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BARBARA COSENS

Resolving Conflict in Non-Ideal, Complex Systems: Solutions for the Law-Science Breakdown in Environmental and Natural Resource Law

ABSTRACT

In 2006, the U.S. Supreme Court decided a consolidated case concerning the scope of the U.S. Army Corps of Engineers' jurisdiction to require permits for dredge and fill of wetlands under section 404 of the Clean Water Act, issuing a plurality, two concurrences, and two dissents. Each opinion has a solid legal foundation, yet none truly makes sense if the science of the resource in question is considered. The opinions in Rapanos v. United States illuminate the struggle at the law-science interface. The problem is not due to either a failure in legal reasoning or a failure in scientific methodology if each is viewed in isolation. Instead, the difficulty lies in the complexity that results when the human system is overlain on the environment and in our failure to account for that complexity in the methods that govern natural resources dispute resolution. The primary purpose of this article is to shift the dialogue from its current bifurcated focus on better science or better laws to a focus on the need for a new, integrated approach at the law-science interface. The article concludes by recommending one such approach, based on the experience of the Colorado water courts, that would involve the designation of specialized federal district courts with scientists on staff.

I. INTRODUCTION

In 2006, the U.S. Supreme Court decided a consolidated case concerning the scope of the U.S. Army Corps of Engineers' jurisdiction to...
require permits for the dredging and filling of wetlands under section 404 of the Clean Water Act.\(^1\) The opinions issued in \textit{Rapanos v. United States} include a plurality, two concurrences, and two dissents. Each opinion has a solid legal foundation in the methodology chosen to reach its conclusion. Yet none makes sense if the science of the resource in question is considered.

The struggle at the law-science interface illustrated by the \textit{Rapanos} case cannot be attributed to either a failure in legal reasoning or a failure in scientific methodology if each is viewed in isolation. Instead, the problem lies in the complexity prevalent in natural systems compounded by the complexity at the interface between law and science—i.e., the overlay of the human system on the environment—and our failure to account for that complexity in either legal procedure or scientific methodology.

This problem is not new to those who study the natural sciences. Scientists have long recognized the increasing complexity and lack of predictability that occurs as studies move from controlled experiments in the laboratory to observation of natural systems.\(^3\) Ways of thinking about these complex, so-called non-ideal systems may help make sense of the added complexity that emerges when the legal system is overlain onto natural systems and may yield an initial understanding of the law-science interface as a complex, non-ideal system itself. This understanding can inform efforts to develop institutions more appropriately designed to address and resolve disputes in environmental and natural resource law.

The first step in understanding the complexity at the law-science interface is to understand that the science of natural systems is itself complex. This article begins by discussing the range of scientific disciplines from those reflecting "pure science," using physical chemistry as an example, to those requiring an understanding of non-ideal, complex systems such as geology and biology. The overlay of social systems such as law not only adds an additional degree of uncertainty, unpredictability, and unreplicability, but also interacts with the natural system in a way that renders solutions from a single discipline, either law or science, inadequate.\(^4\)

\(3\). \textit{Nat'l Acad. of Sci., Nat'l Acad. of Eng'g & Inst. of Med. of Nat'l Acad's., Facilitating Interdisciplinary Research} 32–33 (2005) ("If science and engineering deal with extremely complex systems, the same is true for studies of human society. How human societies evolve, make decisions, interact, and solve problems are all matters that call for diverse insights. Very fundamental questions are inherently complex.").
\(4\). Although many would argue that humans are part of the natural system, humans are considered separately here because we have developed one approach for resolving social disputes—law—and one approach for resolving disputes concerning the state of natural systems—science.
The scientific search for truth in the study of complex natural systems runs head-on into the legal search for finality, yielding legal results that achieve neither scientific accuracy nor finality. This article uses the case study of federal wetlands regulation to illustrate the inadequacy of existing judicial, legislative, and agency mechanisms to provide appropriate decision making in the face of non-ideal, complex systems in the area of environmental and natural resource law. The article concludes with an analysis of alternatives for better integrating science into natural resources dispute resolution and suggests some initial steps for going forward.

II. ENVIRONMENTAL AND NATURAL RESOURCE ISSUES AS NON-IDEAL, COMPLEX SYSTEMS

The laws of thermodynamics predict that chemical systems will conserve energy and tend toward increasing disorder. Thus, chemicals, when mixed together, will form new compounds in a lower energy state. In what is referred to by physical chemists as an "ideal system," all things achieve equilibrium—a final state with the lowest possible energy. By assuming an ideal system, physical chemists can develop mathematical equations to predict the results of reactions between different chemical combinations, and the product can be shown to be repeatable in controlled experiments.

This is the nature of the hard sciences. Outcomes can be predicted by simple rules reflected in mathematical equations. Experiments in

5. That energy can be converted from one form to another but cannot be created or lost—i.e., is conserved—is the first law of thermodynamics. See, e.g., NICHOLAS W. TSCHOGAL, FUNDAMENTALS OF EQUILIBRIUM AND STEADY-STATE THERMODYNAMICS (2000) (that the entropy, or disorder, of a system will increase over time if no energy is added is the second law of thermodynamics).

6. See, e.g., id.


As prefigured above, the simple answer is that the power of science depends on the nature of the problem and the strength of the tools available to analyze it. Good science ranges from the highly precise and accurate methods found in the hard sciences (e.g., Newtonian physics) to heuristic models that expose general patterns in complex systems (e.g., ecology). Science is thus inherently pluralistic, as the different scientific disciplines attest, and a unitary conception of environmental science is neither a desirable end nor a viable goal.

Id. at 2 (citations omitted). See also Holly Doremus, Science Plays Defense: Natural Resource Management in the Bush Administration, 32 ECOLOGY L.Q. 249, 298 (2005) ("With the right
controlled environments are replicable. But to the scientist who studies
natural systems—e.g., the geologist, the ecologist, the social scientist—this
approach is far from "ideal." Natural systems display states that are
repeated over and over again in different settings that cannot be predicted
by the laws of thermodynamics and the assumption of ideality. Examples
range from the uniform relation between the geometry of pool/riffle
sequences and meanders and the width of a river, to the repeated
occurrence of so-called metastable mineral sequences in geothermal
systems and ore bodies, to life. As a result, although natural systems can
be described and compared with accuracy, the predictability of future
behavior is far more uncertain. This leads to much softer answers and
greater disagreement within the discipline on exactly what those answers
should be. This is the nature of complexity.

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12. For additional discussion of this by a legal scholar with a biology background, see Holly Doremus & A. Dan Tarlock Science, Judgment, and Controversy in Natural Resource Regulation, 28th Annual Public Land Law Conference: Science and Democracy in Public Land Conflict: Forest, Fish, and Fire, 26 PUB. LAND & RESOURCES L. REV. 1, 18 (2004) ("First, as sensible ecologists have constantly warned, ecology and the related biological sciences will never reach the precision and elegance of physics and mathematics.")
In addition to the complexity resulting from the sheer number of variables, the difficulty with predicting system behavior through synthesis from a reductionist understanding of the components is that it builds from the assumption of ideal behavior. Ideal behavior assumes no interaction between components. In other words, the assumption is that the behavior observed in isolation will remain unchanged in the face of greater complexity. Yet those who use empirical methods to study natural systems have found that it is often the interactions among components that define the system. This is the very premise of the field of ecology.13

Take, for example, a river. Mathematical descriptions of fluid flow in an ideal system assume no friction. Yet anyone who has run a river knows that it is the edge effects that define the flow: the turbulence around a boulder or fallen log, the riffles over a gravel bed, the eddy on the inside of a curve. It turns out that friction, the component missing in ideal fluid flow, defines a river. Thus, mathematical modeling of river flow includes a term for friction.14 The sediment load of a river adds even greater complexity to defining river flow and channel morphology, requiring the addition of yet another disciplinary component.15 The study of a river becomes even more complex when its development is viewed in a longer timeframe in which tectonics may play a role in shaping its morphology.16 Finally, no one who has observed the channelization, damming, and development of our great rivers can ignore the impact of human intervention.17

Fossil hydrothermal systems provide another example. At moderate temperatures, the flow of fluid through fractures in rock will interact to alter the mineral composition of the rock. In an ideal system, the reactions will go to equilibrium and the resulting mineral assemblage is predictable.18 But in a real system, fluid flow is often faster than the rate of chemical exchange between rock and water; thus, the system will not have time to achieve equilibrium.19 The addition of kinetic information—i.e.,

14. VEN TE CHOW ET AL., APPLIED HYDROLOGY 272–73, 304 (1998) (the term for friction is in the St. Venant equations used to handle river flow).
18. Gallinatti, supra note 9, at 3275.
19. Id.
information on the rate at which a particular reaction at a particular temperature will occur—to a model of that water-rock interaction vastly improves the predictability of the intermediate or "metastable" results. However, simply adding kinetic information to a model built from a reductionist understanding of the system will not result in the repeated occurrence of the same metastable minerals observed over and over again in different natural systems that could not possibly have had the exact same rate of fluid flow. Could it be that some other factor defined by the very nature of the interaction between rock and moving water determines the outcome? It is the possibility, in fact the belief by some, that interactions define natural systems that has led to the development of new disciplines, such as ecology, at the point of interaction, rather than disciplines based on synthesis within the hard sciences.

These examples of complexity and non-ideal behavior at the intersection between system components should not be unfamiliar to the reader who studies the law. The very need for law rests on the complexity of human interaction. A single human alone on an island needs no law. It is the determination of the rights of one human being or group relative to those of another that gives rise to civil law. Rarely are the facts of a legal dispute identical to one that has already been decided, yet often lawyers can predict the outcome of a new case based on the similarity of key controlling features to those of prior cases.

21. This has also been referred to as a problem of scale. David Adelman notes: Simon Levin, an ecological modeler and theorist, describes this approach with characteristic clarity:

"This is the principal technique of scientific inquiry: by changing the scale of description, we move from unpredictable, unrepeatable individual cases to collections of cases whose behavior is regular enough to allow generalizations to be made. In so doing, we trade off the loss of detail or heterogeneity within a group for the gain of predictability; we thereby extract and abstract those fine-scale features that have relevance for the phenomena observed on other scales."

One implication of this approach is that not all levels of abstraction for analyzing a problem are created equal. Just as it would be foolish to try to study the behavior of a gas by attempting to follow the motion of every single gas molecule, so too may it be futile to attempt to understand biodiversity by tracking populations of individual species. Consideration of scale matters for basic scientific understanding and for very practical problems of effective environmental management. In fact, the two are closely linked because identification of strong associations (i.e., patterns) through basic scientific work makes environmental management possible.

Adelman, supra note 7, at 8.
The law provides this degree of certainty and predictability as a result of social contract, not natural law. Yet it nevertheless mimics the behavior of complex natural systems in which multiple variables must be sorted and weighed to determine their importance to the future activity of the system. Quite possibly, it is this similarity that has led us to erroneously conclude that the same process used to resolve disputes between human beings can be used when those disputes concern natural systems. Those involved in the legal system are not alone in making this error.

Within the vast field and number of disciplines we thus refer to as "science," some individuals have sought a unifying theory that will allow for predictability in all systems. E.O. Wilson writes of the inception of this effort, stating,

The dream of intellectual unity first came to full flower in the original Enlightenment, an Icarian flight of the mind that spanned the seventeenth and eighteenth centuries. A vision of secular knowledge in the service of human rights and human progress, it was the West’s greatest contribution to civilization. It launched the modern era for the whole world; we are all its legatees. Then it failed.

Modern scholars engaged in the study of complex systems attribute this failure to the dismissal of complexity as a key component of the system.

In contrast to the search for unity, the vast majority of scientists since the seventeenth and eighteenth centuries have sought replicable and predictable behavior in systems through reductionism—breaking those systems into their component parts. Those scientists coming from a disciplinary world in which reductionism prevails often attempt to describe and predict behavior in more complex systems through synthesis. Thus, to understand an organism, it is built from the cell up. To understand the interaction between the human and natural world, we would study each in isolation and then attempt to bring those separate understandings to bear.
on the resolution of a single environmental problem. As Wilson points out, "The greatest obstacle to consilience by synthesis...is the exponential increase in complexity encountered during the upward progress through levels of organization."\(^{28}\) The advent of high speed computing has made it easier to describe complex systems with multiple variables, but as any modeler of climate change knows, the whole is not merely the sum of the parts.

Just like the natural sciences, natural resources law suffers from the failure of synthesis to accurately represent the behavior of the system. Thus, a legal approach that makes sense based on an understanding of formal rules of statutory construction fails to take into account the complexity of the ecosystem that is subject to competing demands.

Another reason why the current legal process for dispute resolution is inadequate when applied to natural systems is that the legal system and the science of natural systems serve two different masters. In simple terms, science is a search for the truth, whereas litigation is a search for finality. Scientific inquiry has no statute of limitations, no concept of res judicata. Scientific methodology is a process of disproving what we formerly thought to be true, of re-investigating questions thought solved, of re-interpreting information in light of new discoveries.\(^{29}\) In contrast, civil litigation is designed to close the book on a dispute, to provide a forum where, no matter how flawed the inquiry might be, we can achieve peaceful final resolution of conflict.

In environmental and natural resource disputes, finality serves those with economic interests in the resource, whereas science serves those concerned with sustaining the resource itself. The fact that one side of the litigation equation in a typical environmental or natural resource dispute seeks a goal that is not served by the forum provided helps explain why these disputes often face endless gridlock within the judicial system or, alternatively, once the judicial system provides a seemingly final answer, are revisited in the legislature.

When we consider both the different disciplinary goals and techniques of law and science and the increased complexity at the intersection, it becomes clear that understanding the complex behavior in this non-ideal system may require a new way of thinking and a new forum for resolving disputes where these disciplines intersect. It is the possibility that a new understanding of the interface between law and science can improve our approach to dispute resolution in the environment and natural resource areas that is the basis for this article. This is the view that substance matters, that our institutions, including agencies and the judiciary, must

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28. *Id.* at 91.
adapt to the subject matter at hand. One author alluded to this concept in criticizing the handling of a case about climate change by stating:

Long ago, Hamilton argued in The Federalist No. 78 that their inability to apply force or will—leaving the courts with only their “judgment”—would make the judiciary the “least dangerous branch.” He did not foresee how scientific questions could eventually so dominate American public life as to render the rule of law essentially irrelevant to, for example, the biggest environmental problem confronting humanity in the twenty-first century. He did not foresee, that is, the danger of judicial power rendering itself impotent and trapped within its own trumped-up structure.

The following case study illustrates the breakdown that occurs when science and the law are merely combined with no accommodation for the complexity of the interaction.

III. CASE STUDY: THE LAW-SCIENCE INTERFACE IN FEDERAL WETLANDS REGULATION

In 2006, the U.S. Supreme Court decided a consolidated case concerning the scope of the jurisdiction of U.S. Army Corps of Engineers to require permits for the dredging and filling of wetlands under section 404.

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30. One author notes that this adaptation is already occurring in endangered species law, stating,

Law, acting alone, would never have produced the process rules the court devised for critical habitat in the Homebuilders case. Neither would science on its own have led to them. Rather, the law-science process of the ESA, as in other environmental law programs, is an emergent property. Law and science have mingled under the ESA for almost 35 years. The result is a process that does not make complete sense to any lawyer wearing only a law hat, or to any scientist wearing only a science hat. That is to say, the ESA’s law-science process cannot be understood through the reductionist lens of law or science alone. It has properties that do not exist in law alone or in science alone, therefore it no longer makes sense to evaluate the ESA strictly from the perspective of legal process or of science process.


32. The two cases, both from the Sixth Circuit, were Rapanos v. United States, 376 F.3d 629 (2004), and Carabell v. United States, 391 F.3d 704 (2005). The consolidated case is referred to as Rapanos.

of the Clean Water Act. The *Rapanos* case raised the same question that continues to plague courts dealing with natural resources issues: where does the law end and the science begin and who decides? The opinions in *Rapanos* include a plurality, two concurrences, and two dissents. Each opinion is based on a solid legal foundation. However, even though the subject matter of the dispute—water quality—is an area infused with science, none of the five opinions is grounded in a scientific understanding of the resource at issue. In fact, each opinion is sufficiently divorced from the science as to make subsequent implementation extremely difficult.

Much has been written about the law-science dilemma, and efforts have been made to address it. Most of these have focused on the science or the need for transparency in science policy. While these are useful beginnings, none resolve the problem presented by *Rapanos*: if all five U.S. Supreme Court opinions addressing an area in which science is needed to develop and implement the law are completely valid as a legal matter yet have no meaning when the science addressing the resource is considered, then something is wrong with the legal methodology chosen to resolve disputes at the law-science interface in environmental and natural resource law.

This section will discuss the legal background leading to *Rapanos*, the scientific understanding of the relation between wetlands and water quality, and, finally, the five *Rapanos* opinions to illustrate both the validity of the legal reasoning and the absence of any relation between that reasoning and the science.

36. See, e.g., J.B. Ruhl & J. Salzman, *In Defense of Regulatory Peer Review*, 84 WASH. U. L. REV. 1, 10 (2006) (In discussing the need for peer review, the authors state, “The standard argument that agencies must make policy decisions in the face of incomplete and uncertain scientific data, and thus should not be bound to the rigors of peer review, turns the issue on its head. Designed wisely, regulatory peer review can help reveal how much scientific uncertainty underlies an agency decision and can thus demand that the agency explain how the gap was filled.”); Doremus, supra note 7, at 253 (“The core of the problem is not the involvement of politics but its concealment behind a cloak of science.”); Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613, 1617 (1995) (“Although camouflaging controversial policy decisions as science assists the agency in evading various political, legal, and institutional forces, doing so ultimately delays and distorts the standard-setting mission, leaving in its wake a dysfunctional regulatory program.”).
A. The Law: Pre-Rapanos Wetlands Regulation

The Clean Water Act (CWA)\(^{37}\) begins with the ambitious goal "to restore and maintain the chemical, physical and biological integrity of the Nation's waters." To accomplish this goal, the CWA, among other things, prohibits both "discharge of any pollutant,"\(^{38}\) defined as "any addition of any pollutant to navigable waters,"\(^{39}\) except as permitted by the CWA and "discharge of dredge or fill material into the navigable waters"\(^{40}\) except as permitted by the CWA. The CWA defines the "navigable waters" to which it applies as "the waters of the United States, including the territorial seas."\(^ {41}\)

The CWA assigns authority for discharge permits\(^{42}\) and oversight of state programs\(^ {43}\) to the Environmental Protection Agency (EPA) but grants the Corps of Engineers jurisdiction over dredge and fill permits,\(^ {44}\) consistent with its area of authority under the Rivers and Harbors Act of 1899.\(^ {45}\) The legal scope of jurisdiction of the two agencies is constrained at two levels: (1) by the authority of Congress to act in a particular area as set forth in the U.S. Constitution and (2) by the intent of Congress to assign jurisdiction to the agencies as set forth in the Clean Water Act. Although numerous challenges to the constitutionality of the scope of agency jurisdiction under the CWA have been raised, the U.S. Supreme Court has so far restricted its rulings to the intent of Congress under the CWA.\(^ {46}\)

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39. Id. § 1362(12)(A). The full text of the definition is as follows:
   The term "discharge of a pollutant" and the term "discharge of pollutants" each means (A) any addition of any pollutant to navigable waters from any point source, (B) any addition of any pollutant to any waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft.
40. 33 U.S.C. § 1344(a) (2000). Although the CWA is primarily implemented by the EPA, the dredge and fill portions of the Act are administered by the Army Corps of Engineers, 33 U.S.C. § 1344(d) (2000), for reasons of history discussed below.
42. Id. § 1342.
43. Id. § 1342(b).
44. Id. § 1344.
45. Id. § 401 et seq.
46. For a general treatment of the pre-Rapanos agency and court actions, see Donna M. Downing et al., Navigating Through Clean Water Act Jurisdiction: A Legal Review, 23 WETLANDS 475 (2003). Not only is the article a good overview of the sequence of events, but, because it is authored by legal counsel to the EPA and the Corps of Engineers, it also provides insight into possible agency interpretation of those events.
The Corps' initial definition of "waters of the United States" limited its jurisdiction to navigable waters or those waters susceptible to use in interstate commerce. In response to a legal challenge, in 1975 the Corps issued regulations revising its definition of the waters covered by the CWA to include tributaries to navigable waters and all wetlands adjacent to covered waters. Thus, at the time of the first major challenge to Corps jurisdiction over wetlands under the CWA, Corps regulations defined "wetlands" as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."  

In a challenge to the Corps' assertion of jurisdiction over the filling of wetlands located adjacent to a navigable lake and formed by saturation from ground water, the U.S. Supreme Court unanimously reversed the Sixth Circuit's ruling restricting the CWA's jurisdiction to marshes formed by frequent flooding from adjacent navigable waters. The primary legal principle on which the Court based its opinion was deference to the reasonable interpretation of the expert agency given the scientific nature of the question of where "waters ends and land begins." The Court found the interpretation by the Corps to be reasonable because of the legislative history recognizing the complexity of the hydrologic cycle and its function in water quality and the Corps' acknowledgement of the scientific relation between wetlands and the water quality of adjacent water bodies through filtration and reduction in flooding and erosion. The Court left open the question of jurisdiction over wetlands that are not adjacent to navigable waters and their tributaries.  

This opening became the focus of the next round of litigation. In *Solid Waste Agency of Northern Cook County v. United States* (SWANCC), Chief Justice Rehnquist, writing for the five-person majority, found that "isolated

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49. 33 C.F.R. § 328.3(b) (1978).
51. *Id.* at 132.
52. *Id.* at 133-34.
53. *Id.* at 124 n.2.
wetlands” were outside the CWA jurisdiction of the Corps. Language asserting jurisdiction over “isolated wetlands,” or those wetlands not adjacent to navigable waters or their tributaries, had been included in preambles to both EPA and Corps regulations, which stated,

“Waters of the United States” typically include the following waters:

- Which are or would be used as habitat by birds protected by Migratory Bird Treaties; or
- Which are or would be used as habitat by other migratory birds which cross State lines; or
- Which are or would be used as habitat for endangered species; or
- Used to irrigate crops sold in interstate commerce.

The Corps had asserted its authority over the isolated wetlands at issue in SWANCC based on their use by migratory birds. The legal methodology used by the court in rejecting this jurisdiction was twofold.

First, while the Court acknowledged that in United States v. Riverside Bayview Homes, Inc. it interpreted the definition of “navigable waters” in the CWA as “waters of the United States” to include more than traditional navigable waters, the Court stated that it could not read the term “navigable” entirely out of the CWA. The Court stated that “[i]t was the significant nexus between the wetlands and ‘navigable waters’ that informed our reading of the CWA in Riverside Bayview Homes.” Thus, the Court interpreted the text of the CWA itself to determine the intent of Congress rather than the legislative history relied on in Riverside Bayview.

Second, the Court refused to grant deference to the agency interpretation of an ambiguous statute in this case, finding that such deference was inappropriate when the agency interpretation might raise constitutional issues. The Court identifies this as both a “prudential” concern to avoid unnecessarily addressing constitutional issues and a

56. SWANCC, 531 U.S. at 167, 172.
57. Id. at 167.
58. Id. at 172.
federalism concern to exercise caution where a federal-state balance has been established in the regulation of an area formerly left to the states. 59

Unfortunately, while these decisions are defensible and arguably compatible on legal grounds, neither of them provides helpful guidance to the agency scientists who must implement the CWA. Agency scientists appear to have focused on the "substantial nexus" language emphasized by the SWANCC Court to provide a basis for developing an approach that could be scientifically defended by focusing on the relation between the particular wetland and the water quality of a navigable water. 60 This brings us to the relevant science.

B. The Science: Wetlands and Water Quality

As noted above, EPA regulations define wetlands for purposes of the CWA as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." 61 From the perspective of the wetland specialist, it is the plant, animal, and soil characteristics of a particular area as well as the frequency of saturation that delineate the wetland, not the continuous presence of surface water, as the Rapanos court ultimately based its decision on. 62 Wetlands in the United States fall into the following four categories: marshes, swamps, bogs, and fens. 63

Wetlands can be thought of as the transition zone between land and water. 64 Similar to other ecological transition zones, wetlands are biologically rich and diverse, including elements of both zones and their own unique biota that are adapted to live in a frequently changing system. 65

59. Id. at 172-73.
60. See, e.g., Downing et al., supra note 46, at 492 ("It is this question—the 'significant nexus' between an intrastate non-navigable 'isolated' water and the rest of the aquatic ecosystem—that will likely determine whether the water will be protected by the CWA."); Scott G. Leibowitz, Isolated Wetlands and Their Functions: An Ecological Perspective, 23 WETLANDS 517, 526 (2003).
61. 40 C.F.R. § 230.3(t) (2008).
64. COWARDIN ET AL., supra note 62, at 3.
According to the EPA, wetlands cover five percent of the surface area of the coterminous United States, yet they are home to 31 percent of the plant species. But beyond the ecological richness of the habitat, wetlands perform two important functions that render them relevant in a discussion of water quality.

First, due to their proximity to bodies of water, wetlands serve as storage areas in times of high water, both slowing the movement of surface water to a water body and providing overflow when that water body floods. To humans, this function is important both for considerations of flood control and for sediment transport into waterways. One study concluded that restoration of the 100-year floodplain in the Upper Mississippi River basin would allow storage of 39 million acre-feet of water—enough to prevent the floods of 1993 and the resulting roughly $16 billion in damage.

Second, in the process of slowing the movement of runoff from land to a water body and thus allowing suspended sediment to drop out of the water column, wetlands perform a filtration function. This may be aided by the abundance of peat-like material in certain types of wetlands. Similar to a manufactured water filter, this carboniferous layer of material may absorb contaminants such as heavy metals and thus prevent them from entering the water body.

Although scientists may agree that wetlands as a whole perform these functions, the values of an individual wetland may vary. Because wetlands fall on a continuum between continuous and intermittent flooding and range in latitude from the tropics to the tundra, the delineation and water quality value of an individual wetland are likely to vary among experts.

The term “isolated wetland” used in SWANCC is not a scientifically defined term. It is true that wetlands may be isolated geographically,
meaning the wetland is completely surrounded by uplands.\textsuperscript{74} However, although geographically isolated wetlands may lack apparent surface water connections to a water body, hydrologic connections through ground water or intermittent flooding by surface water may still exist.\textsuperscript{75} The degree of connection to other water bodies through ground water will depend on the nature of the underlying substrate, among other factors, and thus will be unique to the particular wetland and potentially difficult to evaluate.\textsuperscript{76} Ecological isolation is a concept disfavored by scientists both because ecologists consider all biota connected at some level\textsuperscript{77} and because dispersal of organisms between wetlands may occur through mechanisms other than a surface water connection.\textsuperscript{78}

Geographically isolated wetlands may still perform important water quality functions; however, few studies have addressed this issue,\textsuperscript{79} and most articles on the subject merely draw the inference that a water quality link will exist when hydrologic connection exists.\textsuperscript{80} Some studies suggest that isolated wetlands may perform an important role in uptake of phosphorus and in denitrification.\textsuperscript{81} More information is available on the continued importance of some geographically isolated wetlands in flood control.\textsuperscript{82} This absence of data on the relation between certain types of wetlands and water quality despite over 30 years of implementation of the CWA is symptomatic of one of the major disconnects between law and science—our failure to take opportunities to learn, which will be discussed further in section IV.

Given the tension between the scientific fact that wetlands exist on a complex continuum between a clear surface water connection and geographic isolation and the legal principles developed in \textit{Riverside Bayview} and SWANCC, it is not surprising that the next challenge to reach the U.S.
Supreme Court focused on a wetland with an unclear surface water connection. We now turn to Rapanos.

C. Rapanos: The Law-Science Trainwreck

On June 19, 2006, the U.S. Supreme Court issued its opinions in Rapanos v. United States after failing to achieve a majority opinion. This section will briefly describe the facts underlying the consolidated cases and then analyze the legal methodology relied on by each of the five opinions.

1. The Factual Setting

In the words of Justice Scalia, “In these consolidated cases, we consider whether four Michigan wetlands, which lie near ditches or man-made drains that eventually empty into traditional navigable waters constitute ‘waters of the United States’ within the meaning of the Act.”

A more detailed description of the wetlands in question can be gleaned from the concurring opinion of Justice Kennedy. In the first consolidated case, developer John Rapanos began filling three wetlands without a permit after being told that one would be necessary. These wetlands are referred to as the “Salzburg site,” the “Hines Road site,” and the “Pine River site.” Wetlands on the Salzburg parcel were found by the district court to be hydrologically connected to tributaries to the navigable KawKawlin River via the Hoppler Drain, and to a creek that is a tributary to the Saginaq River, which flows into Lake Huron. The district court found the Hines Road site to have a surface water connection to the Rose Drain, which feeds into the navigable Tittabawassee River. The

83. 547 U.S. 715 (2006). The Court achieved a majority on the outcome but issued two concurring opinions and two dissents. Justice Scalia wrote for the plurality and was joined by Chief Justice Roberts and Justices Alito and Thomas. Chief Justice Roberts and Justice Kennedy wrote separate opinions with Kennedy concurring in the outcome. Justice Stevens wrote a dissent joined by Justices Souter, Ginsburg, and Breyer. Justice Breyer wrote a separate dissenting opinion.

84. In discerning the factual background from the opinions, it is worth noting that, similar to astute law students, the authors, while each accurately stating the facts, chose those facts that made their approach and conclusion appear most reasonable. Thus, the author of the particular facts chosen for the purposes of this article will be noted in each instance.

85. Rapanos, 547 U.S. at 729 (Scalia, J., writing for the plurality).
86. Id. at 763 (Kennedy, J., concurring).
87. Id. at 762 (Kennedy, J., concurring).
88. Id.
89. Id.
90. Id.
91. Id.
district court found the Pine River site to have a surface water connection to Pine River, which flows into Lake Huron.\textsuperscript{92}

By contrast to the Rapanos scenario, in the other consolidated case the Carabells sought and were denied a permit by the Corps (overriding the decision of the Michigan Department of Environmental Quality)\textsuperscript{93} due to the flood storage function of the wetlands they sought to develop.\textsuperscript{94} The wetland in question was found by the district court to be one mile from the navigable Lake St. Clair. A berm blocks the wetlands' surface water connection with a ditch that empties into the Sutherland-Oemig Drain, which flows to Auvase Creek, a tributary to Lake St. Clair.\textsuperscript{95} A ten-year storm will result in overflow of the berm and storage of flood waters in the wetland.\textsuperscript{96}

In his dissent, Justice Stevens provides additional information on the values of the wetlands in question as described by the government witness at trial. The district court had found the expert witness to be "highly credible,"\textsuperscript{97} and according to the expert's testimony, the wetland functions at the Rapanos sites included floodwater storage, moderation of low flows, and sediment trapping.\textsuperscript{98} Evidence presented to the district court regarding the basis for the rejection of the Carabells' permit application indicated that the wetland performs both storage and filtration functions during flood events.\textsuperscript{99}

In both cases, the Sixth Circuit upheld the Corps' jurisdiction to require dredge and fill permits for the wetlands under section 404 of the

\textsuperscript{92} Id.
\textsuperscript{93} Id. at 765 (Kennedy, J., concurring).
\textsuperscript{94} Id.
\textsuperscript{95} Id. at 764 (Kennedy, J., concurring).
\textsuperscript{96} Id.
\textsuperscript{97} Id. at 790 (Stevens, J., dissenting (quoting App. to Pet. for Cert. in No. 04-1034, p. B7)).
\textsuperscript{98} See id.
\textsuperscript{99} Id. (Stevens, J., dissenting) (quoting App. in No. 04-1384, p. 127a-128a). The letter from the Corps to the Carabells stated,

Your parcel is primarily a forested wetland that provides valuable seasonal habitat for aquatic organisms and year round habitat for terrestrial organisms. Additionally, the site provides water storage functions that, if destroyed, could result in an increased risk of erosion and degradation of water quality in the Sutherland-Oemig Drain, Auvase Creek, and Lake St. Clair. The minimization of impacts to these wetlands is important for conservation and the overall ecology of the region. Because the project development area is a forested wetland, the proposed project would destroy the resources in such a manner that they would not soon recover from impacts of the discharges. The extent of impacts in the project area when considered both individually and cumulatively would be unacceptable and contrary to the public interest.

\textsuperscript{Id. at 791.}
CWA. The parties sought and were granted certiorari, and the cases were consolidated.

2. The Plurality Opinion of Justice Scalia Joined by Chief Justice Roberts and Justices Alito and Thomas

As explained above, the Corps' jurisdiction to regulate wetlands under the authority of the CWA is restricted at both the constitutional and statutory levels. Just as with Riverside Bayview and SWANCC, the Rapanos opinions were decided at and limited to the statutory level. Thus, in determining the scope of the Corps' jurisdiction, the Court had to discern what Congress meant when it defined "navigable waters" as "waters of the United States." 

Justice Scalia answers this question by stating, "on its only plausible interpretation, the phrase 'the waters of the United States' includes only those relatively permanent, standing or continuously flowing bodies of water 'forming geographic features'...oceans, rivers, [and] lakes." Recognizing that Riverside Bayview allowed jurisdiction over wetlands adjacent to navigable waters, and unwilling or unable to get a majority to overturn the prior ruling, Justice Scalia narrows that ruling by requiring that the Corps' jurisdiction over a wetland be limited to "those wetlands with a continuous surface connection to bodies that are 'waters of the United States' in their own right." 

Justice Scalia's sole source for the definition of "waters" as it is used in the CWA is Webster's Dictionary. The requirement of a continuous surface connection lacks an explanation in the text of the opinion other than a desire to establish a clear, bright-line test. Thus, the following paragraphs

103. Rapanos, 547 U.S. at 739 (quoting WEBSTER'S SECOND 2882).
104. Id. at 742. Presumably Scalia's "'waters of the United States' in their own right" means navigable waters as traditionally defined; whereas "waters of the United States" as referred to in the CWA includes these surfacially connected waters. Id.
105. Id. at 739 (quoting WEBSTER'S SECOND 2882). Somewhat amusingly, Justice Scalia does rely on one other source — the 1942 Warner Brothers classic "Casablanca" — for the proposition that a dry desert is not water. Id. at 2218. This is fitting in that Justice Scalia's chosen definition reflects a nineteenth-early-twentieth-century view that if you cannot see it, it is not there. However, the millions of people now living in the southwestern United States in places where no surface water is apparent might disagree.
discuss both why the resort to Webster’s is a valid legal approach and why the chosen definition of “waters” and the requirement of a continuous surface connection results in absolute nonsense from a scientific point of view.

Justice Scalia is often referred to as a “textualist,” even by himself, and his opinion in Rapanos is an excellent illustration of this legal methodology. A textualist approaches legal analysis seeking a strict interpretation of the meaning of the language Congress chose to use at the time the statute was enacted. While there are many legal approaches that could be used in analyzing what is meant by “waters of the United States,” including review of the legislative history and deference to the interpretation of the agency charged with implementation (to be discussed in the context of Justice Stevens’ dissent), the textualist approach focuses only on the language of the CWA itself.

There are four primary justifications for the use of textualism. First, the language that ends up in the statute has been the subject of numerous levels of policy making and review from initial drafting to committee meetings to floor debate, and the legislative history is not an accurate record of the true intent of the language because participants in the process often shape their comments with an eye toward how they would like the statute to be interpreted. Second, citizens are entitled to notice of the laws that govern them, particularly where, as with section 404 of the CWA, criminal sanctions for violations are possible. Third, limiting judicial interpretation to the actual text limits judicial discretion to pick and choose

106. See Looking It Up: Dictionaries and Statutory Interpretation, 107 HARV. L. REV. 1437, 1437-39 (1994). One author notes that while the U.S. Supreme Court has referred to dictionaries in over 600 cases over two centuries, it has dramatically increased its usage since the mid-1980s. Id. at 1437. The author also notes that rarely before the present period did the Court use the dictionary as the central factor in an important determination. Id. at 1439-40.


109. See id.


111. See SCALIA, supra note 108.


113. Looking It Up, supra note 106, at 1441-42.

114. 33 U.S.C. § 1319(c) (2000) (providing for criminal penalties); 33 U.S.C. § 1344 (providing for permits for dredge and fill of wetlands and specifically noting that "the Administrator [may] take action pursuant to section 1319 of this title"); id. § 1344(n). No criminal actions were filed against Carabell; however, a criminal action filed separately from this case was filed against Rapanos. Rapanos v. United States, 547 U.S. 715, 763 (Kennedy, J., concurring).
among interpretations that fit the justices' desired outcome.115 Finally, where issues of federalism are concerned, states' interests are best protected by requiring a clear statement of Congress's intent to intrude upon an area of traditional state control.116 Thus, despite the extensive criticism of Justice Scalia's opinion in *Rapanos*,117 it must be admitted that he relied on a legitimate legal methodology for arriving at his conclusion. Unfortunately for the agency scientists who must now implement the CWA, this legitimate legal approach resulted in a meaningless conclusion from a scientific viewpoint.

Justice Scalia's dictionary definition of "waters" and his requirement of a continuous surface water connection divorce the legal term from the scientific reality. Scalia states that "the watercourses through which *intermittent* waters typically flow...are, by and large, not 'waters of the United States.'"118 However, in addition to its ecological importance, the value of a wetland (in fact of these particular wetlands) under the CWA is that it stores water and sediment when flooding occurs, an event that by


116. *Rapanos*, 547 U.S. at 738. Here, the traditional role referred to is a state's jurisdiction over water within its territory. See, e.g., United States v. New Mexico, 438 U.S. 696, 705 (1978). The federalism argument is somewhat disingenuous when applied to the situation at hand. Most western states have laws defining "waters" or "waters subject to appropriation" to distinguish between those waters that can become an item of property and thus commerce and those waters that cannot. See, e.g., N.M. STAT. ANN. § 72-1-1 (1978) (defining "waters" as anything in a channel); Sporhase v. Nebraska, 458 U.S. 941, 954 (1982) (concluding that water, once appropriated, is an article of commerce). If the true concern is deference to states, why not defer to their definition? Certainly, western congressional representatives of states participating in drafting the CWA would have known of these definitions. Nevertheless, this would not resolve the legitimate question of how a layperson is to interpret the term "waters."

117. For example, see a series of articles on the case in volume 22 of *Natural Resources & Environment*, published in 2007 by the American Bar Association. In particular, see James Murphy, *Hard to Navigate: Rapanos and the Future of Protecting Our Waters*, 22 NAT. RESOURCES & ENV'T 3 (2007) (referring to the case as "one of the most important, and befuddling, CWA decisions the Court has ever issued"); Joshua A. Bloom, *What's Next After Rapanos*, id. at 13 ("Unfortunately, the Court has done little more than muddy the waters in defining the extent of the federal government's authority under the CWA...."); Robin Kundis Craig, *Which Way Federalism Under Section 402?*, id. at 20 ("The Supreme Court's decision...clouds the future of the Clean Water Act's (CWA's) National Pollutant Discharge Elimination System...."); W. Parker Moore & Fred R. Wagner, *A Regulatory Proposal That Even the Supreme Court Could Love*, id. at 34 ("It is unlikely the lower courts will be able to iron out the regulatory wrinkles left in the wake of Rapanos."); Donna Downing et al., *Technical and Scientific Challenges in Implementing Rapanos' "Water of the United States, "* id. at 42 (stating, "[Rapanos and SWANCC] create new scientific and technical challenges" and "[t]he jurisdictional terms such as 'relatively permanent' and 'significant nexus' used in the Rapanos opinion are legal concepts").
definition is intermittent, and filters that water as it returns to a water body via a groundwater connection, an event that by definition occurs beneath the surface of the ground. Furthermore, very few of the water bodies in the southwestern United States fit Justice Scalia’s definition, despite the fact that the water from them, though intermittent, is relied on for drinking water and irrigation and bought, sold, and transferred as an article of commerce. Thus, the charge of the CWA to agency scientists to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters” is thwarted by the textural clarity sought by Scalia. Limiting water quality protection to wetlands with a continuous surface connection removes all those wetlands that provide significant water quality functions, yet have merely intermittent or subsurface connections to water used to meet human needs—i.e., water used in commerce.

None of the scientific definitions of wetlands appear to require continuous connection to surface flow. As noted above, wetlands are delineated by the soil and biota that result from conditions of saturation, whether the water causing the saturation is visible or not and whether it is surface or ground water. Of course, delineation of wetlands is not the question in Rapanos; rather, it is what constitutes a “water of the United States.” But scientifically, a continuous surface connection does not determine the importance of a particular wetland in the water quality of a navigable waterway or water used in interstate commerce. Rather, the key inquiry is the role that the wetland plays in storing floodwater and sediment and filtering out contaminants.

119. Id. at 741. Note that both scientists and lawyers have spent considerable time and effort arguing for protection of wetlands under the CWA on ecological bases. Justice Scalia resoundingly rejects this as an independent basis for jurisdiction. Id. at 742 (citing SWANCC, 531 U.S. at 167, 171). This article will leave the analysis of this conclusion to others.

120. A map of the eastern plateau region of Arizona shows most surface water sources, including portions of the Little Colorado River, to be intermittent. 2 ARIZONA WATER ATLAS 50 (2006 draft), available at http://www.azwater.gov/dwr/Content/Find_by_Program/Rural_Programs/content/water_atlas/ArizonaWaterAtlas_Vol1_Introduction_Draft_June 2006.pdf. Of the 92 large reservoirs built for water use in the area, 33 are intermittent or dry. Id. at 36.

Surface water is a municipal supply for the cities of Flagstaff and Page and for the town of Eager in the southeastern corner of the planning area. It is also utilized for agricultural irrigation by Indian and non-Indian users. Surface water from the Lake Mary reservoir system is an important municipal supply for the City of Flagstaff. Because surface water is drought sensitive, it can be unreliable.

123. 40 C.F.R. § 230.3(t).
124. FUNCTIONS AND VALUES, supra note 65; EPA, supra note 68.
In denying the Corps’ jurisdiction over a wetland with a “mere hydrologic connection” to a navigable water, Scalia cites Riverside Bayview for the proposition that drawing the line between where land begins and water ends may, at times, be difficult.\(^\text{125}\) According to Scalia, the Court in that case only deferred to the definition relied on by the Corps because a wetland adjacent to a navigable water “is itself a part of those waters.”\(^\text{126}\) Yet, once again, this reference to “part of those waters” has no scientific meaning unless it is related to the ecology or the water quality of the navigable river.

Scalia’s textural response, had it garnered a majority, has all the trappings of finality valued by the legal system. However, Scalia’s failure to account for the complexity of the natural system, and his construction of a definition that, while clear, denies water quality protection for many waters used for human needs, means the dispute will inevitably continue. Whether through resort to the courts, Congress, or other non-judicial means, those concerned with real water quality protection will continue to pursue a remedy.

3. The Concurring Opinion of Chief Justice Roberts

Chief Justice Roberts writes a concurring opinion in Rapanos merely to explain his reasons for joining the plurality rather than applying the legal methodology of deference to an agency interpretation used by Justice Stevens in the dissent and described below.\(^\text{127}\) The basis for Chief Justice Roberts’ refusal to defer is the fact that the Corps did not change the regulations detailing the scope of their jurisdiction after the U.S. Supreme Court struck down the portion referred to as the “Migratory Bird Rule.”\(^\text{128}\) This rationale is extremely weak as a legal matter given that the Corps’


\(^{126}\) Id. (quoting Riverside Bayview, 474 U.S. at 132, 135 & n.9).

\(^{127}\) Id. at 757–36.

\(^{128}\) Id. As explained in the Rapanos dissent, the Corps published notice seeking comment following SWANCC and decided not to act after 43 states and 99 percent of the comments requested that the Corps not reduce the scope of jurisdiction. Id. at 738 n.4. However, the Corps did direct its field staff that it could no longer assert jurisdiction over “isolated,” intrastate, non-navigable water bodies.” Downing et al., supra note 46, at 475 (citing a Corps of Engineers legal memorandum dated January 19, 2001). The legal memorandum was superseded by a guidance published in the Federal Register on January 15, 2003, directing field staff that “SWANCC squarely eliminates CWA jurisdiction over isolated waters that are intrastate and non-navigable, where the sole basis for asserting CWA jurisdiction is the actual or potential use of the waters as habitat for migratory birds that cross state lines in their migrations.” Advance Notice of Proposed Rulemaking on the Clean Water Act Regulatory Definition of “Waters of the United States,” 68 Fed. Reg. 1991–96 (Jan. 15, 2003) (to be codified at 33 C.F.R. pts. 110, 112, 116, 117, 122, 230, 232, 300, 401).
basis for asserting jurisdiction over the wetlands at issue in *Rapanos* and *Carabell* had nothing to do with the presence of migratory birds. Nevertheless, it was sufficient to persuade the Chief Justice to join the plurality, and the analysis above of that opinion's lack of scientific grounding will not be repeated here.

4. The Concurring Opinion of Justice Kennedy

More than any of the other justices, Justice Kennedy attempts to incorporate the science of wetlands into his legal conclusions. The legal basis of Justice Kennedy's opinion is that the wetlands in *Rapanos* do not meet the test for CWA jurisdiction established in precedent. Justice Kennedy focuses on a line from *SWANCC* that Chief Justice Rehnquist used to distinguish that case from *Riverside Bayview*. This line, which was also used in another context by the plurality, states, "It was the significant nexus between the wetlands and 'navigable waters' that informed our reading of the CWA in *Riverside Bayview Homes*." Thus, rather than rely on the text of the CWA as the plurality did, Justice Kennedy draws his key language—significant nexus—from the Court's opinion interpreting the CWA.

Justice Kennedy's approach is a legal methodology commonly used in the interpretation of both constitutional and statutory texts. The Court often develops an interpretive approach or test in the context of one set of facts and then continues to refine and build on that approach as new factual situations come before it. What is somewhat unusual in Justice Kennedy's application of the methodology is that "significant nexus" was not a test set forth in *Riverside Bayview*. In that case the Court used the methodology relied on by Justice Stevens in the *Rapanos* dissent and discussed below, premised on deference to the interpretation of the CWA by the Corps. Rather than an articulated test, "significant nexus" was used by Chief

129. Justice Kennedy refers to this lack of connection between possible post-*SWANCC* rulemaking and the issue in these cases by stating, "New rulemaking could have averted the disagreement here only if the Corps had anticipated the unprecedented reading of the Act that the plurality advances." *Rapanos*, 547 U.S. at 778.

130. *Id.* at 726 ("In *SWANCC*, we considered the application of the Corps' 'Migratory Bird Rule' to 'an abandoned sand and gravel pit in northern Illinois.' 531 U.S., at 162, 121 S. Ct. 675. Observing that '[i]t was the significant nexus between the wetlands and 'navigable waters' that informed our reading of the CWA in *Riverside Bayview*, id., at 167, 121 S. Ct. 675 (emphasis added), we held that *Riverside Bayview* did not establish 'that the jurisdiction of the Corps extends to ponds that are not adjacent to open water.' 531 U.S., at 168, 121 S. Ct. 675 (emphasis deleted).")


Justice Rehnquist in *SWANCC* merely as a basis to distinguish the outcome in that case from the one in *Riverside Bayview*. However, Justice Kennedy's approach may be appropriate given that what the Court was called on to do in *Rapanos* was to place the wetlands at issue on one side or the other of the line between wetlands adjacent to navigable waters—jurisdiction appropriate under *Riverside Bayview*—and so-called "isolated wetlands"—jurisdiction inappropriate under *SWANCC*. What better rule to use in making that determination than the one articulated by the Court as the basis for drawing a line between adjacent and isolated wetlands? Nevertheless, the fact that three cases were necessary to articulate a test found nowhere in the text of the CWA or Corps' regulations does not bode well for those seeking predictability in the implementation of a statute. Consistent with the legal methodology when a new test is articulated or clarified, Justice Kennedy would remand *Rapanos* and *Carabell* to the lower court for application of the test.135

Justice Kennedy's concurrence goes further than any of the other opinions in seeking to ground its legal conclusions in the science of wetlands. Although his legal test is that the wetlands must have "significant nexus," what they must have a significant nexus to is the downstream water quality of a navigable body of water.136 This principle diverges from the plurality's requirement of a continuous physical surface connection and is intended to better reflect the scientific connection between wetlands and water quality.

To support his conclusion, Justice Kennedy references the connection between wetlands and water quality as explained in the scientific and other literature. First, in discussing the basis for the Court's conclusions in *Riverside Bayview*, Justice Kennedy cites the Corps' own regulations for identifying the water quality functions of a wetland that are lost when it is filled, stating, "in regulatory provisions that remain in effect, the Corps had concluded that wetlands perform important functions such as filtering and purifying water draining into adjacent water bodies, slowing the flow of runoff into lakes, rivers, and streams so as to prevent flooding and erosion, and providing critical habitat for aquatic animal species."137 Justice Kennedy goes on to reference the regulations addressing the filtering and purifying functions when discussing the possible

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136. Id. at 781.
137. Id. at 766 (citing *Riverside Bayview*, 474 U.S. at 134-35 (internal citations omitted)).
importance of wetlands in the removal of toxic pollutants from transport into navigable waters.\textsuperscript{138}

In addition, Justice Kennedy cites a technical government report for the concept that "wetlands play a critical role in controlling and filtering runoff"\textsuperscript{139} and articles from the popular media to point out how the wetland function of trapping sediment during flood events is important to downstream water quality and the life of downstream dams.\textsuperscript{140} He notes that the "act of filling and draining itself may cause the release of nutrients, toxins, and pathogens that were trapped, neutralized, and perhaps amenable to filtering or detoxification in the wetlands."\textsuperscript{141} Justice Kennedy also uses the amici briefs filed in the case to support the scientific basis of his interpretation of significant nexus, stating that "amici here have noted that nutrient-rich runoff from the Mississippi River has created a hypoxic, or oxygen-depleted, 'dead zone' in the Gulf of Mexico that at times approaches the size of Massachusetts and New Jersey."\textsuperscript{142}

Finally, Justice Kennedy explains his reason for rejecting the dissent by describing it as requiring no connection or "nexus" between a wetland and the water quality of a navigable water body.\textsuperscript{143} Using the rule of statutory interpretation that Congress does not insert words into a statute for no reason,\textsuperscript{144} Justice Kennedy states that "the dissent reads a central requirement out—namely, the requirement that the word 'navigable' in 'navigable waters' be given some importance."\textsuperscript{145} Justice Kennedy also takes

\begin{itemize}
  \item \textsuperscript{138} Id. at 774-75.
  \item \textsuperscript{140} Rapanos, 547 U.S. at 774-75 (citing Henry Fountain, Unloved, But Not Unbuilt, N.Y. TIMES, June 5, 2005, at 3; Anthony DePalma, Rebuilding a River Upstate, For the Love of a Tiny Mussel; Dam to Be Demolished to Save an Endangered Species, N.Y. TIMES, Apr. 26, 2004, at 1; A. Kent MacDougall, Damage Can Be Irreversible Drought, Floods, Erosion Add to Impact of Tree Loss, L.A. TIMES, June 19, 1987, at 10).
  \item \textsuperscript{141} Rapanos, 547 U.S. at 775 (citing U.S. CONG., OFF. OF TECH. ASSESSMENT, supra note 139, at 43, 48-52.
  \item \textsuperscript{142} Rapanos, 547 U.S. at 777 (citing Brief for Association of State Wetland Managers et al. as Amici Curiae Supporting Respondents, at 21-23, Rapanos, 547 U.S. 715 (2006); Brief for Environmental Law Institute as Amicus Curiae Supporting Respondents, at 23, Rapanos, 547 U.S. 715 (2006)).
  \item \textsuperscript{143} Rapanos, 547 U.S. at 779.
  \item \textsuperscript{145} Rapanos, 547 U.S. at 778.
\end{itemize}
issue with the Corps regulation that would allow jurisdiction where no "significance nexus" exists for the same reason.\footnote{146}

Justice Kennedy comes the closest among the Rapanos justices to connecting his legal reasoning to the science of wetlands. Yet his failure to obtain agreement on his opinion from any other justice suggests that the law does not require that decisions governing highly technical natural resources disputes be grounded in science. Furthermore, the fact that Justice Kennedy's legal approach required articulating a test not found in the language of the CWA or the agency regulations means that his approach provides no guidance for resolving disputes in other areas of environmental or natural resource law.

5. The Dissent of Justice Stevens Joined by Justices Souter, Ginsburg, and Breyer

In his dissent, Justice Stevens relies on the legal principle of deference to the regulations of an agency charged with implementing a technical statute, stating,

In my view, the proper analysis is straightforward. The Army Corps has determined that wetlands adjacent to tributaries of traditionally navigable waters preserve the quality of our Nation's waters by, among other things, providing habitat for aquatic animals, keeping excessive sediment and toxic pollutants out of adjacent waters, and reducing downstream flooding by absorbing water at times of high flow. The Corps' resulting decision to treat these wetlands as encompassed within the term "waters of the United States" is a quintessential example of the Executive's reasonable interpretation of a statutory provision. See \textit{Chevron} U.S.A. Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837, 842-45 (1984).\footnote{147}

"Chevron deference," referred to by the name of the case articulating the standard, is based on the administrative law concept that when Congress enacts a statute in a highly technical area and delegates authority to an agency to implement that statute, it intends for the agency to apply its own scientific expertise to interpret ambiguous terms in the statute.\footnote{148} The \textit{Chevron} case itself addressed another complex environmental law—the Clean Air Act—and has become one of the most heavily cited cases in administrative law.\footnote{149}

Justice Stevens notes that the practical meaning of \textit{Chevron} deference in this case is that when faced with the difficult task of drawing

\footnotesize{146. Id. at 779.}
\footnotesize{147. Id. at 788.}
\footnotesize{149. WILLIAM F. FUNK & RICHARD H. SEAMON, \textsc{Administrative Law} 261 (2d ed. 2006).}
a line between an adjacent and an isolated wetland, the agency's judgment should prevail. Justice Stevens further addresses the concern that the Corps' regulations may be so broad as to encompass wetlands with no relation to the water quality of the nearby navigable water body by noting that an assertion of jurisdiction merely requires application for a permit. The Corps may issue that permit and allow fill to proceed for any wetland that is not important to the water quality of the waters of the United States.

Under the Chevron standard, the Court must still find the agency interpretation of the statute to be reasonable. Justice Stevens uses many of the same scientific attributes of wetlands noted by Justice Kennedy to clarify the meaning of "significant nexus." Thus, Justice Stevens, in rejecting the plurality's requirement that the water body regulated be relatively permanent, states that "[i]ntermittent streams can carry pollutants just as perennial streams can, and their regulation may prove as important for flood control purposes." Justice Stevens further notes that the wetlands at issue in Carabell "demonstrate [that a] wetland separated by a berm from adjacent tributaries may still prove important to downstream water quality." Finally, he notes that fill can be transported downstream and thereby cause an adverse impact on the water quality and the biological integrity of the downstream waters.

On its face, deference to an expert agency would appear to be an excellent strategy for better incorporating scientific understanding into the law. However, this approach has been subject to growing criticism, including the argument that once the Court articulated Chevron deference, agency interpretation itself became infused with political agendas and is thus suspect. This growing discontent with the politicization of agencies

150. Rapanos, 547 U.S. at 792.
151. Id. at 794.
152. Chevron, 467 U.S. at 844.
153. Rapanos, 547 U.S. at 804.
154. Id. at 806.
155. Id. at 807 (citing United States v. Deaton, 332 F.3d 698, 707 (4th Cir. 2003), for the concept of pollutant transport from tributaries to navigable rivers; U.S. CONG., OFF. OF TECH. ASSESSMENT, supra note 139, at 43, 48; Don C. Erman & Vernon M. Hawthorne, The Quantitative Importance of an Intermittent Stream in the Spawning of Rainbow Trout, 105 TRANSACTIONS OF AM. FISHERIES SOC'Y 675-81 (1976); Brief for American Rivers et al. as Amici Curiae at 14 (for the concept that sediment can cover gravels and thereby impair spawning in both navigable waters and their tributaries)).
and the Court's related discomfort with deference may explain the failure of Justice Stevens' approach to garner a majority of justices.

A simplistic solution to this problem would be for courts to distinguish between an agency's scientific determination—where deference is due—and political maneuvering—where no deference is due. Some courts have attempted to do this by denying deference where an agency's "scientific" interpretation changes abruptly with a change in political administrations. However, in most cases science and policy are legitimately interwoven in agency decision making. In this case, the meaning of "waters of the United States" is not a purely scientific question. The agency implementing it is constrained by both constitutional law and the scope of the statutory language. Thus, its interpretation is intricately bound by both law and science, and some judicial involvement in assessing that interpretation is inevitable.

6. The Dissent by Justice Breyer

Justice Breyer concurs in the dissent but writes separately to emphasize two points. First, he agrees with the dissent that deference is appropriate and seeks to emphasize that "Congress intended the Army Corps of Engineers to make the complex technical judgments that lie at the heart of the present cases." Second, it is his belief that Congress intended the jurisdiction of the CWA to extend to the full extent of its constitutional Commerce Clause powers. Justice Breyer writes to send a message to the agency that if it wrote a regulation interpreting "waters of the United States" to reflect that broad jurisdiction, he believes it would be entitled to Chevron deference.

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157. See, e.g., Ruhl & Salzman, supra note 36, at 10 (In discussing the need for peer review, the authors state, "The standard argument that agencies must make policy decisions in the face of incomplete and uncertain scientific data, and thus should not be bound to the rigors of peer review, turns the issue on its head. Designed wisely, regulatory peer review can help reveal how much scientific uncertainty underlies an agency decision and can thus demand that the agency explain how the gap was filled."); Doremus, supra note 7, at 253 ("The core of the problem is not the involvement of politics but its concealment behind a cloak of science."); Wagner, supra note 36, at 1617 ("Although camouflaging controversial policy decisions as science assists the agency in evading various political, legal, and institutional forces, doing so ultimately delays and distorts the standard-setting mission, leaving in its wake a dysfunctional regulatory program.").


159. Rapanos, 547 U.S. at 811.

160. Id.
The basis for Justice Breyer's determination that Congress intended to exercise the full extent of its Commerce Clause powers in this area draws on both wetlands science and yet another legitimate legal source for determining congressional intent: the purpose or goal articulated by Congress in the statute itself. The statutory purpose of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Justice Breyer draws the connection between this articulated purpose and the need for the full exercise of relevant Commerce Clause powers by stating that "Congress might well have decided the only way to achieve this goal is to write a statute that defines 'waters' broadly and to leave the enforcing agency with the task of restricting the scope of that definition, either wholesale through regulation or retail through development permissions." Therefore, a broad legal definition is required to achieve the scientific goals set out by Congress.

Given that each of the five justices writing an opinion in Rapanos used a legitimate legal methodology to arrive at their differing conclusions, yet all failed to achieve a result that makes sense from a scientific viewpoint, the fracturing of the Court in this and other environmental and natural resource cases indicates a fundamental underlying problem in the legal disposition of natural resources disputes. In this case, when the legal system's goal of achieving finality and establishing a clear bright-line rule that can be used to resolve future disputes was imposed upon the complex reality of wetlands science, the end result was neither final nor scientifically sound. When legitimate legal reasoning makes no scientific sense in an area infused with science, it is time to reevaluate the underlying legal process.

IV. DISPUTE RESOLUTION IN NON-IDEAL, COMPLEX SYSTEMS

The problems encountered by the Rapanos Court are common in environmental and natural resource law. The current gridlock in resolving environmental disputes within the legal arena ranges from endangered species to climate change. To characterize this apparent breakdown at

161.  Id.
163.  Rapanos, 547 U.S. at 811.
the interface between law and science as the result of erroneous legal reasoning, political maneuvering, or "junk science" merely scratches the surface and ignores the complexity that emerges when problems occur at the interface between disciplines. The source of the problem is that the methodology appropriate for understanding the behavior of a system or resolving issues within the discipline — either law or science — is no longer appropriate when addressing issues at the interface. Ultimately, continued resort to traditional legal forums and methodology for resolving natural resource disputes will render the judicial system irrelevant for resolving those problems since people will only expend so many resources on failed efforts before they turn to other methods. The need to alter our approach in a way that accounts for the complexity, uncertainty, and non-ideal behavior that occurs at the intersection between law and natural science is not limited to the judicial realm, but must begin with the drafting of laws and implementation by agencies.

A. Congress: The Drafting of Laws

An obvious answer to the problem encountered by the courts in Rapanos is better bill drafting by Congress. If Congress used terms with defined scientific meaning to describe the scope of regulation intended under the CWA, litigation would be reduced. If, for example, Congress defined "waters of the United States" not only expressly but also in the context of the scientific understanding of hydrologic connections, it would eliminate the need for litigation over this definition.

Two barriers exist to this simple answer. First, neutral scientific advice to Congress is lacking. In 1995, Congress withdrew funding for the


167. While it might also be argued that scientific methodology must also be reformed to better integrate social and political systems, this article focuses on reform within the legal system.

168. This does not mean that, by acknowledging hydrologic connection, Congress must protect connected waters, simply that it be express about whether it intends that protection or not.
Office of Technology Assessment (OTA), the nonpartisan technical advisory office for Congress. In the farewell page on OTA’s website, the concern of the parting scientist is implied in the following statement: “For 23 years, the nonpartisan analytical agency assisted Congress with the complex and highly technical issues that increasingly affect our society.” With the increasing complexity of environmental and natural resource issues facing society, it is nothing short of foolish for Congress to limit its technical advice to lobbyists and partisan staff. Restoring funding to OTA would be an important first step in improving bill drafting.

However, many federal statutes that are now the subject of intense litigation over their meaning were drafted during the time OTA was operational. This raises the second barrier to improved bill drafting: Congress. Clarity in bill drafting is frequently sacrificed for bill passage.

Ambiguity may simply be the only means to obtain agreement on a law when there is no underlying agreement among a majority of members about what the goals of the law and the powers of the enforcing agency should be.

Despite the bleak outlook for clearer and more scientifically grounded legislation, another potential avenue for improvement remains. To date, we have failed to learn as much as we could from the implementation of environmental laws over the past 30 years. Consider the statement of one agency scientist struggling with the implementation of the CWA between SWANCC and Rapanos:

A number of studies have examined the hydrologic and water-quality function of isolated wetlands....Most of this information describes how individual or local groups of wetlands function. Studies are needed that examine how isolated wetlands contribute to regional hydrology or water quality and the extent to which these functions are influenced by isolation.

This absence of data is troubling after roughly 30 years of implementation. Yet, it is hardly the fault of the agency. Congress rarely approves or funds the monitoring of results from the implementation of a law. It seems at first glance a waste of money: merely a way for scientists to collect more data to play with or a purely academic exercise. But consider the costs that could be saved by taxpayers and the regulated community if we were to improve

170. Doremus & Tarlock, supra note 12, at 24 (“Congress has shown no interest in facing up to the political costs of making these choices explicitly. It is more politically advantageous to declare aspirational goals in ringing terms, but leave the implementing agencies with the hard task of determining the extent to which those goals will be achieved.”) (citation omitted)).
171. Leibowitz, supra note 60, at 521 (citations omitted).
agency decision making over time. One way in which regulatory science differs from research science is that, since the regulatory research agenda is set by the political process rather than by the scientist, regulatory science misses opportunities to build a body of knowledge that will result in this improved decision making. Although resources are too scarce to monitor all aspects of implementation, targeting areas in which scientific and policy choices must be made to fill data gaps would be a start toward improving understanding of how law, science, and policy interact.

The targeted monitoring recommended above must be incorporated into bill drafting in two ways. First, environmental legislation must require monitoring of results, particularly in areas of scientific uncertainty and controversy. Second, environmental legislation must delegate authority to agencies, within specified parameters, to adapt their implementation based on the results of this monitoring. Only through this adaptive process can the implementation of environmental legislation evolve into more efficient and effective regulation over time. This brings us to the work of the agency.

B. Agency Decision Making

The environmental and natural resource problems we face are increasingly the subject of complicated and lengthy statutes delegating implementation to agencies with scientific expertise. The Rapanos case, for example, involves the Clean Water Act and its extensive delegation of regulatory authority to the EPA and the Corps of Engineers. Such large, scientifically staffed agencies were developed in response to the increasing complexity of the nation's environmental and natural resource problems and the solutions created to address those problems. Reliance on the agencies' scientific expertise is exactly what Congress had in mind when it started down the environmental regulatory path. However, problems arise when the power to affect people's lives or livelihoods is delegated to an agency using methods no layperson can understand. In the sheer complexity of the issues, the transparency we have come to expect of government action is sacrificed. It is unsurprising that in the face of such inaccessibility, those affected resort to the judicial system. If any of the methods suggested below for improving how the judiciary handles

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172. This may resemble what has been referred to as adaptive management. See, e.g., Janet C. Neuman, *Adaptive Management: How Water Law Needs to Change*, 31 ENVTL. L. REP. 11,432 (2001) (discussing the need to introduce flexible "adaptive" management into the prior appropriation system). However, it is intended here to encompass broader parameters for monitoring, including relevant social changes.


174. *Id.*
scientific issues are to succeed, parallel changes to agency development of the scientific record must occur.

Two main problems arise regarding the use of science by agencies implementing environmental and natural resource laws: 175 (1) scientific uncertainty: the timeline and subject matter of regulatory implementation dictates that decisions be made in the face of imperfect knowledge and substantial data gaps 176 or the science needed for implementation may be relatively new and untested 177 and (2) regulatory science or science-policy: the agency often makes policy choices to fill data gaps, but those choices may either be deliberately hidden under a cloak of science to be afforded deference, or so thoroughly intermeshed with choices based on science that separating the science from the policy may be impossible. 178

1. Scientific Uncertainty

The fact that there are no absolute answers to most questions involving the study of natural systems should come as no surprise after the discussion of complexity. Natural systems occur at the interface between multiple scientific disciplines and between the so-called hard and soft sciences. Except for the most simplistic critics of agency science, most scholars recognize that scientific uncertainty cannot be entirely eliminated

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175. Much has been written about the good science/bad science debate and the Information Quality Act, 44 U.S.C. § 3516 (2000). See, e.g., Stephen M. Johnson, Junking the "Junk Science" Law: Reforming the Information Quality Act, 58 ADMIN. L. REV. 37 (2006); O'Reilly, supra note 35. Because it is the author's opinion that this is primarily a political debate and act, and the courts remain the appropriate forum for challenge to agency action, it will not be discussed in the context of this article.

176. See, e.g., Doremus & Tarlock supra note 12; Johnson, supra note 175, at 47 ("As academics have frequently noted, there are, and have always been important gaps in the information that the government needs in order to make decisions to protect health, safety, and the environment."); Ruhl, supra note 30, at 8; Ruhl & Salzman, supra note 36; Sidney A. Shapiro, OMB and the Politicization of Risk Assessment 3 (draft paper prepared for Law, Science and the Environment Conference, Lewis and Clark Law School, 2007), http://www.lclark.edu/dept/elaw/2007_lse_papers.html (last visited Jan. 2, 2008); Wagner, supra note 36, at 1619.

177. Shapiro, supra note 176, at 5–6.

178. See, e.g., Doremus, supra note 7, at 253; Thomas O. McGarity, Our Science Is Sound Science and Their Science Is Junk Science: Science-based Strategies for Avoiding Accountability and Responsibility for Risk-Producing Products and Activities, 52 U. KAN. L. REV. 897, 932 (2004); Ruhl & Salzman, supra note 36, at 20; Wagner, supra note 36 ("Although camouflaging controversial policy decisions as science assists the agency in evading various political, legal, and institutional forces, doing so ultimately delays and distorts the standard-setting mission, leaving in its wake a dysfunctional regulatory program.").
and its presence is not a result of bad science or failure on the part of the agency.¹⁷⁹

Generally, discussions about the challenge of decision making in the face of uncertainty focus on the use of policy to fill gaps, as discussed below; thus, how gaps are filled is considered a legal rather than scientific issue.¹⁸⁰ However, researchers in sciences that work at the interface between disciplines, particularly those in the environmental and natural resource sciences, are never able to fill all the gaps with data. Although aggravated by the tight deadlines agencies often face, this is a fundamental aspect of the scientific study of complex, non-ideal systems. Data gaps are filled by resort to scientific judgment as part of the scientific process, and this gap-filling does not become a policy decision rather than a part of the scientific methodology simply by virtue of the fact that it is made in a regulatory setting.

2. Regulatory Science or Science Policy

The scientific method used in agency decision making differs both fundamentally and necessarily from what we think of as academic research science because it takes place in a forum where policy and social need are taken into consideration; where the problem is identified and defined outside the agency (frequently by Congress) and, as a result, may not be a

¹⁷⁹ See, e.g., Johnson, supra note 175, at 47-48 ("As academics have frequently noted, there are, and have always been, important gaps in the information that the government needs in order to make decisions to protect health, safety, and the environment."); Wagner, supra note 36, at 1619; see also Doremus & Tarlock, supra note 12, at 3; Ruhl, supra note 30, at 8; Ruhl & Salzman, supra note 36; Shapiro, supra note 176, at 3.

¹⁸⁰ Shapiro, supra note 176, at 3 ("The ultimate question of whether an agency has sufficient proof that a statutory risk trigger has been met is a legal, not a scientific, issue. It is a legal issue, in part, because Congress intended agencies to make regulatory decisions on the basis of imperfect knowledge. Agencies therefore do not conform to scientific standards of certainty. As Judge Skelly Wright once explained, 'Agencies are not limited to scientific facts, to 95% certainties.' This means an agency determination that there is sufficient evidence to satisfy a risk trigger can be legally valid even if the scientific community does not universally agree about the degree of risk that exists." (citations omitted)). See also Ruhl & Salzman, supra note 36. In recommending a different kind of peer review for agency science, Ruhl and Salzman state, "regulatory peer review can help inform the public about where an agency's use of science in support of a proposed decision ends and where its use of professional judgment and normative policy choices begins." Id. at 20-21 ("Whether innocent or deliberate, this kind of misuse of science does not necessarily lead to poor policy decisions. After all, agencies may have no choice but to extrapolate from incomplete data when a decision needs to be made at that moment. It can raise concerns, however, if an agency justifies its decision to the public, courts, and legislature as being driven chiefly by the science when it is in fact based on a policy judgment informed by inconclusive science."); Doremus & Tarlock, supra note 12, at 3 ("Typically, the disputes are fundamentally about how incomplete data are interpreted and applied, rather than about what the data are or how they have been gathered.").
purely scientific question, and where agency scientists generally synthesize information obtained by other scientists rather than collecting data themselves. As discussed above, it is common for scientists to use judgment to fill data gaps in the complex sciences. However, what differs in the regulatory setting is that the exercise of scientific judgment may be influenced one way or the other by social or political considerations. In some cases, the direction agency scientists must take when faced with uncertainty is dictated by Congress. In fact, there is evidence that Congress has been fully aware of the need for gap filling when it delegates authority to agencies and intends for the agency to use judgment that may not be based on science to fill the gaps. Thus,

the Clean Air Act [requires] that EPA set National Ambient Air Quality Standards, "allowing an adequate margin of safety [that is] requisite to protect the public health"; and in the Clean Water Act's Total Maximum Daily Load provision, [the EPA is directed] to set TMDLs with "a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." Thus, law, agency policy, and scientific judgment may all play a role in reaching a single decision. Separating them for the sake of transparency, as recommended by some, may not be so easily done.

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181. Wagner, supra note 36, at 1619 (quoting nuclear physicist Alvin Weinberg, who refers to "trans-science" as "questions which can be asked of science and yet which cannot be answered by science").

182. See, e.g., Ruhl & Salzman, supra note 36, at 6 ("Just as scientific peer review involves independent evaluation of scientific research, regulatory peer review refers to the outside evaluation of an administrative agency's compilation, selection, or use of scientific data to support a proposed regulatory decision such as a rule, standard, permit, or other policy.").

183. McGarity, supra note 178, at 932 ("The courts must also recognize that the policy-relevant conclusions of scientific studies are never based exclusively upon science. Policy considerations frequently have an impact on interpretations of raw scientific data. More importantly, policy nearly always drives the inferences that an expert draws from scientific studies." (citations omitted)).

184. See Shapiro, supra note 176.


186. See, e.g., Ruhl & Salzman, supra note 36, at 10. In discussing the need for peer review, the authors state, The standard argument that agencies must make policy decisions in the face of incomplete and uncertain scientific data, and thus should not be bound to the rigors of peer review, turns the issue on its head. Designed wisely, regulatory peer review can help reveal how much scientific uncertainty underlies an agency decision and can thus demand that the agency explain how the gap was filled.
Nevertheless, most scholars recommend some sort of requirement that the agency articulate the degree of uncertainty and explain how gaps were filled. Ruhl and Salzman recommend a different kind of peer review, which they refer to as “regulatory peer review,” to resolve this problem. Whereas traditional peer review evaluates research in which original data are collected and analyzed, regulatory peer review evaluates how an agency makes use of data and studies done elsewhere and how data gaps were filled to reach a decision. Although this approach may be helpful in certain circumstances, particularly where high levels of controversy exist, it is just as easy to bias a science review panel as it is an

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Id. See also Doremus, supra note 7, at 253 (“The core of the problem is not the involvement of politics but its concealment behind a cloak of science.”); Wagner, supra note 36, at 1617 (“Although camouflaging controversial policy decisions as science assists the agency in evading various political, legal, and institutional forces, doing so ultimately delays and distorts the standard-setting mission, leaving in its wake a dysfunctional regulatory program.”).

187. Ruhl, supra note 30, at 8 (“Rather, I suggest we accept that science will never completely answer the questions posed in the ESA, that agencies inevitably are making decisions in a chaotic world in which information is never adequate to provide certainty, and questions about policy and science blur together.”).

188. See, e.g., Doremus, supra note 7, at 290. Doremus states, political choices cannot be removed from the process. Instead of trying to remove them, it would be more helpful to focus on making the political elements of these decisions more transparent. At the moment, the determinative points in the decision making process tend to be hidden from public view, so that the public never has the opportunity to untangle the contributions of career scientists and political appointees to the ultimate decision. That can allow decisions that are in fact primarily political to be disguised as scientific ones.

189. Ruhl & Salzman, supra note 36, at 10. The authors summarize their idea of “regulatory peer review” as follows:

When focused on the latter inquiry—the question of whether the agency’s claims of scientific support for its decision are justified—regulatory peer review can help inform the public about where an agency’s use of science in support of a proposed decision ends and where its use of professional judgment and normative policy choices begins.

Id. See also Shapiro, supra note 176, at 10.

190. Ruhl & Salzman, supra note 36, at 10 (In recommending a different kind of peer review for agency science, the authors state, “regulatory peer review can help inform the public about where an agency’s use of science in support of a proposed decision ends and where its use of professional judgment and normative policy choices begins.”).

191. J.B. Ruhl’s experience with regulatory review was as a participant on a review panel of the scientific basis for a jeopardy opinion on operation of a Reclamation project in the Klamath basin, a particularly acrimonious issue. Id. n.8.
agency's management. Use of specialized district courts described below as the avenue for review would provide a forum to review these types of questions. In addition, the development of a record by the agency describing its decision-making process in light of uncertainty would facilitate this review.

C. The Judiciary

1. Choosing a Model

The complexity of dispute resolution in the environmental and natural resource arena requires a forum in which knowledge of law and science can be integrated. The traditional judicial model in which part of the required neutrality of the third-party judge stems from lack of knowledge in the substantive area will no longer work. Acting alone, the judicial system will not only fail to achieve results that optimize human use of natural resources, but will also fail to achieve the more limited goal of finality as decisions lacking a scientific grounding will drive interest groups to other forums for solutions. Knowledge of more than legal process is required to sort through the complex problems in which science and scientific uncertainty dominate.

To understand complex systems, scientists frequently turn to models that allow analysis of the interrelation between multiple variables. High speed computing has provided a valuable tool for examining complex scientific problems with multiple variables and degrees of uncertainty through the development of models. Law and policy are not so readily examined through this quantitative, binary method. Yet legal processes,

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192. See generally McGarity, supra note 178, at 897; see also Shapiro, supra note 176, at 7 ("Regulatory science can also be politicized when an administrator stacks scientific advisory panels with scientists whose previous work or professional orientation indicates they will resolve ambiguous scientific issues in a manner friendly to the administrator's policy preferences.").


The basic structure of our legal institutions was established long before we understood the nature of environmental problems, indeed long before we recognized such a category of problems. The design of those institutions is at best an awkward fit for environmental problems. The institutions are highly fragmented, while the problems they are supposed to solve cross boundaries almost gleefully, spilling from one parcel or one political jurisdiction to another, migrating from air to water to land, and infiltrating even the largest protected areas.

Id.

194. As noted above, monitoring the results of a particular law or policy and using those results to improve implementation can, in certain circumstances, be quantified and modeled. Models that take a systems approach may be particularly useful in this effort, but are beyond
too, can be modeled. Legal models use language rather than numbers. A legal model tends to provide a general framework that can be adapted to specific situations. Nevertheless, there are several important similarities in the process of selecting appropriate quantitative and legal models.

First, similar to, for example, a hydrologic model of a water basin, the best legal model for a particular situation is of the appropriate scale or easily adapted to the scale of the problem. Some legal models are so adaptable that they can be scaled up or down to fit the need. For example, the model of three coequal branches of government set forth by the U.S. Constitution has proven successful at the national scale, and also at the scales of state and tribal governments. Other legal models that were developed with a specific problem in mind are not so easily adapted to a problem of a different scale.

Second, because of the complexity of both the real system and the model, the best model is one in which at least some of the component parts have been tested in similar situations. The process of adapting the model to a new situation must include an effort to analyze the effectiveness of prior tests and to modify the model accordingly. In addition, the model must be sufficiently general to allow its adaptation to issues ranging from water quality to endangered species.

Finally, just as many in the legal and policy communities criticize scientists for ignoring legal, social, and political reality in their approach to problem solving, the best legal model cannot ignore social and political reality by assuming an overly "ideal" system. Should the model ignore the fact that institutional changes in a democracy are slow and incremental, that the cost of developing new forums for dispute resolution must be minimized, and that the neutrality so important to a judicial system

the scope of this article. See generally ANDREW FORD, MODELING THE ENVIRONMENT: AN INTRODUCTION TO SYSTEM DYNAMICS MODELING OF ENVIRONMENTAL SYSTEMS (1999).


196. For example, The Utton Transboundary Resources Center at the University of New Mexico recently sponsored a study that resulted in the production of a Model Interstate Water Compact, available at http://uttoncenter.unm.edu/model_compacts.html (last visited Aug. 29, 2007). Although extremely useful on the scale of the type of setting that led to the project—a multi-state, variable climate, surface water dominated system like the Colorado River—the model is of only limited use for a small interstate basin with a relatively homogenous economy and climate that is dominated by groundwater sources such as the Palouse Basin shared by Washington and Idaho. The Palouse Basin is part of ongoing research by the author and a multidisciplinary team focused on developing case studies for use in the University of Idaho's new graduate program in Water Resources.

197. Cosens, supra note 195.

198. For some reason, we tend to refer to this as being too "academic," whereas my guess would be that scientists refer to it as an "ideal" world.
established primarily on process cannot be sacrificed when substance is introduced, it will be a model of purely academic usefulness.\textsuperscript{199}

With these points in mind, the following discussion uses the Colorado water court system as a model forum for natural resources dispute resolution that could be adapted for use in the federal district court system to accommodate complexity in environmental and natural resource dispute resolution.\textsuperscript{200} Parallel modifications within state court systems could follow if the experiment is considered successful.

2. The Colorado Water Court System as a Model

The current Colorado water court system was created by the Water Right Determination and Administration Act of 1969 (1969 Act).\textsuperscript{201} The 1969 Act designates seven divisions corresponding to the major water basins in the state.\textsuperscript{202} Each division has a water court within the state district court system and one district court judge selected to preside. Water judges may hear non-water related cases in their roles as district court judges, but they are the only judges within the division to hear water cases. In addition to the water judge, each water court has a district engineer, a water clerk, and a referee. While the water judge is assigned the role of determining water rights, resolving water use disputes, and hearing requests for changes in use,\textsuperscript{203} the referee, who has the status of a magistrate and is appointed by the water judge,\textsuperscript{204} first investigates and attempts to settle filed cases.\textsuperscript{205} Of particular importance in this process is the fact that, in general, referees

\textsuperscript{199} A pilot project initiated by the American Association for the Advancement of Science (AAAS) and the American Bar Association is underway to allow selection of an expert or panel of experts for a court to rely on for scientific matters. See Justice Stephen G. Breyer, \textit{The Interdependence of Science and Law}, in \textit{SCIENCE AND TECHNOLOGY POLICY YEARBOOK} (AAAS 1999), available at http://www.aaas.org/spp/yearbook/chap9.htm (last visited Nov. 28, 2007); Mark S. Frankel, \textit{The Role of Science in Making Good Decisions} (AAAS Testimony before the House Committee on Science, June 10, 1998), available at http://www.aaas.org/spp/sfrl/projects/testim/mftest.htm (last visited Nov. 28, 2007); H.R. COMM. ON SCI., 105TH CONGRESS, \textit{UNLOCKING OUR FUTURE: TOWARD A NEW NATIONAL SCIENCE POLICY § IV.E}, at 54–55 (Comm. Print 105-B 1998). However, this approach seems more suited to science matters that arise in criminal cases and certain civil cases such as product liability. In the vast realm of review of regulatory action, this approach may not only lack the uniformity and cost effectiveness necessary for implementation, but also may fail to provide the integrated legal-scientific solutions made possible by the recommendation set forth in the following text.

\textsuperscript{200} This article focuses on changes to the federal district court system. To the extent that challenges to federal agency action in the environment and natural resources area go directly to the D.C. Circuit Court, the same recommendations apply.

\textsuperscript{201} COLO. REV. STAT. ANN. § 37-92-201 (West 2004).
\textsuperscript{202} Id. § 37-92-201(1).
\textsuperscript{203} Id. § 37-92-203.
\textsuperscript{204} Id. § 37-92-203(4).
\textsuperscript{205} Id. § 37-92-203(7).
have both science and legal training. Justice Hobbs of the Colorado Supreme Court estimates that 95 percent of the cases filed are settled by the referees. If a case is not settled, the referee submits a report to the water judge, and those cases are heard de novo.

In addition to the expert referee, the water judge also has a division engineer on staff. The 1969 Act separates water administration from the adjudication of water rights by the water court. Administration is done by the state engineer through his or her division engineers. The referee may turn to the division engineer for consultation on cases, and the division engineer may appear before the water judge as an expert. In turn, it is the responsibility of the water judge to issue any injunction necessary to carry out the administrative orders of the State Engineer. Finally, the water court is also assigned a clerk to maintain water court records.

Analyses of the effectiveness of the Colorado water court system have concluded that it has encouraged "expertise, sophistication, and innovation in water management." The system not only provides water judges with access to neutral technical expertise, it also allows these judges to develop their own expertise over time. In addition, it has been observed that the designation of a particular judge to preside over water cases has led to greater consistency in district court level rulings on water disputes.

Certain aspects of the Colorado water court system provide a useful template for the development of a dispute resolution forum for federal environmental and natural resources cases. First, the inclusion of the water court system within the existing district court system provides for ease of administration and docketing of cases and avoids creating any new or separate level within the judiciary. Applying this to the federal district court system, the designated judge with a small environment and natural resource docket would continue to hear other cases before the district court, and the designation of an area of specialty would not result in any

207. O'LEARY, supra note 206, at 17.
210. Id.
211. Id.
212. Id. § 37-92-503.
213. Id. § 37-92-204.
214. O'LEARY, supra note 206.
215. Id.
216. Id.
reduction of case management efficiency. Conversely, a district with a heavy environment and natural resource docket could seek appointment of more than one judge to this area.

Second, the selection of referees with expertise in relevant areas of science and law provides the Colorado district water judges with neutral technical expertise. In the federal district court system, judges' access to neutral scientific information is hampered by the fact that scientific studies based on field data may not meet the current federal standard for admissibility due to their lack of replicability and high levels of uncertainty. For example, in the environment and natural resource fields, just because a particular field methodology is appropriate within the discipline and has received peer review does not mean that two different scientists applying the same approach to the same locale will reach the same conclusions. The number of variables and degree of uncertainty in the measurement of each variable and its interaction with others is simply too great. As discussed above, scientists routinely exercise their judgment in the face of such uncertainty. However, when science becomes the basis of a case, judgments will frequently be governed by the desired end result — i.e., the result most favorable to the expert's client. Although most "science advocacy" remains within the range of credible scientific outcomes, a judge has little guidance on how to choose between two sets of scientific assumptions made by opposing parties. Traditional legal methodology such as deference to the agency or placement of the burden of proof may resolve the immediate case, but if it results in a scientifically inadequate solution, the dispute will resume. Neutral technical advice can help a judge sort

217. The current federal standard is articulated in Daubert v. Merrill Dow Pharmaceuticals, Inc., 509 U.S. 579, 580 (1993). In Daubert, the Court relaxed the former standard for admission of scientific evidence in court, which had required general acceptance in the particular scientific field, and instead articulated four non-exclusive factors to be applied by the trial court judge acting as gatekeeper. The factors are (1) the "theory or technique...can be (and has been) tested"; (2) the "theory or technique has been subjected to peer review and publication"; (3) a "known or potential error rate" has been determined; and (4) the technique has "wide-spread acceptance" in the particular area of science. See also Margaret A. Berger, The Supreme Court's Trilogy on the Admissibility of Expert Testimony, in Reference Manual on Scientific Evidence 72 (Fed. Jud. Ctr. ed., West 1994).

218. This term has been used in a variety of ways both to indicate representation of a client and to indicate distortion of the scientific methods. See, e.g., Frederick R. Anderson, Science Advocacy and Scientific Due Process, 16 Issues in Sci. & Tech., Summer 2000, at 71, 74; William Stelle, Jr., Overcoming the Seven Myths of Columbia River Salmon Recovery, 28 Envt'l. L. 493, 499 (1998) ("[A]genda-driven science advocacy continues to color the debate, and to cloud the underlying policy issues that lie at the core of salmon recovery in the Basin."); Margaret A. Shannon et al., Science Advocacy Is Inevitable: Deal with It, in Proceedings of the Society of American Foresters Annual Conference (1996).
through scientific evidence and increase the likelihood that science advocacy will be distinguished from scientific judgment.

Third, the use of referees in the Colorado water courts to investigate the case and facilitate settlement has reduced the court's docket and provided a forum for creative solutions backed by court oversight to ensure consistency. This is a method already familiar to the federal judicial system. The U.S. Supreme Court has long used special masters to resolve interstate water disputes. In those disputes, the report and recommendations of the special master are filed with the Supreme Court. The parties may file objections and the Court considers the objections with reference to the report of the special master. Application of this approach to environmental and natural resource disputes at the district court level would both elevate the degree of neutral technical analysis and promote discussion of the types of solutions often found only in settlement. The increasing resort to settlement of Indian water rights is attributed, in part, to the ability to craft physical solutions that minimize impact and maximize benefit to all parties. Yet the settlement process is ad hoc and depends on the financial ability of the parties to establish a forum. A court-organized settlement process for federal environmental disputes would create a forum more accessible to all and increase opportunities for creative solutions.

Finally, by designating a particular judge within each district court to handle specific types of natural resources cases, even judges without scientific backgrounds will be able to gain expertise in the area. In the Colorado water court system, appointment is by the state supreme court for one-year terms. However, most terms are renewed repeatedly, resulting in highly experienced water judges. Enhancing this growth of expertise is the fact that western water judges and special masters have developed a forum for continuing education on the procedural and substantive issues

220. Id.
221. Id.
222. For example, settlement has become a highly favored approach in Indian water right disputes because results often lead to development of infrastructure and administrative processes. See generally TRIBAL WATER RIGHTS: ESSAYS IN CONTEMPORARY LAW, POLICY, AND ECONOMICS (John E. Thorson et al. eds., 2006); NEGOTIATING TRIBAL WATER RIGHTS (Bonnie G. Colby et al. eds., 2005).
224. Cosens, supra note 223, at 949.
225. COLO. REV. STAT. ANN. § 37-92-203(2) (West 2004).
226. O'LEARY, supra note 206, at 19.
addressed in water cases. In recent years, the forum has included workshops on scientific issues. Another novel feature of the forum is that the participants agree in advance that all discussions are to be confidential, which allows judges to discuss particular issues currently before them. A similar forum for continuing education for designated environmental and natural resource judges in the federal court system would be valuable both for facilitating a dialogue among these judges and for enhancing judicial expertise.

Two elements of the Colorado water court system are not recommended for a federal environmental and natural resource system. Both have to do with the difference between the relative roles of the state court and the Colorado State Engineer, as compared to those of the federal courts and agencies.

Even before the 1969 Water Distribution and Administration Act, Colorado divided authority over water rights between the courts and the State Engineer. Determinations of water rights and changes in water rights were to be done in district court, while administration and water measurement were to be done by the State Engineer. By contrast, most western states have adopted permit systems that allow for an initial administrative determination of new water rights without having to go through the court system. Criticism of the Colorado approach includes the high cost of hiring experts and lawyers to assert a water right in court. An administrative permit system is less costly and less formal and therefore more accessible to those with fewer resources.

In the federal context, an extensive administrative system is already established—and for good reason, given the highly technical nature of implementation. In addition, the scientific subject matter is much more

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227. Information on Dividing the Waters can be found at http://www.dividingthewaters.org/. "Dividing the Waters is a collaboration of a network of judges, special masters and referees who preside over western water adjudications and other complex water litigation." Id. The project seeks to "improve the management and outcome of general stream adjudications and other complex water-related litigation affecting western people and the region's environment." Id. The project serves state trial judges, state appellate judges, federal trial and appellate judges, and U.S. Supreme Court special masters. Id.

228. The State Engineer's office in Colorado was established in 1881 and is within the Division of Water Resources of the Department of Natural Resources. See http://water.state.co.us/.


230. O'LEARY, supra note 206, at 17.

231. Id.

232. See, e.g., Clean Water Act, 33 U.S.C. § 1311 (2000) (requiring the EPA to set effluent limitations for point source discharges); id. § 1313 (requiring the EPA to review state water
diverse than water allocation. Thus, it remains appropriate that federal environmental or natural resource agencies act in the first instance prior to consideration of an issue by a specialized branch of the federal district court system.

In addition, since this means that many of the challenges that reach the federal district court system will be challenges to agency action or efforts at agency enforcement, it would be inappropriate to also have agency personnel on the court staff. Rather than placing agency personnel on court staff, it may be appropriate to address the range of potential media with the appointment of referees with specialized areas—e.g., air, water, endangered species, toxics, etc. Finally, the development of an agency record delineating science and policy choices, as discussed above, and improved decision making through monitoring and adjusted implementation can only be accomplished within a system in which the decisions in the first instance lie with the agency.

V. CONCLUSIONS

Our failure to account for the complexity of the intersection between human and natural systems in legal disputes involving natural resources threatens to render that system irrelevant if it cannot adapt. The inability of the U.S. Supreme Court to achieve a majority opinion in Rapanos v. United States and, of even greater concern, the failure of any of the opinions in that case to provide meaningful guidance to the scientists who must implement the Clean Water Act illustrates the current breakdown at the interface between law and science. Addressing the complexity at that interface requires reforming the legal process used to resolve these disputes. The appointment of specific federal district court judges to address environmental and natural resource disputes and the addition of neutral scientists and settlement masters to the court’s staff would provide an initial step toward developing a more appropriate method for natural resource dispute resolution.

quality standards); id. § 1314 (requiring the EPA to develop water quality criteria); see also Clean Air Act, 42 U.S.C. §§ 7408, 7409 (2000) (requiring the EPA to establish air quality criteria for certain pollutants); id. § 7410 (requiring the EPA to review state implementation plans); id. § 7411 (requiring the EPA to establish standards of performance for new stationary sources of air pollutants).