Protected: same as prior Conditionally Protected: same as prior Possibly Protected: same as prior Not Protected: same as prior
2020 Navigable Waters Protection Rule	"(i) Waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce […] (ii) Tributaries of waters identified in paragraph (1)(i) of this definition; (iii) Ditches that satisfy any of the conditions identified in paragraph (1)(i) of this definition […] (iv) Lakes and ponds that satisfy any of the conditions identified in paragraph (1)(i) of this definitions, lakes and ponds that contribute perennial or intermittent		Adjacent wetlands (must "abut" or have direct surface connection)

	flow to a water identified in paragraph (1)(i) of this definition in a typical year either directly or indirectly through a water(s) identified in paragraphs (1)(ii) through (vi) of this definition or through water features identified in paragraph (2) of this definition so long as those water features convey perennial or intermittent flow downstream, and lakes and ponds that are flooded by a water identified in paragraphs (1)(i) through (v) of this definition in a typical year; (v) impoundments […]; (vi) adjacent wetlands to waters identified in paragraphs (1)(i) through (v) of this definition (explicitly excluded: ephemeral flow)		
	Protected: lowest estimate of OHWM (100 ha, after Walsh and Ward) Conditionally Protected: highest estimate of OHWM (proxy for ephemeral cutoff) (1 ha, after Walsh and Ward) Possibly Protected: none Not Protected: none	Protected: all lakes intersecting "protected" streams Conditionally Protected: all lakes intersecting "conditionally protected" streams Possibly Protected: none Not Protected: all other lakes	Protected: all wetlands intersecting "protected" streams and lakes Conditionally Protected: all wetlands intersecting "conditionally protected" streams and lakes Possibly Protected: none Not Protected: all other wetlands

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