Case No. 15-3751/15-3799/15-3817/15-3820/15-3822/15-3823/15-3831/
15-3837/15-3839/15- 3850/15-3853/15-3858/15-3885/15-3887/15-3948/
15-4159/15-4162/15-4188/15-4211/15-4234/15-4305/15-4404

IN THE UNITED STATES COURT OF APPEALS
FOR THE SIXTH CIRCUIT

MURRAY ENERGY CORPORATION et al., Petitioners, v. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY; GINA MCCARTHY; UNITED STATES ARMY CORPS OF ENGINEERS; JOHN MCHUGH; JO-ELLEN DARCY, Respondents.	)	In re: ENVIRONMENTAL PROTECTION AGENCY AND DEPARTMENT OF DEFENSE, FINAL RULE: CLEAN WATER RULE: DEFINITION OF "WATERS OF THE UNITED STATES," 80 FED. REG. 37,054 (JUNE 29, 2015)

On Petitions for Review of a Final Rule of the United States Environmental Protection Agency and the United States Army Corps of Engineers

Brief of Dr. M. Siobhan Fennessy, Dr. Carol A. Johnston, Dr. Marinus L. Otte, Dr. Margaret Palmer, Dr. James E. Perry, Professor Charles Simenstad, Dr. Benjamin R. Tanner, Dr. Dan Tufford, Dr. R. Eugene Turner, Dr. Kirsten Work, Dr. Scott C. Yaich, and Dr. Joy B. Zedler as Amici Curiae in Support of Respondents and in Support of Upholding the Clean Water Rule

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INTERESTS OF AMICI CURIAE[1]

Amici curiae are wetland and water scientists, actively involved in research and teaching about the fresh and estuarine waters of the United States. As practicing scientists who have spent our careers studying streams, wetlands, and other aquatic ecosystems, we—and many in our profession—have long explored the ways in which human activities that affect one part of a watershed can also affect—and damage—other parts of that watershed. In doing so, we have applied the basic tools of our profession: literature review, on-site observations, measurements, experimental manipulations, studies of "natural experiments," and modeling based on observations and our understanding of the physical sciences. Based upon these tools, we believe that current science provides sound support for the Clean Water Rule.

As scientists, we weigh in on the definition of "waters of the United States" under the Clean Water Act (CWA), 33 U.S.C. §1251 et seq. (1972), relying on our research and experience with tributaries and geographically proximate adjacent waters. In this brief, we elaborate on the scientific basis behind efforts to address human activities that alter the integrity of aquatic ecosystems. Damage to these systems can affect society in a number of ways, including: harming human welfare

[1] In accordance with Federal Rule of Appellate Procedure 29(a)(4)(E), this brief was not authored in whole or in part by a party's counsel, no party or party's counsel contributed money that was intended to fund preparing or submitting the brief, and no person—other than the amici curiae or their counsel—contributed money that was intended to fund preparing or submitting the brief.

and property via flooding, impairing human health via water pollution, loss of recreational opportunities, and threatening species, including commercial species harvested in fisheries, via water pollution and a loss of connectivity. Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: Wetlands and Water* 1–3 (José Sarukhán et al. eds., 2005); *The Economic and Market Value of Coasts and Estuaries: What's at Stake?* (Linwood H. Pendleton ed., 2008), *available at* http://www.era.noaa.gov/pdfs/052008final_econ.pdf; *see also* David Moreno-Mateos & Margaret A. Palmer, *Watershed Processes as Drivers for Aquatic Ecosystem Restoration, in Foundations of Restoration Ecology* (Margaret A. Palmer et al. eds., 2d ed. 2016). We believe that the Clean Water Rule's definition of "waters of the United States," 80 Fed. Reg. 37,054 (June 29, 2015), is a scientifically justified approach to address these impacts.

I. The Clean Water Rule is scientifically sound.

In drafting the Clean Water Rule, the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) utilized many methodologies employed by amici in our research and by others. The agencies studied key chemical, physical, and biological features of water systems and relied upon studies that used rigorous and respected methodologies in researching aquatic ecosystems.

A. Key chemical, physical, and biological features are used to study water systems.

An early major National Research Council report, *Wetlands: Characteristics and Boundaries* (1995), which amici Joy Zedler and Carol Johnston co-authored, outlined three structural components of wetlands that apply generally to all water systems: water, substrate (physical and chemical features), and biota (animal, plant, and microorganism life). *Id.* at 3–4; *see also* Figure 1. Each component interacts with the others to shape the functions (services) of water systems. In

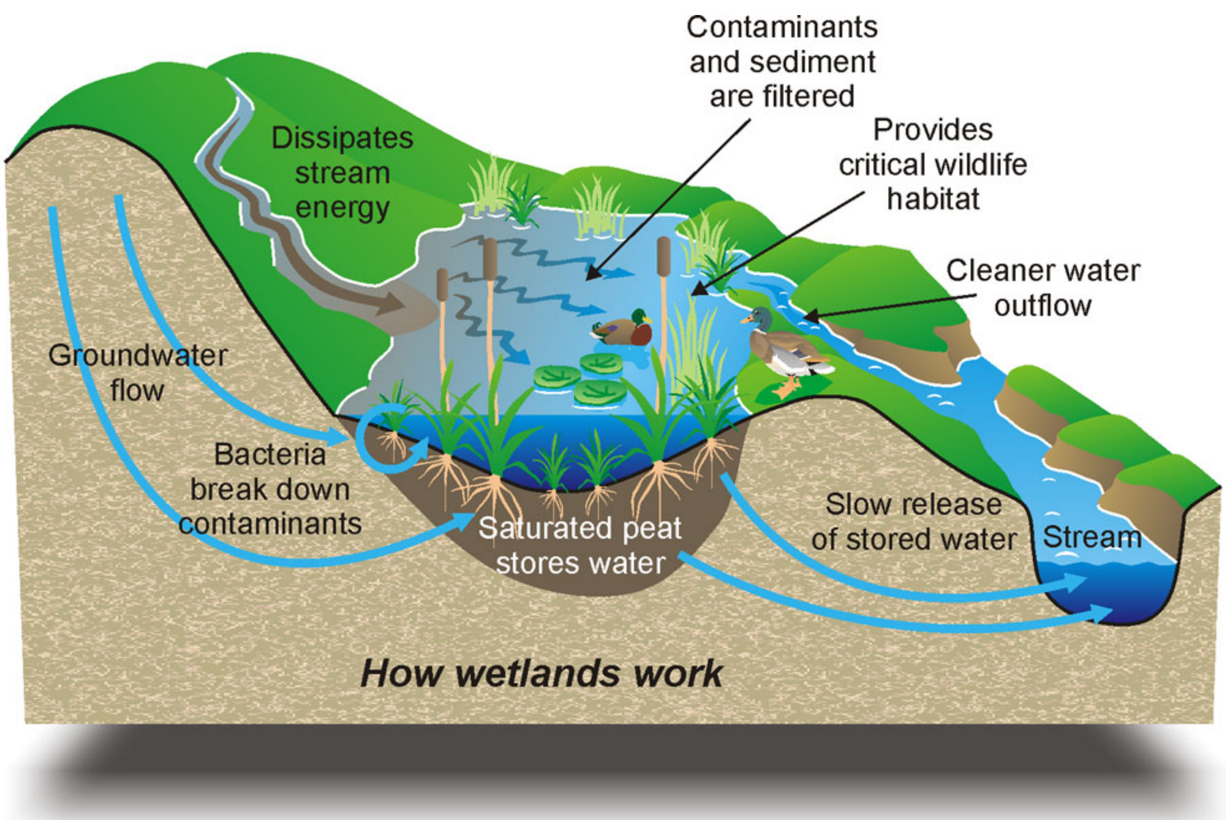

Figure 1. How Wetlands Work. Source: Delaware Wetland Monitoring and Assessment Program.

the study underlying the Clean Water Rule, the EPA and the Corps examined connections among these three factors to provide an integrated perspective on water systems. EPA Office of Research & Dev., *Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence* 1-2 to 1-19 (Jan. 2015) [hereinafter *Connectivity Report*].

B. Rigorous research methods are used to study these attributes, and to study aquatic ecosystems as a whole.

The study of water systems integrates several scientific disciplines. In the context of understanding wetlands, hydrology, geology, and chemistry are used to examine how wetlands regulate stream flow, filter pollutants and sediment, incorporate excess nutrients, act to control flooding, and connect to groundwater. *See, e.g.*, Carol A. Johnston, *Sediment and Nutrient Retention by Freshwater Wetlands: Effects on Surface Water Quality*, 21 Critical Rev. Envtl. Control 491–565 (1991); Donald L. Hey & Nancy S. Philippi, *Flood Reduction Through Wetland Restoration: The Upper Mississippi River Basin as a Case History*, 3 Restoration Ecology 4–17 (2006); Peter J. Hancock et al., *Preface: Hydrogeoecology, the Interdisciplinary Study of Groundwater Dependent Ecosystems*, 17 Hydrogeology J. 1–3 (2009). Ecological research can be used to examine the role of wetlands as habitats for fish and wildlife, and their support of food webs within and among interconnected water systems. *See, e.g.*, Matthew J. Gray et al., *Management of Wetlands for Wildlife*, in 3 *Wetland Techniques:*

Applications and Management 121–80 (J.T. Anderson & C.A. Davis eds., 2013); Michael E. Sierszen et al., *Watershed and Lake Influences on the Energetic Base of Coastal Wetland Food Webs Across the Great Lakes Basin*, 38 J. Great Lakes Res. 418–28 (2012). Underlying this cross-disciplinary approach is a focus on the various methodologies noted above. We do not apply these methods independently of each other, but rather actively compare them to ensure that our results are robust and reproducible. *Cf.* David Goodstein, *How Science Works*, in Fed. Judicial Ctr., *Reference Manual on Scientific Evidence* 37, 44 (3d ed. 2011).

To study water systems, we use a wide range of sampling and analytical methods to make our on-site observations and measurements. *See* R.D. DeLaune et al., *Methods in Biogeochemistry of Wetlands* (2013). These methods include examining the chemical and physical characteristics of the waters, characterizing soil and sediment samples, and sampling plant communities. *See generally id.*; *see also Tools in Fluvial Geomorphology* (G. Mathias Kondolf & Hervé Piégay eds., 2d ed. 2016). These sampling and analytical methods are well-established, rigorous, and refined over time; we use them to enhance our understanding of the relationships between the various components of water systems.

Watershed or hydrologic studies may make use of “natural experiments” (a form of observational study), which focus on comparing a natural event or feature with areas (or times) with and without the event or feature. Fed. Judicial Ctr., *Reference Manual on Scientific Evidence* 290 (2011); *see also* Judith A. Layzer, *Natural Experiments: Ecosystem-Based Management and the Environment* (2008). In studying developed and undeveloped watersheds, for example, the assignment of subjects (e.g., watersheds) to groups (e.g., developed or not) is akin to randomization. Such natural experiments are often necessary because ethical considerations (i.e., concerns of deliberately damaging those systems), size, and cost create barriers for actual experiments on existing systems. *See* Susan Haack, *Defending Science—Within Reason: Between Scientism and Cynicism* (2003). Rather than disrupting existing systems, we look toward variations to extrapolate the effects of differences on the overall water system.

We also rely on modeling methods to enhance our understanding of the water-system relationships. *See* Nat'l Judicial Coll., *Hydrologic Modeling Benchbook* 31 (2010) (describing computer-based models as "essential" for understanding water systems). Models serve multiple purposes. First, they enable us to test our understanding of interrelationships between different components of a water system. *Id.* Second, they enable us to predict the outcomes of potential human activities that may cause damage—without modifying those systems. *Id.* Models also make it possible to study processes at scales of watersheds to continents that are too extensive to be investigated by observations alone, and to simulate scenarios of hydrologic and other wetland/watershed processes drawn from historical record. *E.g.*, Kangsheng Wu & Carol A. Johnston, *Hydrologic Comparison Between a Forested and a Wetland/Lake Dominated Watershed Using SWAT*, 22 Hydrological Processes 1431–42 (2008).

The Connectivity Report reached its conclusions using studies that applied all of these methodologies. Indeed, the EPA, in its Connectivity Report, compiled these studies in a manner to ensure the use of high-quality, relevant research. *Connectivity Report*, *supra* at 1-17; *see also* U.S. Envtl. Prot. Agency & U.S. Dep't of Army, *Technical Support Document for the Clean Water Rule: Definition of Waters of the United States* 158–63 (May 27, 2015) [hereinafter *Technical Support Document*] (describing the extensive process of peer review of the Connectivity Report itself, including the use of a panel of 27 technical experts from an array of relevant fields, as well as other public processes). Moreover, the Connectivity Report included only studies that were peer reviewed or otherwise verified for quality assurance. *Id.* The focus on high standards and verification through peer review means that the Connectivity Report used the best available science to develop the Clean Water Rule. *See* Clean Water Rule, 80 Fed. Reg. at 37,055; *see also, e.g.*, P.J. Sullivan et al., *Report: Best Science Committee, Defining and Implementing Best Available Science for Fisheries and Environmental Science, Policy, and Management*, 31 Fisheries 460, 462 (2006) (describing assurance of data quality and use of rigorous peer review as aspects of best available science).

II. "Waters of the United States" is a legal determination informed by science.

Jurisdiction under the CWA has both legal and scientific components. The CWA defines the term "navigable waters" as "waters of the United States," which has been further refined by case law, regulation, and agency guidance. There is no question that traditional navigable waters, interstate waters, and the territorial seas (hereinafter collectively referred to as "primary waters") are "waters of the United States." For other waters, such as tributaries and waters adjacent to those tributaries, scientific research plays a critical role in determining how they affect the chemical, physical, and biological integrity of primary waters, and thus their qualifications for CWA protection.

A. As a legal matter, CWA jurisdiction requires a "significant nexus" to a primary water.

While "waters of the United States" include more than primary waters, the CWA's jurisdictional scope has limits. In *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, the U.S. Supreme Court noted that the term "navigable" has some import in CWA jurisdictional determinations. 531 U.S. 159, 172 (2001). Accordingly, agencies and courts have employed the "significant nexus" analysis, endorsed by Justice Kennedy in *Rapanos v. United States*. 547 U.S. 715, 759 (2006) (Kennedy, J., concurring in the judgment). This approach recognizes that upstream waters must be protected to ensure the integrity of primary waters. *Id.* at 774–75.

B. As a scientific matter, the Clean Water Rule's approach to "significant nexus" is sound.

The Clean Water Rule relies on the best available science to establish criteria for the requisite "significant nexus" between primary waters and other waters. Primary waters do not exist in isolation. Nat'l Research Council, *Compensating for Wetland Losses Under the Clean Water Act* 46–59 (2001). Rather, they are heavily influenced by their interactions with streams, wetlands, and open waters within their watersheds. As the Connectivity Report correctly emphasizes:

> The structure and function of downstream waters highly depend on materials—broadly defined as any physical, chemical, or biological entity—that originate outside of the downstream waters. Most of the constituent materials in rivers, for example, originate from aquatic ecosystems located upstream in the drainage network or elsewhere in the drainage basin, and are transported to the river through flowpaths[.]

Connectivity Report, *supra*, at ES-15. The Clean Water Rule appropriately defines "significant nexus" using scientifically supported functions to demonstrate strong chemical, physical, and biological connections between upstream waters and primary waters.

Scientific literature strongly supports the nine functions listed in the Clean Water Rule's "significant nexus" definition. First, each function relates to the chemical, physical, and/or biological integrity of primary waters. For example, wetlands enhance the chemical integrity of downstream waters through trapping, transforming, and filtering pollutants. *See* Carol A. Johnston et al., *The Cumulative Effect of Wetlands on Stream Water Quality and Quantity: A Landscape Approach*, 10 Biogeochemistry 105–41 (1990). Wetlands also recycle nutrients and export organic material. *See* Michael E. McClain et al., *Biogeochemical Hot Spots and Hot Moments at the Interface of Terrestrial and Aquatic Ecosystems*, 6 Ecosystems 301–12 (2003); Nathan J. Smucker & Naomi E. Detenbeck, *Meta-Analysis of Lost Ecosystem Attributes in Urban Streams and the Effectiveness of Out-of-Channel Management Practices*, 22 Restoration Ecology 741–48 (2014).

Similarly, the functions of streams, wetlands, and open waters affect the physical integrity of downstream waters. *See, e.g.*, Tim D. Fletcher et al., *Protection of Stream Ecosystems from Urban Stormwater Runoff: The Multiple Benefits of an Ecohydrological Approach*, 38 Progress in Physical Geography 543–55 (2014). These waters contribute flow to primary waters. *See, e.g.*, Carol A. Johnston & Boris A. Shmagin, *Regionalization, Seasonality, and Trends of Streamflow in the U.S. Great Lakes Basin*, 362 J. Hydrology 69–88 (2008). Research has shown that many wetlands without a year-round surface connection to primary waters flow into perennial streams a significant amount of the time, thereby contributing water and other materials downstream. *See, e.g.*, Owen T.

McDonough et al., *Surface Hydrologic Connectivity Between Delmarva Bay Wetlands and Nearby Streams Along a Gradient of Agricultural Alteration*, 35 Wetlands 41–53 (2015); Heather E. Golden et al., *Hydrologic Connectivity Between Geographically Isolated Wetlands and Surface Water Systems: A Review of Select Modeling Methods*, 53 Envtl. Modelling & Software 190–206 (2014).

Wetlands also retain and attenuate floodwaters, as well as store runoff. *See* Hisashi Ogawa & James W. Male, *Simulating the Flood Mitigation Role of Wetlands*, 112 J. Water Resources Plan. & Mgmt. 114–28 (1986); Carol A. Johnston, *Material Fluxes Across Wetland Ecotones in Northern Landscapes*, 3 Ecological Applications 424–40 (1993). In addition, they trap sediment, thereby preventing the degradation of downstream water quality. *See* Carol A. Johnston et al., *Nutrient Trapping by Sediment Deposition in a Seasonally Flooded Lakeside Wetland*, 13 J. Envtl. Quality 283–90 (1984).

The Clean Water Rule's definition of "significant nexus" also recognizes how streams, wetlands, and open waters affect the biological integrity of downstream waters. Such waters provide important foraging, nesting, breeding, spawning, and nursery habitat for species that occur in primary waters. *See* Marcus Sheaves, *Consequences of Ecological Connectivity: The Coastal Ecosystem Mosaic*, 391 Marine Ecology Progress Series 107–15 (2009); Raymond D. Semlitsch & J. Russell Bodie, *Are Small, Isolated Wetlands Expendable?*, 12

Conservation Biology 1129–33 (1998); Shannon E. Pittman et al., *Movement Ecology of Amphibians: A Missing Component to Understanding Amphibian Declines*, 169 Biological Conservation 44–53 (2014).

Connectivity refers to "the degree to which components of a watershed are joined and interact by transport mechanisms that function across multiple spatial and temporal scales." *Connectivity Report*, *supra*, at ES-6. Whether the functions of a particular stream, wetland, or open water (or a group of "similarly situated" waters) satisfy the legal threshold of "significant nexus" depends on the extent of its connectivity with primary waters. We examine the Clean Water Rule's categorical application of the "significant nexus" test below.

III. Best available science supports the Clean Water Rule's categorical treatment of tributaries.

Our research and that of other scientists demonstrates extensive connections between tributaries and their downstream primary waters sufficient to warrant categorical inclusion under the Clean Water Rule. *See* R. Eugene Turner & Nancy N. Rabalais, *Linking Landscape and Water Quality in the Mississippi River Basin for 200 Years*, 53 BioScience 563–72 (2003). The U.S. Supreme Court has held that federal agencies may craft a categorical rule to assert CWA jurisdiction over certain waters. *United States v. Riverside Bayview Homes, Inc.*, 474 U.S. 121, 135 (1985). The Court noted that so long as "it is reasonable . . . to conclude that, in the majority of cases" the category of waters has "significant effects on water quality and the aquatic ecosystem, its definition can stand." *Id.* at 135 n.9.

A. The Clean Water Rule's definition of tributary is scientifically sound.

The Clean Water Rule defines "tributary" in a manner consistent with our scientific understanding. At its most basic level, a tributary is simply a waterbody that flows into a larger waterbody. From a scientific perspective, "a tributary is the smaller of two intersecting channels, and the larger is the main stem." Lee Benda et al., *The Network Dynamics Hypothesis: How Channel Networks Structure Riverine Habitats*, 54 BioScience 413, 415 (2004). A standard stream ordering system classifies the smallest streams as first-order streams; when two streams meet, they form a second-order stream and so on. *See* Arthur N. Strahler, *Quantitative Analysis of Watershed Geomorphology*, 38 Transactions of American Geophysical Union 913–20 (1957). The smaller waters are intrinsically linked to primary waters both structurally and functionally. *See* Dennis F. Whigham et al., *Impacts of Freshwater Wetlands on Water Quality: A Landscape Perspective*, 12 Envtl. Mgmt. 663–71 (1988). Indeed, "[t]he great majority of the total length of river systems is comprised of lower-order or headwater systems." J. David Allan & María M. Castillo, *Stream Ecology: Structure and Function of Running Waters* 2 (2d ed. 2007); *see also* Ken M. Fritz et al., *Comparing the Extent and Permanence* *of Headwater Streams from Two Field Surveys to Values from Hydrographic Databases and Maps*, 49 J. Am. Water Resources Ass'n 867–82 (2013).

Under the Clean Water Rule, a "tributary . . . contributes flow, either directly or through another water" to primary waters and is "characterized by the presence of the physical indicators of a bed and banks and an ordinary high water mark." 80 Fed. Reg. at 37,105. The Clean Water Rule notes that tributaries may be natural or human-made and include "rivers, streams, [and] canals," as well as ditches that are not otherwise excluded by the Rule. *Id.* From a scientific perspective, whether a tributary is natural or human-made is immaterial; what matters is whether the water contributes flow to another waterbody.

Under the Clean Water Rule, a water meets the definition of a tributary even if it contributes flow to a primary water through a non-jurisdictional water. This approach is also sound because the scientific definition of tributary focuses on the hydrologic connection between waters.

From a scientific perspective, the Clean Water Rule's definition of "tributary" could be considered conservative. In addition to requiring a bed and banks (channels), it also provides that a tributary must have an ordinary high water mark (OHWM). In comments to the EPA, however, the Scientific Advisory Board noted that not all tributaries have OHWMs. Ltr. from EPA Sci. Advisory Bd., to Gina McCarthy, EPA Administrator, *Science Advisory Board (SAB) Consideration* *of the Adequacy of the Scientific and Technical Basis of the EPA's Proposed Rule Titled "Definition of Waters of the United States Under the Clean Water Act"* (Sept. 30, 2014) (on file with epa.gov). The OHWM requirement (which is ultimately a limitation on what constitutes a water of the United States) is not dictated by science, but we recognize that the agencies must set boundaries along gradients to apply the CWA on a national basis.

B. Compelling scientific evidence demonstrates that tributaries significantly affect the chemical, physical, and biological integrity of primary waters.

The National Academy of Sciences has extensively documented the connections between tributaries and downstream waters. *See, e.g.*, Nat'l Research Council, *Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay: An Evaluation of Program Strategies and Implementation* (2011); Nat'l Research Council, *Missouri River Planning: Recognizing and Incorporating Sediment Management* (2011). Scientific studies demonstrate how tributaries significantly affect the functions and integrity of downstream waters through chemical, physical, and biological interrelationships, especially regarding how physical aspects (e.g., flow) can influence chemical processes (e.g., pesticide contamination), which in turn can affect the biological features (e.g., species) of a water. Below we highlight a few examples of connections between tributaries and primary waters.

We find evidence of strong chemical connections between tributaries and downstream primary waters in the movement of contaminants and pathogens. Sediment-laden waters typically transport some contaminants (such as mercury) from tributaries to downstream waters. *See* Willem Salomons & Ulrike Förtsner, *Metals in the Hydrocycle* (1984). Waterborne pathogens (such as bacteria and viruses) that originate from agricultural and municipal wastes are also transported to downstream waters through tributaries. *See* Pramod K. Pandey et al., *Contamination of Water Resources by Pathogenic Bacteria*, 4 AMB Express (2014); Cassandra C. Jokinen et al., *Spatial and Temporal Drivers of Zoonotic Pathogen Contamination of an Agricultural Watershed*, 41 J. Envtl. Quality 242–52 (2012); Isabelle Jalliffier-Verne et al., *Cumulative Effects of Fecal Contamination from Combined Sewer Overflows: Management for Source Water Protection*, 174 J. Envtl. Mgmt. 62–70 (2016). Pathogens may pose a risk to human health, highlighting the importance of regulating and protecting tributaries to ensure the integrity of primary waters.

Tributaries also have important physical connections with downstream primary waters. The water flow from tributaries helps to create and maintain river networks. Indeed, most of the water in most rivers comes from tributaries. *See, e.g.*, Richard B. Alexander et al., *The Role of Headwater Streams in Downstream Water Quality*, 43 J. Am. Water Resources Ass'n 41–59 (2007).

Furthermore, tributaries support the metabolism of river ecosystems. For example, they export organic matter (dissolved and particulate) that is incorporated into the food webs of downstream waters, and the resulting turbid water shades and protects fish and amphibians from damage by ultraviolet radiation. *E.g.*, Paul C. Frost et al., *Environmental Controls of UV-B Radiation in Forested Streams of Northern Michigan*, 82 Photochemistry & Photobiology 781–86 (2006). Other biological connections relate to the passive and active transport of living organisms. *See* Judy L. Meyer et al., *The Contribution of Headwater Streams to Biodiversity in River Networks*, 43 J. Am. Water Resources Ass'n 86 (2007) (discussing how organisms rely on streams); Moreno-Mateos & Palmer, *supra*; Carol A. Johnston, *Beaver Wetlands*, in *Wetland Habitats of North America: Ecology and Conservation Concerns* 161–72 (Darold P. Batzer & Andrew H. Baldwin eds., 2012).

Accordingly, the Clean Water Rule's categorical treatment of tributaries reflects scientific reality.

IV. Best available science supports the Clean Water Rule's categorical treatment of adjacent waters based on geographic proximity.

Our research demonstrates that adjacent waters warrant regulation under the Clean Water Rule because of their chemical, physical, and biological connections to downstream primary waters.

A. Compelling scientific evidence demonstrates that waters within 100 feet of an OHWM significantly affect the chemical, physical, and biological integrity of primary waters.

Waters, including wetlands, ponds, oxbows, and impoundments, within 100 feet of an OHWM are "hotspots" of ecological function/processes and species diversity affecting the flux of materials (water, sediment, energy, organic matter, pollutants, and organisms) to primary waters. *See* Peter M. Groffman et al., *Down by the Riverside: Urban Riparian Ecology*, 1 Frontiers Ecology & Env't 315–21 (2003). These adjacent waters affect the movement of pollutants from uplands into streams and rivers; regulate stream temperatures, light, and flow regimes; reduce downstream flooding; and provide nursery areas and critical habitat for aquatic biota, including threatened and endangered species. *See* J. V. Ward et al., *Riverine Landscape Diversity*, 47 Freshwater Biology 517–39 (2002). Riparian wetlands act as buffers, effectively reducing concentrations of nutrients and other pollutants. For example, riparian wetlands may remove up to 100% of the nitrate-nitrogen that enters them. *See* M. S. Fennessy & J. Cronk, *The Effectiveness and Restoration Potential of Riparian Ecotones for the Management of Nonpoint Source Pollution*, *Particularly Nitrate*, 27 Critical Revs. Envtl. Sci. & Tech. 285–317 (1997). Nitrate is a serious water pollutant and a major contributor to coastal algal blooms, as in the Gulf of Mexico's hypoxic "dead zone," as well as nuisance algal blooms in many other surface waters. *See* William J. Mitsch et al., *Nitrate-Nitrogen Retention in the Mississippi River Basin*, 24 Ecological Engineering 267–78 (2005).

These adjacent waters can act as sources, sinks, or transformers of materials from upland habitats. As sources, adjacent waters contribute organic materials, such as leaf litter, that provide food (energy) for many in-stream species. *See* Robin L. Vannote et al., *The River Continuum Concept*, 37 Canadian J. Fisheries & Aquatic Sci. 130–37 (1980). They also carry woody debris, which increases habitat complexity and biodiversity. *See* J. David Allan, *Stream Ecology: Structure and Function of Running Waters* (1st ed. 1995); J. V. Ward et al., *Riverine Landscape Diversity*, 47 Freshwater Biology 517–39 (2002).

Adjacent waters are also major sinks for materials. By capturing and storing sediment eroded from nearby uplands, they reduce downstream sediment transport and its negative effects on fish feeding and spawning, macroinvertebrate communities, and overall habitat quality. *See* C. P. Newcombe & D. D. MacDonald, *Effects of Suspended Sediments on Aquatic Ecosystems*, 11 N. Am. J. Fisheries Mgmt. 72–82 (1991). These adjacent waters convert materials from one form to another; plants and algae can consume nutrients and bind them in their tissues, reducing the risk of downstream eutrophication. Wetlands in particular mitigate nonpoint source pollution, such as insecticides and fertilizers, thus protecting stream water quality and drinking water supplies. *E.g.*, Robert Everich et al., *Efficacy of a Vegetative Buffer for Reducing the Potential Runoff of the Insect Growth Regulator Novaluron*, in *Pesticide Mitigation Strategies for Surface Water Quality* 175–88 (2011); Mitsch et al., *supra*. Adjacent waters also slow the movement of materials and biota, by providing temporary storage of excess water during times of high precipitation to dissipate the energy of flows (reducing erosion and soil loss) and attenuate flood peaks. *See* William J. Mitsch & J. Gosselink, *Wetlands* (5th ed. 2015).

Hydrologic connections do not need to be continuous to have a substantial effect on downstream primary waters. Hydrologic connectivity involves longitudinal, lateral, and vertical exchange, and adjacent waters are intimately linked to streams and rivers both in space (i.e., proximity to the OHWM), and time (e.g., by means of high water and flood events). Seasonal high water levels increase connectivity, promoting the lateral movement of animals between lakes, wetlands, stream channels, and their adjacent waters. This facilitates use of critical spawning and nursery habitats by fish, and supports the biological integrity of the system. Many fish are sustained by varied habitats dispersed throughout the watershed for spawning, nurseries, growth, and maturation. *See* Kurt D. Fausch et al., *Landscapes to Riverscapes: Bridging the Gap Between Research and Conservation of Stream Fishes*, 52 BioScience 483–98 (2002).

Overall, the benefits of protecting waters within 100 feet of an OHWM accrue both locally (at that point on the river system) and cumulatively (at the watershed scale). The Clean Water Rule's categorical inclusion of these adjacent waters reflects scientific reality.

B. Compelling scientific evidence demonstrates that waters within 100-year floodplains significantly affect the chemical, physical, and biological integrity of primary waters.

The Clean Water Rule's coverage of waters within 100-year floodplains is based on scientific understanding of watershed dynamics. These dynamics include not only surface expressions of connectivity (floods), but also underlying hydrologic conditions.

Every primary water has a watershed, which can be described as the land area that drains into that primary water and its tributaries. *See* Paul R. Bierman & David R. Montgomery, *Key Concepts in Geomorphology* (2014). During any flood event, primary waters and their tributaries may overflow their banks. *Id.* The proportion of land that becomes obviously flooded (the "floodplain") depends upon rate and total amount of rainfall. The geographic extent of the floodplain also depends upon the watershed's topography, soil saturation, and geological characteristics. *See* W. R. Osterkamp & J.M. Friedman, *The Disparity Between Extreme Rainfall Events and Rare Floods—With Emphasis on the Semi-Arid American West*, 14 Hydrological Processes 2817–29 (2000). A landscape with more topographic relief (steeper) will have a smaller floodplain than a flatter landscape where floodwaters more readily spread outward. *See* A.D. Howard, *Modelling Channel Evolution and Floodplain Morphology*, in *Floodplain Processes* 15–62 (Malcolm G. Anderson et al. eds., 1996).

Although every flood is unique in extent and duration, we describe floodplains statistically to characterize other hydrologic (non-flooding) features. *See* G. R. Pandy & V.-T.-V. Nguyen, *A Comparative Study of Regression Based Methods in Regional Flood Frequency Analysis*, 225 J. Hydrology 92–101 (1999). For example, the "100-year floodplain" represents the land area covered by floodwaters that have a 1% chance of occurring in any given year (1/100 likelihood). This definition is entirely statistical; such floods can occur more often in a 100-year floodplain, even two years or more in a row. It is incorrect to conclude that waters on a 100-year floodplain have a connection with a primary water only once in a century because the actual hydrologic connections extend beyond surface flooding alone.

Furthermore, changes in land use can affect flood dynamics. Increasing the proportion of the landscape that is covered with impermeable surfaces (such as streets and roofs) may increase flood intensity and duration. *See* E. S. Bedan & J.C. Clausen, *Stormwater Runoff Quality and Quantity from Traditional and Low*

Impact Development Watersheds, 4 J. Am. Water Resources Ass'n 998–1008 (2009).

Floodwaters are only the surface expressions of a flood. Rainfall permeates into the soil and often moves underground toward open waterbodies, such as primary waters. *See* William M. Alley et al., *Flow and Storage in Groundwater Systems*, 296 Sci. 1985–90 (2002); Florian Malard et al., *A Landscape Perspective of Surface-Subsurface Hydrological Exchanges in River Corridors*, 47 Freshwater Biology 621–40 (2002). Groundwater movement occurs in the absence of a 100-year flood. The results from tracing techniques demonstrate how large proportions of streamflow are derived from groundwater. *E.g.*, Alley et al., *supra*.

We in the water science community understand that factors other than surface flooding determine the actual extent of hydrologic connections between waters in a floodplain. The direction of movement and the rate at which the water moves depends upon topography, geology, and rainfall. *See* Jack A. Stanford & J.V. Ward, *An Ecosystem Perspective of Alluvial Rivers: Connectivity and the Hyporheic Corridor*, 12 J. N. Am. Benthological Soc'y 48–60 (1993); Alley et al., *supra*. Impermeable subsurface layers, like clay layers under sand and/or limestone in Florida, can reduce the downward movement of water and force it to move laterally. *See* Peter W. Bush & Richard H. Johnston, *Ground-Water Hydraulics, Regional Flow, and Ground-Water Development of the Floridan Aquifer System in*

Florida and in Parts of Georgia, South Carolina, and Alabama: Regional Aquifer-System Analysis (U.S. Geological Survey, Professional Paper 1403-C, 1988), *available at* https://pubs.usgs.gov/pp/1403c/report.pdf. Often subsurface impermeable (or semi-permeable) layers are not level; they may slope toward waterbodies, and this subsurface lateral flow may re-emerge in a surface waterbody, such as a primary water. However, subsurface lateral flow can occur even without sloping impermeable layers; when more water pools in a particular subsurface location, lateral flow will occur from areas of higher pressure to areas of lower pressure, which may be river channels, wetlands, or lakes. *See* Jacob Bear, *Hydraulics of Groundwater* (2012).

Many different types of waterbodies can occur in 100-year floodplains. Tributaries and other waters can be connected to a primary river in more than one way. *See* C. Amoros & G. Bornette, *Connectivity and Biocomplexity in Waterbodies of Riverine Floodplains*, 47 Freshwater Biology 761–76 (2002). Headwaters and tributaries may flow directly into primary waters, adding organic matter and constituents that create unique water chemistry in the primary water. *See* Takashi Gomi et al., *Understanding Processes and Downstream Linkages of Headwater Systems: Headwaters Differ from Downstream Reaches by Their Close Coupling to Hillslope Processes, More Temporal and Spatial Variation, and Their Need for Different Means of Protection from Land Use*, 52 BioScience 905–16

(2002). Wetlands may border primary waters, buffering the input of floodwaters, altering the water chemistry of floodwaters and the primary water itself, and providing habitat and resources for local biota. *See* Joy B. Zedler, *Wetlands at Your Service: Reducing Impacts of Agriculture at the Watershed Scale*, 1 Frontiers in Ecology & Env't 65–72 (2003).

Even other waterbodies with no obvious surface connections to primary waters may still be hydrologically connected to them. Lakes, ponds, wetlands, and streams that flow into these apparently isolated waterbodies may have no surface connections to the primary water but, in addition to storing water as previously described, can have subsurface connections through groundwater. Bear, *supra*. These subsurface connections can carry water to primary waters; for example, water seeping down out of an apparently isolated waterbody may hit an impermeable layer and move laterally until it emerges in the primary waterbody. *See* Geoffrey C. Poole, *Fluvial Landscape Ecology: Addressing Uniqueness Within the River Discontinuum*, 41 Freshwater Biology 641–60 (2002). Therefore, loss of an apparently isolated waterbody can reduce water volume and alter flow characteristics of a primary water.

Evidence for these connections can be observed in the physical and chemical properties of primary waters. *See* Malard et al., *supra*. Temperature, alkalinity, salinity, nitrate, other chemicals and pollutants, and dyes have been used as tracers to show the impact of groundwater connections to surface waters. *See* C. Soulsby et al., *Inferring Groundwater Influences on Surface Water in Montane Catchments from Hydrochemical Surveys of Springs and Streamwaters*, 333 J. Hydrology 199–213 (2007). Furthermore, additions of pollutants into apparently isolated waterbodies or disparate areas of the watershed can affect primary waters. *See* David N. Lerner & Bob Harris, *The Relationship Between Land Use and Groundwater Resources and Quality*, 26 Land Use Pol'y S265–S273 (2009). Tracer and stable isotope studies have established the path and rate of water movements in Florida, substantiating that a distant source can pollute primary waters. *See* M. Badruzzaman et al., *Sources of Nutrients Impacting Surface Waters in Florida: A Review*, 109 J. Envtl. Mgmt. 80–92 (2012). These studies highlight the chemical, physical, and biological connections between a primary water and other waterbodies that are located within its 100-year floodplain, thus justifying the inclusion of these adjacent waters in the Clean Water Rule.

C. Compelling scientific evidence demonstrates that waters within 1500 feet of high tide lines of tidally influenced primary waters or OHWMs of the Great Lakes significantly affect the integrity of these primary waters.

Scientific evidence strongly supports protecting waters located within 1500 feet of such primary waters. These waters have the same types of connections and functions as the tributaries and other adjacent waters discussed *supra*. Adjacent waters within 1500 feet of primary waters have important chemical connections to those waters. Adjacent waters that were thought to be isolated have become more saline, providing empirical data regarding the groundwater connection between adjacent waters and primary waters. *See, e.g.*, Cameron Wood & Glenn A. Harrington, *Influence of Seasonal Variations in Sea Level on the Salinity Regime of a Coastal Groundwater-Fed Wetland*, 53 Groundwater 90–98 (2014). In addition, adjacent waters in the 1500-foot zone may release freshwater into coastal waters, thereby reducing the salinity of these waters. *See*, *e.g.*, Fred H. Sklar & Joan A. Browder, *Coastal Environmental Impacts Brought About by Alterations to Freshwater Flow in the Gulf of Mexico*, 22 Envtl. Mgmt. 547–62 (1998).

Indeed, the inputs of groundwater into coastal waters are quite large, and groundwater can contain high levels of dissolved solids and nutrients. *See, e.g.*, Willard S. Moore, *Large Groundwater Inputs to Coastal Waters Revealed by 226-Ra Enrichments*, 380 Nature 612–614 (1996); Matthew A. Charette et al., *Utility of Radium Isotopes for Evaluating the Input and Transport of Groundwater-Derived Nitrogen to a Cape Cod Estuary*, 46 Limnology & Oceanography 465–70 (2001); J. M. Krest et al., *Marsh Nutrient Export Supplied by Groundwater Discharge: Evidence from Radium Measurements*, 14 Global Biogeochemical Cycles 167–76 (2000). As in inland systems, coastal wetlands remove nutrients, such as nitrate, thereby reducing down-gradient eutrophication in primary waters. *See* Marcelo Ardón et al., *Drought-Induced Saltwater Incursion Leads to Increased Wetland*

Nitrogen Export, 19 Global Change Biology 2976–85 (2013). Thus, adjacent waters protect and improve the quality of primary waters by removing harmful contaminants or transforming and transporting nutrients to primary waters. *See* Clifford N. Dahm, *Nutrient Dynamics of the Delta: Effects on Primary Producers*, 14 S.F. Estuary & Watershed Sci. Art. 4 (2016).

Adjacent waters also physically influence primary waters through surface and subsurface connections. *See* Figure 2. Adjacent waters contribute flow to

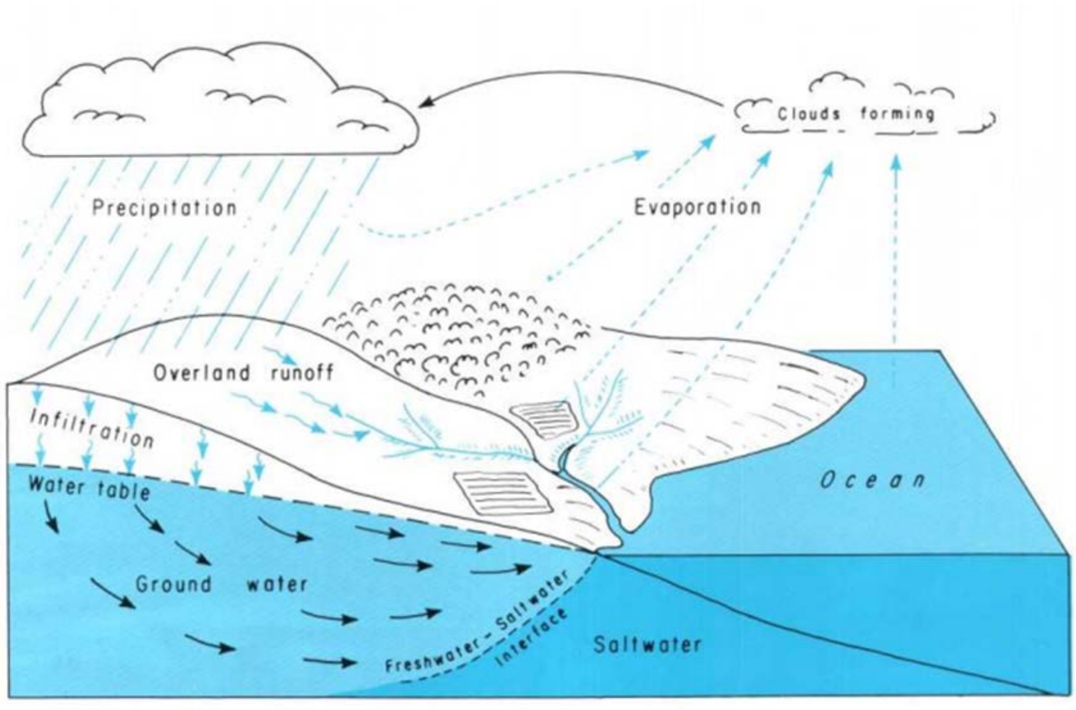

Figure 2. Freshwater-Saltwater Interface. Adapted from Ralph C. Heath, *Basic Ground-Water Hydrology* (U.S. Geological Survey, Water-Supply Paper 2220, 1998), *available* at http://pubs.er.usgs.gov/pubs/wsp/wsp2220.

nearby primary waters and retain floodwaters and sediments. *See, e.g.*, Paul M. Barlow, *Ground Water in Freshwater-Saltwater Environments of the Atlantic*

Coast (U.S. Geological Survey, Circular 1262, 2003), *available at* https://pubs.usgs.gov/circ/2003/circ1262/pdf/circ1262.pdf. Further, adjacent waters have a significant impact on the biological integrity of primary waters. Wetlands near tidally influenced primary waters can serve as a critical source of freshwater for some species that use wetlands and coastal waters. *See Technical Support Document*, *supra*, at 292–93. Adjacent wetlands, lakes, ponds, and other waters also provide important foraging and breeding habitat for coastal species. *See, e.g.*, David J. Jude & Janice Pappas, *Fish Utilization of Great Lakes Coastal Wetlands*, 18 J. Great Lakes Res. 651–72 (1992); Michael E. Sierszen et al., *A Review of Selected Ecosystem Services Provided by Coastal Wetlands of the Laurentian Great Lakes*, 15 Aquatic Ecosystem Health & Mgmt. 92–106 (2012).

Distance is but one factor that affects the connectivity between waters, and as with the other geographical distance limitations discussed *supra*, the agencies' selection of 1500 feet as the distance limitation is conservative from a scientific perspective. Indeed, waters located beyond this threshold can be chemically, physically, and biologically connected to tidally influenced primary waters or the Great Lakes. While the categorical jurisdictional line could have been drawn farther from high tide lines, we find strong scientific support connecting the majority of lakes, wetlands, ponds, and other waters located within this 1500-foot area to primary waters.

Once again, the Clean Water Rule's categorical inclusion of these adjacent waters reflects scientific reality.

V. Conclusion

The U.S. Supreme Court has held that federal agencies may protect waters on a categorical basis if most waters in that category have a significant effect on primary waters. The best available science overwhelmingly demonstrates that the waters treated categorically in the Clean Water Rule have significant chemical, physical, and biological connections to primary waters. Accordingly, we write in support of upholding the Clean Water Rule.

Date: January 20, 2017

Respectfully submitted,

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Date: January 20, 2017

/s/ Royal C. Gardner
Royal C. Gardner

CERTIFICATE OF SERVICE

I hereby certify that on January 20, 2017, I electronically filed a true and correct copy of the foregoing Brief of Dr. M. Siobhan Fennessy, Dr. Carol A. Johnston, Dr. Marinus L. Otte, Dr. Margaret Palmer, Dr. James E. Perry, Professor Charles Simenstad, Dr. Benjamin R. Tanner, Dr. Dan Tufford, Dr. R. Eugene Turner, Dr. Kirsten Work, Dr. Scott C. Yaich, and Dr. Joy B. Zedler as Amici Curiae in Support of Respondents and in Support of Upholding the Clean Water Rule with the Clerk of the Court for the United States Court of Appeals for the Sixth Circuit using the Court's appellate CM/ECF system, which will send notification of this filing to the attorneys of record.

Date: January 20, 2017

/s/ Royal C. Gardner
Royal C. Gardner

ADDENDUM

Amici Curiae Biographies[2]

Dr. M. Siobhan Fennessy is the Jordan Professor of Biology and Environmental Studies at Kenyon College where she teaches and conducts research on wetland ecosystems. She serves on the National Research Council's Water Science and Technology Board, and had been appointed to two NRC committees. A Fulbright Fellow, she was recently appointed to the Intergovernmental Platform on Biodiversity and Ecosystem Services for the global assessment of land degradation and restoration, and to the Ramsar Convention's Scientific and Technical and Review Panel.

Dr. Carol A. Johnston is a Professor at South Dakota State University, where she teaches ecology and environmental science. She served on the National Research Council's Water Science and Technology Board and on NRC committees studying wetland mitigation, wetland delineation, and watershed management. She is a Fellow of the Society of Wetland Scientists, and received the National Wetlands Award for Science Research from the Environmental Law Institute in 2009.

Dr. Marinus L. Otte is a Professor in the Department of Biological Sciences at North Dakota State University, and has been specializing in many aspects of wetland science for more than 25 years. He has worked on both coastal and inland wetlands in the United States (Minnesota, North Dakota, and South Carolina), China, Ireland, and the Netherlands. He teaches Wetland Science, Ecotoxicology, Environmental Science, and Plant Systematics. He has served as Editor-in-Chief of the scientific journal *Wetlands* since 2012.

Dr. Margaret Palmer is Director of the National Socio-Environmental Synthesis Center, a National Science Foundation and University of Maryland supported research center. A Distinguished University Professor at the University of Maryland, she oversees a research group focused on watershed science and restoration ecology. Having worked on streams, wetlands, and estuaries for more than 30 years, she is past Director of the Chesapeake Biological Laboratory, currently serves on the editorial boards of the journals *Restoration Ecology* and *Science*, and is an elected fellow of the Society for Freshwater Science.

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[2] Affiliations of amici curiae and their counsel are provided for identification purposes only.

Dr. James E. Perry is a Professor of Marine Science at the College of William and Mary's Virginia Institute of Marine Science. A past president of the Society of Wetland Scientists (SWS), he has overseen its Professional Certification Program and its Ethics Committee. He is also a member of the Coastal and Estuarine Research Federation, Ecological Society of America, and Society of Ecological Restoration. He has published over 50 peer-reviewed journal articles and book chapters.

Charles Simenstad is a Research Professor in the School of Aquatic and Fishery Sciences, at the University of Washington, where he focuses on the structure and function of tidal wetlands within the broader landscape context of estuarine and coastal ecosystems. He is Co-Editor-in-Chief of the scientific journal *Estuaries and Coasts*, serves on the Environmental Advisory Board to the Chief of the U.S. Army Corps of Engineers, and contributed to the NRC Committee on Compensating for Wetland Losses.

Dr. Benjamin R. Tanner is an Assistant Professor of Environmental Science and Studies at Stetson University, where his research focuses on wetland sediment records of environmental change. He has worked on both tidal saline and inland freshwater wetlands at multiple sites in Florida, the Carolinas, and Maine. He teaches advanced courses on wetland systems, soils and hydrology, and wetland identification and delineation.

Dr. Dan Tufford focuses his research on watershed ecology and water resources management. His work ranges from field studies to simulation modeling and includes water quality, hydrology, and landscape interactions. His recent projects include integrating climate science and water management, and watershed modeling for the North Inlet-Winyah Bay National Estuarine Research Reserve. He is currently a member of the Board of Directors for the Columbia Audubon Society and on the state Advisory Board for Audubon South Carolina.

Dr. R. Eugene Turner is the 71st Boyd Professor in the Louisiana State University System where he teaches restoration and wetland ecology courses and maintains a healthy research program. He has been Chair or Co-Chair of the INTECOL Wetlands Working Group (WWG) since 1976, Executive Board Member of INTECOL and of the non-profit Green Lands, Blue Waters, and serves on various national scientific committees, and two editorial boards. He has been on NRC committees including the Committee on Compensating for Wetland Losses.

Dr. Kirsten Work is a Professor in the Stetson University Biology Department. Over the course of her career, she has studied a broad range of freshwater systems, from lakes in the upper Midwest and Alaska to streams, rivers, and reservoirs in the Great Plains to springs, lakes, and wetlands in Florida. She is particularly interested in the role of disturbance aquatic on ecosystem function. Her current studies focus on fish diversity in Florida springs.

Dr. Scott C. Yaich has worked in the field of wetland conservation for over 30 years, has been a Certified Wetland Scientist, and is a Certified Wildlife Biologist. He worked as the Wetlands and Waterfowl Program Coordinator, Chief of Wildlife Management, and Assistant Director of Conservation for the Arkansas Game and Fish Commission, and as a specialist in wetland habitat conservation for the U.S. Fish and Wildlife Service. He also served as staff and Council member of the North American Wetlands Conservation Council.

Dr. Joy B. Zedler is Professor Emerita (Botany and Aldo Leopold Professor of Restoration Ecology) at the University of Wisconsin-Madison. She continues to publish her wetland ecology research, to advise on Adaptive Restoration, and to help edit two journals, *Restoration Ecology* and *Ecosystem Health and Sustainability*. She is a member of the California Delta's Independent Science Board and a Trustee of the Wisconsin Chapter of The Nature Conservancy. She served on four NRC committees and chaired its Committee on Mitigating Wetland Losses.