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Resilience and Water Governance

Addressing Fragmentation and Uncertainty in Water Allocation and Water Quality Law

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The U.S. EPA reports that almost half of the nation's rivers and two-thirds of its lakes are use-impaired due to poor water quality (U.S. EPA 1998, 2002, 2010; Houck 2002). The Western Water Policy Review Advisory Commission identified both poor water quality and unhealthy aquatic systems among the water challenges facing the West (Western Water Policy Review Advisory Commission 1998). The water quality impairment is caused both by chemical pollution and physical alteration of streams. Nutrients and excess sediment impair water quality in 30 percent of the nation's streams (U.S. EPA 2011). In the Great Basin nearly two-thirds of the native fish are either listed under the Endangered Species Act (ESA) or considered of concern by the U.S. Fish and Wildlife Service (USFWS). Water development is considered second only to the introduction of nonnative fish in causing these problems (Doremus 2001).

In 1906, Justice Holmes, writing for a majority of the U.S. Supreme Court in an opinion that denied an injunction against the disposal of Chicago's sewage into the Missouri River, stated, "It is a question of the first magnitude whether the destiny of the great rivers is to be the sewers of the cities along their banks or to be protected against everything which threatens their purity," thus requiring clear proof of the source of serious harm if the court is to act in the absence of Congressional legislation (*Missouri v. Illinois* 1906). It would be sixty-six years before Congress would act.

By many accounts, the efforts under the 1972 Federal Water Pollution Control Act, commonly known as the Clean Water Act (CWA), to clean up point source discharges from municipal sewage and industrial activities under the National Pollutant Discharge Elimination System program have been successful (e.g., Houck 2002; Adler et al. 1993). Similarly, by all accounts and relying on the statistics above, it is also clear that the cleanup of non–point source pollution is insufficient to achieve the goal of the CWA to "restore and maintain the chemical, physical and biological integrity of the Nation's waters" (CWA § 1251(a)). Diffuse sources of pollution resulting from land use activities, including agriculture, timber harvest, and development in the floodplain; dewatering of streams for beneficial use of water; and loss of the ability of streams to handle sediment input due to modification of floodplains and adjacent wetlands, continue to present challenges to efforts to achieve water quality standards. It is not that the CWA does not address non–point source issues. Whether due to the inadequacy of the approach or of its implementation, it has not yielded the results sought of fishable, swimmable rivers.

A report of the National Research Council (NRC) to Congress in 2001 identified uncertainty as a key barrier to management decision making and improved water quality under the CWA and recommended that the states and EPA move forward with management actions "while making substantial efforts to reduce uncertainty" (NRC 2001). Further, the NRC specifically recommended against the practice of measuring the success of the program to address non–point source pollution (also referred to as the total maximum daily load [TMDL] program) by the attainment of administrative goals, but rather by measurable improvements in water quality. In addition, the NRC report and a report of an expert panel, including coauthor Stow, assembled by the Center for the Analysis and Prediction of River Basin Environmental Systems at Duke University, recommended the use of adaptive implementation to address uncertainty (NRC 2001; Shabman et al. 2007).

In this chapter, we identify two areas that must be addressed in reforming water law and water quality law if the nation's stated goals are to be achieved:

(1) Fragmentation. Lack of integration between regulation of point source and non–point source pollution, non–point source pollution and land use regulation, and water quality and water allocation regulation not only places an absolute limit on the ability of current regulation to achieve its goals, but imposes high costs and diminishing returns on any efforts toward those goals under existing regulation.

(2) Uncertainty. The diversity of both the physical and biological features of water bodies and of the sources of non–point source pollution require site-specific responses. Yet the cost of characterizing water quality on a water body by water body basis and the failure to follow up on efforts to achieve water quality standards with monitoring of results inhibits improvements in water quality characterization and identification of land use changes that are effective in moving toward water quality goals. In contrast to the early expectations of a fairly straightforward calculation of pollutant loads (Houck 2002), studies have shown that even modeling of relatively data-rich systems shows variance in excess of 50 percent (Stow et al. 2003).

Integration of water resource management and adaptation in the face of uncertainty require new approaches to natural resource management and regulation. Resilience theory provides a foundation for relating these changes to the complexity of the social-ecological system and for the necessary communication across disciplines to define those changes. Resilience theory as applied to ecological systems addresses a system's ability to respond to change while continuing to provide, or to shift to a state in which it will provide, a full range of ecosystem services or function (Walker and Salt 2006). On paper, the traditional approach to natural resource management involving single-variable optimization can be implemented by individual resource management or regulatory agencies acting at a single scale. But the complexity of social-ecological systems will lead to unexpected and unwanted results if management and regulation continue down that path.

The concept of resilience made its appearance in the study of ecological systems in the work of C. S. Holling (1973) and his recognition that ecosystems are not static. When applied to ecological systems without a human component, resilience theory focuses on both the capacity of the system to return to its prior level of self-organization following a disturbance and the degree to which that capacity is influenced by or sensitive to changes at smaller and larger scales (Gunderson and Holling 2002; Walker et al. 2004). Resilience theorists call on adaptive management, in which the natural adaptive abilities of an ecosystem are emphasized and promoted over the active management, control, and resource exploitation of the system to foster ecological resilience (Folke et al. 2005). The term "adaptive implementation" used by Shabman et al. (2007) incorporates the concepts of adaptive management but applies them in a setting in which the agency must implement a specific regulatory statute rather than acting under its general management authority over a particular resource or area of land. Both concepts allow for incremental action in the face of uncertainty, along with constant monitoring and feedback to improve management or regulatory decisions.

We use resilience theory to explore the legal changes and implementation approaches necessary to achieve adaptive implementation of the CWA and integrated water resource management within the current U.S. framework, which places water quality oversight at the federal level, water allocation at the state level, and most land use decisions at the local level. We begin by exploring fragmentation and uncertainty issues in current water management and regulation.

Water Management: Sources of Fragmentation and Uncertainty

Discussion of means to address fragmentation and uncertainty in water management must begin with an explanation of how the current system arose in the United States and how that leads to fragmentation and lack of adaptability in the face of uncertainty. History matters, because it informs the choice of approaches that may be politically acceptable. In addition, the greater the understanding of how the current system arose, the greater the chance of avoiding unintended consequences in changing it. We begin with the law applicable to water quality, follow this with discussions of management of aquatic species and then water allocation, and conclude with land use regulation.

Water Quality

Historically water quality issues were considered a matter of state law. Dilution was the primary focus of water quality control, and a public nuisance suit was the primary legal remedy to the impact on downstream states when Justice Holmes wrote the words quoted above. Several events and reports spurred federal action. In January 1969 a Union Oil well off the coast of Santa Barbara, California, blew out. In June 1969 the Cuyahoga River in Cleveland, Ohio, burned (Adler et al. 1993). A 1971 report titled *Water Wasteland*, compiled by researchers for Ralph Nader, detailed fish kills, water courses and beaches unfit for swimming, contaminated drinking water, and loss of bird species due to toxic chemicals in water (Adler et al. 1993). That same year, similar findings were presented in the Second Annual Report of the President's Council on Environmental Quality (Adler et al. 1993). Leaving water quality to the states was apparently not working. Federal action up until this time had focused primarily on financial assistance for sewage treatment plants.

Water quality standards under the CWA are set on a water body basis and are tailored to the particular use of that water body, including recreation and habitat for endangered species (33 USC § 1313). Because water quality standards are based on use, it is theoretically those who control its use who should set those standards; at least this was the argument states made to Congress as the CWA was being crafted (Houck 2002). Governors seeking to retain state control provided testimony to Congress that ranged from the 1970s equivalent of the need for local knowledge and flexibility; to the constitutionality of federal interference with state control of any but interstate waters, an argument that persists today (e.g., see *Rapanos v. United States*, 2006); to claims that states were already doing a great job (Houck 2002), an argument made despite the fact that it was inconsistent with the scientific data before Congress. An additional argument made was that a standards-based program that can take into account the individual assimilative capacity of specific water bodies was the appropriate approach (Houck 2002). As will be discussed below, despite this argument, states have failed to consider the assimilative capacity of a water body when allocating water for use. Rarely is pollutant load a consideration when approving a new water diversion right, despite the fact that increased diversion reduces the ability of the water body to dilute pollutants. This might make sense in the water abundance of the eastern United States, but its proponents were not limited to the nonarid states.

Despite the tremendous success of the National Pollutant Discharge Elimination System program, the nation's waters remain polluted. Houck provides a list of agricultural and silviculture impacts in various states, then concludes that these sources:

> have several characteristics in common. Individually small, it is their cumulative impacts that are the problem, and we have not yet in any medium found an easy way to persuade people to fix problems for which they are only a small contributing factor. Furthermore, although individually small, these sources are supported by industries with a political lock on state legislatures and, in some cases, on Congress as well. (Houck 2002)

Most effort to abate non–point source pollution has proceeded under the entirely voluntary provisions of section 319, which provides both technical assistance and grants for state management programs (33 U.S.C. § 1329). Yet another provision holds more potential for clout—section 303(d).

States setting standards had been the approach of the Water Quality Act of 1965, which was applicable to interstate waters, but the arguments in favor of keeping it prevailed only for what was viewed as a backup provision—section 303(d), applicable only if a water body did not meet water quality standards with regulation of point sources. The TMDL program under section 303(d) embodies an approach "that both the states and pollution dischargers insisted on" (Houck 2002). Section 303(d) was a provision that appeared and was treated as an afterthought in passage of the 1972 CWA (Houck 2002), yet it contains more clout than originally thought. Under section 303(d), once standards are set, TMDLs are set on a water body by water body basis for each pollutant found in excess of the applicable standard (33 U.S.C. § 1313(d); Houck 2002). Loads are then allocated between point and non–point sources as appropriate. Despite the existence of the provision in the CWA since 1972, nothing happened for a decade. Because the provision was assumed not to trigger EPA action until a state submitted TMDLs, states could sit back and do nothing (Houck 2002). A series of citizen suits in the late 1980s challenged this assumption and prevailed on the issue of the EPA's need to act if the state failed to submit TMDLs (e.g., *Alaska Center of the Environment v. Reilly*, 1991; *Alaska Center for the Environment v. Reilly*, 1992); this was followed by a successful challenge to the assumption that a state could submit anything and get off the hook (*Idaho Sportsmen's Coalition v. Browner* 1996). Thus, the arduous process of characterizing the water quality of the nation's waters began, only to find that this process of characterizing the water quality of every water body within a state involves an enormous undertaking and is fraught with uncertainty, as discussed below (Shabman et al. 2007).

Aquatic Species

Similar to water quality regulation, take of fish and wildlife has traditionally been a matter of state concern (Goble et al. 2006), whereas the preservation of the habitats various species rely upon has often occurred at the federal level (e.g., Migratory Bird Treaty Act of 1918; Land and Water Conservation Fund Act of 1965). With much of the funding for state fish and wildlife agencies coming from hunting and fishing licenses, state management focuses on game species and sport and commercial fisheries. With a few exceptions, federal land preservation rarely focused on biodiversity and generally preserved land already in federal ownership. The primary tool for restricting development of private land, land use zoning, is rarely used for purposes of biodiversity protection.

For most aquatic species and nongame species, the approach of states and federal land preservation once again fell short. Increasing human population, an even greater rate of increasing consumption, and the resulting loss of habitat caused the loss of "over five hundred species formerly found in the United States . . . [with] an additional 47 percent of the species unique to this country" at risk (Goble et al. 2006). The Biological Resources Division of the U.S. Geological Survey (USGS) identifies freshwater fish as the single most endangered vertebrate group in the United States (Doremus 2001).

Similar to the history of federal regulation of water quality, Congress stepped in to fill the gap with passage of the ESA in 1973. The ESA combines both time-honored approaches: restriction on take (sections 7 and 9) and preservation of habitat (section 4) (Goble et al. 2006). For listings of aquatic species and designation of their critical habitat, the USFWS lists resident fish species and NOAA Fisheries lists ocean and anadromous fish species.

The regulation of water quality and listing of aquatic species, both at the federal level, has led to some degree of coordination. Listed species must be included as one of the "uses" for which water quality standards are designated (CWA §§ 1251(a)(2), 1313(c)(2)(A)). However, as described above, achieving these standards remains elusive and, as described below, efforts are hampered by uncertainty.

Water Allocation

Although the system of water allocation differs between the eastern and western United States, the fact that water allocation remains at the state level, water quality regulation at the federal level, and land use decisions at the local level is equally applicable. For purposes of this chapter, western water allocation can simply be considered the worst case scenario in terms of separation of water allocation law from other management and regulatory efforts aimed at the water resource.

Western water allocation arose both as a means to manage water in an arid region (e.g., Stegner 1953) and to provide certainty to investment for extraction and development of natural resources (e.g., *Irwin v. Phillips* 1855). In the late 1800s, John Wesley Powell recognized that rivers would control western development and recommended to Congress that the federal government draw jurisdictional boundaries along topographic divides (Stegner 1953; Reisner 1987). He also noted that the cost of water development would require formation of collectives or irrigation districts for the control of land and water (Stegner 1953). Congress did not take his recommendations in defining political boundaries. States ignored much of his advice concerning shared development and shared water use.

Under U.S. Supreme Court interpretation of federal law, water allocation and management is a matter of state law (*California Oregon Power*

Co. v. Beaver Portland Cement Co. 1935; *United States v. Rio Grande Irrigation Co.* 1899). Without the foresight that this land would come to be home to a population that must share its water resources for economic pursuits as diverse as irrigation and fishing or the havoc that dewatering of streams would play on habitat, state courts sought a means of allocation that protected investment (Wilkinson 1985; Dellapenna 2000). The result: the doctrine of prior appropriation, followed in some form by most western states (Hutchins 1971).

Under prior appropriation, the right of the earliest appropriator on a stream is satisfied first; junior appropriators take the remaining water. Shortages are not shared among appropriators. Due to the high variability in annual water supply, the fact that the largest use, irrigation, does not require a constant diversion of water, and the fact that state water allocation criteria generally do not require consideration of instream flow, state agencies generally approve water allocation permits to the point that all water is allocated in the wettest year. As drought becomes an increasingly frequent occurrence, this practice leads to dewatering of many streams at certain times of the year in areas of irrigated agriculture.

The allocation of appropriative water rights to individuals rather than geographically related communities, as recommended by Powell, also significantly reduced the possibility that allocation and management decisions would be made for the good of the community as a whole or for the long-term health of the riparian habitat (Tarlock 2000). Additionally, the practice inhibits any effort to adapt as new knowledge on the effects of diversion is gained. The relative control over water diversion of the individual, as opposed to the state, is implemented for the most part as though diversion decisions are unrelated to water quality. States that have requirements for consideration of impact on water quality (e.g., Montana Code § 85-2-311(f)), generally limit it to the water quality required by another appropriator. Some states include criteria that could be interpreted more broadly to address the affect on water quality in general, such as Idaho's public interest criteria (Idaho Code § 42-203A(5)(e)). In either case, it is an inquiry that takes place prior to issuing a permit to divert water and is a one-time consideration, after which the permit is viewed as a property right. In the two states used as examples, water allocation and water quality decisions are housed in separate agencies; thus, imposing an additional barrier to thorough review of allocation decisions in light of water quality impacts.

In addition, growing urban demand for water in the western United States and increasing call for dedication of water to instream flow for ecological purposes has run headlong into this rigid system of property rights. States authorize water transfers and increasingly have established water banks to facilitate the movement of water from one use to another (e.g., Dellapenna 2000). Because the voluntary nature of water transfers may prevent water availability for a new use, some states allow development of the new use but require mitigation for effects on existing rights. Mitigation measures can be voluntarily agreed to among affected parties; a party could consider water quality in the mitigation process. However, mitigation or augmentation may also be approved by the state over the protest of an existing right holder. In such a case, water quality is not a consideration (e.g., Idaho Administrative Code § 37.03.11.043; Colorado Revised Statutes § 37–92–305).

State courts considering whether the reliance of a pollutant discharge permit on mixing to achieve water quality standards can be grounds for denial of an allocation permit have characterized the issue as whether the discharge permit gives rise to a water right (e.g., *City of Thornton v. Bijou Irrigation Co.* 1996). This leads to the logical answer—no. In contrast, if water quality and water quantity are integrated, it might be more appropriate to ask whether the public interest requires that water for dilution remain in the stream, thus limiting stream allocation with water quality discharge in mind.

Application of the take provisions of the ESA to reduce water diversion has run headlong into the use of the system of property rights to allocate water in the western United States. The property right to water recognized in the western United States is a mere use right and thus differs from a property right to land, which is the right to possess and exclude others from the actual land. Idaho law describes the nature of the property right as it was understood at common law:

> All the waters of the state, when flowing in their natural channels, including the waters of all natural springs and lakes within the boundaries of the state are declared to be the property of the state . . . and the right to the use of any of the public waters which have heretofore

> been or may hereafter be allotted or beneficially applied, shall not be considered as being a property right in itself, but such right shall become the complement of, or one of the appurtenances of, the land or other thing to which, through necessity, said water is being applied. (Idaho Code § 42–101)

Yet despite this very clear difference between a use right and a right to the actual water, recent court decisions have interpreted *any* diminishment in use due to application of the ESA to be a Fifth Amendment Taking because the water itself is taken, rather than looking to the change in value of the "land or other thing to which . . . [it] is being applied" (see *Casitas Municipal Water District v. United States*, 2008). This view prevents any coordination between water allocation under existing rights and determination of flow needs under the ESA or water quality standards set for listed species without payment to the water right holder.

Land Use

During colonial times, land use regulation occurred at multiple levels of government (e.g., Hart 1995–1996). However, since at least the recognition of the constitutionality of local land use zoning (*Village of Euclid v. Ambler Realty Co.* 1926), land use decisions have been considered a matter of state law and are generally delegated to local subdivisions of the state through state constitutions or statutes (e.g., Heim 2005; Baker and Rodriguez 2009). In addition, a majority of states recognize municipal home rule by either statutes or constitutions, which effectively allows a municipality to act for the health and welfare of its community even in the absence of state delegation, as long as the action does not conflict with state or federal law. Some states have interpreted home rule authority to allow land use zoning that is not consistent with state-mandated comprehensive plans (e.g., Heim 2005; Baker and Rodriguez 2009). Although a viable means to ensure tailoring to local needs, economics, and values, lack of integration with other levels of government decision making impedes efforts to address non–point source pollution.

As noted above, the primary sources of non–point source pollution are related to land use activities. EPA's *Watershed Approach Framework* recognizes the relation between non–point source pollution and land use and calls for a local, watershed-based approach to assure tailoring to both the characteristics of the local pollution problem and local social and economic needs (U.S. EPA 1996). However, the section on implementation includes nothing about the use of local land use planning and regulation as a tool, leaving implementation to voluntary measures (U.S. EPA 1996).

Surprisingly, interpretation by courts of Fifth Amendment takings by restriction on land use to prevent take of critical habitat is not as limited as the interpretation applied to water rights, with the analyses appropriately looking at the degree in reduction in value of the particular property in question (Meltz 2009). However, it is the absence in coordination between ESA designations of critical habitat and local land use planning that is a greater hindrance. Development in the floodplain has substantial impact on temperature, sediment load, and other factors that affect aquatic species (*NWF v. FEMA* 2004; National Marine Fisheries Service Northwest Region 2008; Williams 2011). Yet there appears to be no requirement for coordination between local floodplain ordinances and efforts to meet water quality standards.

The relation between land use zoning and water allocation is also problematic. Many states have comprehensive approaches for water allocation and management. The lower courts in at least one state have struck down local attempts to use land use zoning to protect water quality and supply as preempted by state law (e.g., *Ralph Naylor Farms, LLC v. Latah County* 2006; *Eagle Creek Partners, LLC v. Blaine County* 2008).

This description of the fragmentation of water management illustrates the difficulty of implementing a flexible approach. Authority divided among multiple federal, state, and local entities to use greater flexibility without robust coordination could create havoc. Yet our political system, the recognition of property rights to water, and investment dependent on the current regulatory approach prevent wholesale implementation of a new approach. In this chapter, we will look at changes to improve flexibility and integration within the framework of the existing system. The next major section turns to resilience theory and network analysis to inform these changes, but first we consider the added complexity of uncertainty.

Uncertainty

The problems raised by fragmentation of water quality regulation, species management, water allocation, and land use planning are compounded by uncertainty in both the characterization of aquatic health and the ecological and social consequences of particular actions. The problem of uncertainty extends to each of the areas of regulation addressed, but will be discussed here in the context of water quality.

The process of characterizing the water quality of every water body within a state involves an enormous undertaking and is fraught with uncertainty (Shabman et al. 2007). Added to the uncertainty of characterizing the water quality of a water body is the uncertainty associated with characterizing the sources of non–point source pollutants. As noted by Houck (2002):

> The Achilles' heel of water quality standards-based regulation has always been the difficulty of ascribing and quantifying environmental effects for particular discharge sources. There is always another possible source, or another possible reason . . . [a]nd when we come to more complex biological impacts such as the fate and effects of nutrients, particularly those effects hundreds of miles downstream, we are beyond any pretense of precise mathematics for cause and effect decisions. The question is whether we are also, for these same reasons, beyond the reach of law. (58)

Houck concludes that with the CWA requirement for a margin of safety in any TMDL order, we should not be "beyond the reach of the law," because the margin can account for the degree of uncertainty. The question we seek to explore in this chapter is not the legal requirement but the practical question of how best to proceed in the face of uncertainty. Recognizing that it is not enough simply to have the authority to act, we seek positive results.

Two related theories inform the discussion of how to address fragmentation and uncertainty: network and resilience theory. The following sections describe how these theories inform solutions to the problem followed by specific application to water management and regulation.

Network Theory: Integration across Multiple Entities and Jurisdictions

The study of resilience in social-ecological systems has led to the development of the concept of the adaptive cycle to describe the state and evolution of a self-organizing system and panarchy theory to describe the overlapping and multiscalar structure of adaptive cycles linked across scales (Holling 2001; Gunderson and Holling 2002). The adaptive cycle consists of: (1) a growth phase leading to; (2) increasing conservation, which at some point may become sufficiently rigid that a small perturbation leads to; (3) collapse or "release," a chaotic phase resulting in; (4) reorganization and innovation in a context in which the cost of failure is low. Some innovation will succeed, leading back to (1) growth (Holling 2001). The idea that management for resilience could mean allowing collapse of a system does not instill faith in the approach by those who recognize stability as one of the key factors in an economic system. But panarchy recognizes that adaptive cycles occur at many scales and feedback occurs across scales. Higher, slower cycles may provide stability for smaller scales to engage in innovation and adaptation while minimizing the risk of collapse (Holling 2001; Gunderson and Holling 2002). Innovation and adaptation at smaller scales can feed back to the maintenance of stability at larger scales. Viewed from the perspective of the U.S. system, stable federal and state law can provide room for local innovation. Experimentation at the scale of a watershed does not involve the degree of risk or political aversion present if experimentation was undertaken at the scale of a river basin. For example, local changes in tillage practice followed by monitoring of both pollutant results and economic viability can, if successful, provide information to facilitate adoption elsewhere. Moving from structural to nonstructural flood control (i.e. reconnecting the river to the floodplain) can have both water quality and habitat benefits, yet could be highly risky if undertaken on a large scale without substantial data on the resulting flood control benefits. Nested scales of management authority thus allow for local adaptation while providing large scale stability.

Furthermore, the concept of panarchy cautions that there will be linkage among the results of actions at different scales whether or not strict legal lines are drawn between authorities and jurisdictions. Thus, a local land use decision to build in a river floodplain may lead to increased need for investment in storage across an international boundary. If the ecological system will not allow us to ignore the linkage among scales, then it is advisable to approach the linkages among agencies and jurisdictions deliberately and build them to facilitate adaptation.

Analogous to the concept of nested scales in ecological systems, integration of water resource management requires moving from a focus on efficiency and clean lines between jurisdictional authorities, to a focus on diversity, redundancy, and multiple levels of management, including a role for local knowledge and local action. The adaptive state of systems at scales above and below the scale of a system of interest may enhance or detract from the resilience of the system of interest (Walker et al. 2004; Walker and Salt 2006).

> In applying this concept to a river basin, while coordination may be needed across the entire basin, issues that arise do not always require action at such a large scale. Designation of an entity with authority at the scale of the particular ecological system can serve as the mechanism for coordination at that scale, but it is not a replacement for diversity in governance at multiple scales (Huitema et al. 2009). Scholars recognize that a scale appropriate for one problem may not be relevant for another (Ruhl and Salzman 2010). In addition, complex systems do not always have clearly identifiable scales for governance (Ruhl and Salzman 2010). In contrast to the difficult search for the appropriate match in scale, resilience thinking rejects the call for a single, efficient level of management and instead calls for multiple overlapping authorities. At the same time, coordination across scales is necessary. As noted by Lee (1993) in reference to the Columbia River Basin: Each of the major uses of the basin's resources is managed by a different constellation of human institutions, each set of

> managers guards its rights and prerogatives, and none is sufficiently powerful to bring the others to heel. Multiple management of multiple uses produces a tragedy of the commons. (28)

Instead, a networked approach informed by resilience allows response at different scales across different entities depending on the source and impacts of the problem. Importantly, it leads to consideration of minor changes to the existing diverse system, rather than an entirely new approach.

Complicating the scale issue even more are situations in which the source of the problem and the negative impact occur at different scales, thus removing any incentive for action at the scale of the problem source (Long 2010). This situation highlights the need for response capacity at multiple, linked scales. In the United States, we have seen the results of this mismatch in the form of backlash to some of the environmental laws passed in the 1970s. For example, the failure of states to take action led to federal regulation to achieve clean water, (Federal Water Pollution Control Act (CWA §§ 1251–1387), clean air (Clean Air Act of 1963 [CAA]), and species protection (ESA). Yet although the scale of the problem is federal, the source may be local land use planning in the case of non–point source pollution (Adler et al. 1993), or local development of wetlands important to filtration of polluted water and flood mitigation on a larger scale (*Rapanos v. United States* 2006; Cosens 2008), or local development that will endanger an obscure species important to biodiversity in general (*National Association of Home Builders v. Babbitt* 1997). Problems such as non–point source pollution that result from the cumulative effect of many small activities, some located far from the point at which the cumulative effect begins to violate water quality standards, require both local capacity to act and enhanced monitoring to tie source to impact.

All too frequently, those of us in the academy propose governance changes based on the ideal end point we seek to achieve without regard to where we are now. The resistance to change and slow incremental process with which it occurs in a democratic system, coupled with the fact that the slow pace ensures deliberation and consideration of equity and justice, is possibly what led to Winston Churchill's famous quote that "democracy is the worst form of government, except for all the rest that have been tried." Rather than propose an entirely new form of nested levels of governance, this article seeks to make use of the existing diversity and multiple scales of water governance while developing means to integrate across and within various scales. In doing so, we propose process changes coupled with more minor changes to substantive law.

Substantive laws govern what is managed, who is regulated, and the goal of that management or regulation. Administrative law governs how these functions are implemented (Stewart 2003). The term "administrative law" is used in this article to refer to any law governing the process of agency or governing body decision making. For example, administrative law is used here in reference to U.S. domestic law to include not only the Administrative Procedure Act, but procedural requirements in substantive law, such as the requirement for development of an Environmental Impact Statement in the National Environmental Policy Act of 1970 (NEPA §§ 4321 et seq.) or the requirement of consultation in the ESA (§§ 1531 et seq.).

Three changes that will not disrupt the existing legal system that establishes and allocates authority among institutions are needed to facilitate adaptable response at multiple scales: (1) enhanced monitoring; (2) increased local capacity; and (3) vertical and horizontal networks across jurisdictions and scales to allow coordinated response among overlapping authorities without high transaction costs. Because enhanced monitoring is also a major factor in addressing uncertainty, it will be discussed below. The following paragraphs explore the use of networks to allow flexibility in the scale of response, multiscalar response, and enhanced flow of resources to the local level.

The need for local capacity with robust networks to multiple levels can be seen more clearly if the example used is a sudden, high-risk situation. It is on the local level, not the level of an entity like the U.S. Department of Homeland Security, that a major portion of the resources are needed for response to events like Hurricane Katrina or 9/11. Yet without the link to assistance both from other communities and from state, national, and international levels, a disaster of such magnitude will be beyond the capacity of any local government.

In addition, studies of postdisaster short and long-term relief indicate that networks for coordination and clear definition of roles must be addressed prior to a disaster if local organizations are to be effectively used in providing relief (Stys 2011). Taking the example of emergency response further, a proven and highly robust system for multiagency/jurisdiction networking is presented to the general public on national news on an annual, if not more frequent, basis. The example is the incident command system for multijurisdictional response to a large-scale, often mass casualty, emergency. The incident command system is a highly robust process for multientity response to an emergency, in which the scale and timing was highly uncertain prior to its occurrence (e.g., see U.S. Department of Homeland Security; U.S. Forest Service 2000). Rather than create a new agency at the scale of every conceivable emergency, the incident command system provides a means for rapid crisis response across multiple agencies at the same level and through multiple levels of agencies.

The incident command system works on the theory that rapid coordination requires that no more than seven people report to any one person. The incident commander is at the top level of response and is selected based on the nature and location of the emergency. No more than seven people or entities report to the incident commander, no more than seven to each of those seven, and so on, until the on-the-ground response to, for example, a wildfire, a flood, or an earthquake may involve hundreds or even thousands of people. In one author's (Cosens) experience as a search and rescue volunteer, the initial hours or even days of response to a large-scale emergency are often chaotic, as response personnel move into position, assess the scope of the problem, and identify the chain of command. However, within a remarkably short period of time, given the level of uncertainty involved, a relatively smooth operation emerges in which information and coordination of decisions in response to changes in the problem flow rapidly within and between levels. Although referred to by some as a "command and control" approach (Stys 2011), the incident command system is highly adaptive to meet the type, location, and scale of a disaster. The result is a clear line of hierarchical authority leading to the "command and control" description. This hierarchical approach fits the emergency nature of the situation, but it is the ease of formation of networks for flow of information and resources made possible by the conscious focus on flexible cross-entity and cross-scale coordination that serves as a lesson for water management.

Other than a flood, earthquake, landslide, wildfire, or volcanic eruption, the types of change and uncertainty in a river basin do not occur on the timescale of an emergency. Fortunately, examples of establishment of networks for management of slower processes also exist. Efforts to coordinate across different levels and authorities are reflected in the move toward integrated water resource management (Global Water Partnership 2000, 2002; European Union Council Directive 2000). A formal structure for integrated water resource management does not currently exist in the United States. Ruhl and Salzman describe a process in the Mississippi River Basin and Gulf of Mexico in which "weak ties" are formed among individuals working at various levels of government and nongovernmental organizations as a solution to the scale of response needed for a water quality issue in which the pollution sources are diffuse and basin-wide (Ruhl and Salzman 2010).

Effective networks rely on two primary components: (1) the existence of certain social skills among people within the network; and (2) facilitation of, and removal of barriers to, cross-agency and cross-scale interaction. In their work on adaptive governance, Folke et al. (2005) note that success in managing ecological systems for resilience often depends on the involvement of key personality types such as *mavens* ("altruistic individuals, with social skills, who serve as information brokers, sharing and trading what they know"), *connectors* ("individuals who know lots of people not only by numbers but the kind of people they know and in particular the diversity of acquaintances"), and *entrepreneurial leaders* (creative decision makers willing to risk being the first to try something). This is consistent with author Cosens's observation of multijurisdictional water negotiations, in which success is often determined by key personalities involved (Cosens 1998).

Administrative law and institutional structure cannot mandate the individuals involved, but could be designed to maximize diversity, thus increasing the likelihood that these personality types are represented. In addition, organizational structures may be set up to provide positions and incentives for people who play the roles of maven, connector, and entrepreneurial leader within governmental entities. Clearly, there is also a role for our institutions of higher education in educating students with the skills necessary to bring people together and to communicate across boundaries.

That certain types of people are needed to form transjurisdictional networks is not a satisfying answer in itself. Any solution formalized in an administrative process must strike a balance between facilitation of network formation and avoidance of a rigid structure that cannot adapt to changing scale and type of problem. We can take lessons from experience with systems like the incident command system for emergency response to improve the capacity of networks to form and act adaptively and to facilitate that improvement by incorporating the following elements into administrative law and resource allocation.

First, coordination and communication among different entities works better if its requirement is explicit (Bingham 2009). Thus, it must be a written legal requirement that is assigned to a specific position created within each entity without imposing rigid requirements on the position. Establishment of a network framework upfront can also avoid transaction costs encountered with the ad hoc development of a network after a problem is identified (Huitema et al. 2009).

Second, practice improves response. Under the incident command system, the operation appears to be much smoother in response to incidents, such as wildfire, that occur somewhat predictably on an annual timescale, than it is in response to rare events, such as a hurricane or earthquake. In the context of river management, this could translate into frequent information sharing among entities as a building block in the relationships necessary for multijurisdictional decision making.

Third, substantial resources must be devoted to the local level, since local actors are likely to be a component of response to any scale of problem. The current structure of resource availability, both with respect to funding and people, for entities that manage natural resources may need to be inverted, with greater resources made available at the local rather than at the national level. Once again, the flow of resources in response to an emergency serves as an illustration of the need. Few question the need for the largest number of people responding to a wildfire to be those on the ground. This same thinking should be imported to resource management in general.

Fourth, harmonization of methods and regulations in the area of overlap will result in more effective networks (Zaring 2009). While noting the important role of social networks in environmental compliance, Bodin and Crona (2009) note that not all networks are equal in their effectiveness. By studying the topology of networks, their work has begun to identify key characteristics. Although intuitively we might consider a cohesive group to be more likely to achieve self-regulation, complex problems require a balance between cohesion and diversity of network membership to foster creative solutions, use of local knowledge, and adaptive capacity. In addition, ties to external sources for knowledge and resources and to assure legitimacy are necessary. Thus, the current diversity in entities with water management authority on any particular river basin is actually an asset. Rather than remove the diversity already present, simply altering process through administrative law to harmonize methods and regulations will enhance network response.

Finally, attention must be paid to the difference between formal and informal networks. For effective management across multiple entities, networks with low transaction costs are needed (Huitema et al. 2009). One way to achieve this goal is to build network formation into the administrative process rather than leaving it to be formed on an ad hoc basis when a problem arises. Models for coordination across entities and scales imbedded in administrative law could greatly reduce these transaction costs. At the same time, caution is warranted in any attempt to formalize the interaction across entities and scales before understanding existing informal networks for communication and action. Research by Bodin and Crona (2009) suggests that informal networks appear to be more successful than an imposed structure. Informal network formation can be facilitated through capacity building, identification of influential actors through use of social network analysis prior to establishing lines of coordination, encouraging broad participation, and providing a forum for communication (Bodin and Crona 2009). It may be more important to remove legal barriers to network formation than to mandate a particular structure.

Resilience Theory: Adaptation in the Face of Uncertainty

As noted earlier, resilience as applied to ecological systems addresses a system's ability to respond to change while continuing to provide, or returning to a state in which it will provide, a full range of ecosystem services or functions (Walker and Salt 2006). Resilience theory provides a framework for moving from management through optimization to a more adaptive form of management based on recognition of the complexity of an ecological system and the associated uncertainty.

To apply resilience theory to governance, it is also necessary to define the use of terms related to resource management. Much of the literature calls on adaptive management to achieve resilience (Lee 1999; Folke et al. 2005; Huitema et al. 2009). The term adaptive management has been used to describe a process of learning through monitoring ecosystem response to a particular action followed by incremental change in the action based on what is learned (Lee 1999; Folke et al. 2005; Huitema et al. 2009), and generally applies to management action by a single entity. Under adaptive management, the natural adaptive abilities of an ecosystem are emphasized and promoted over the active management, control, optimization, and resource exploitation of the system (Folke et al. 2005). Continual and artificial maintenance of an ecosystem within human-defined parameters is less desirable. Instead, natural disruptions to the ecosystem are allowed to take place. The ecosystem becomes more resilient through natural disruptions (Ruhl 2011).

Adaptive implementation is a similar concept, but applies to the implementation of a regulatory statute such as the CWA rather than general management authority over a particular ecosystem (Shabman et al. 2007). Fostering the natural adaptive abilities of an ecosystem and providing a system of management or regulatory implementation that adapts to the results lessens the need to predict the full implications of a management or regulatory activity prior to taking action. Uncertainty is accounted for in the incremental adjustment to change. Adaptive implementation will require three key components: (1) authority to make incremental adjustments to decisions based on monitoring, (2) monitoring, and (3) implementation at the smallest relevant scale with accompanying capacity building. Of course, overarching all of this is the need for "buy-in" from stakeholders, especially the regulated community. One component of achieving this may be to allow implementation measures to go either way as the result of monitoring—that is, to become more or less stringent depending on results.

The current gap between the recognition by resilience scientists that adaptive management is an appropriate management tool in the face of uncertainty and the achievement of practical adaptive management implementation arises from a failure to recognize and integrate the social component. It is not enough that monitoring and incremental adjustment will provide the best results in the face of uncertainty. The decisions on whether to use adaptive management, what to monitor, and how to make incremental adjustment must be done in a manner that will foster political acceptance. Thus, to achieve implementation of adaptive management requires attention to the process of governance used to carry it out. In this context, "governance [or adaptive governance in the context of implementation of adaptive management] is the process of resolving trade-offs and of providing a vision and direction for sustainability, management is the operationalization of this vision . . ." (Boyle and Pond 2001, 122). By its definition, governance will involve trade-offs and thus may not lead to the perfect scientific result for the ecological system. But the flaw in implementing adaptive management without the integration of the social system is that it makes the same mistake as traditional management, by optimizing for a subset of the system—the ecosystem. Coupled with adaptive management, an appropriate form of governance addresses the entire social-ecological system. This raises the question: What are the components of governance necessary to gain political acceptance for implementation of adaptive management? Cosens (2010, 2013) has developed a framework for legitimacy as a term to describe the necessary components in adaptive governance elsewhere and that work will be summarized and applied in the following paragraphs.

It is a basic tenet of political theory that people seek legitimacy in the actions of those who govern them (Bodansky 1999). Legitimacy can be thought of in simple terms as a measure of how persuasive the basis for a particular action is (Bodansky 1999). Legitimacy includes the justification for assertion of authority and has both popular and normative aspects (Bodansky 1999). Thus, an assertion of authority must be both justified (normative) and perceived to be justified (popular) to be legitimate (Bodansky 1999).

Democracy therefore emerges as a system with a high level of legitimacy. Through the process of electing those who govern, people consent to their leadership. In casting a vote, a person is reflecting his or her perception of who can best govern. But when democratic nations move from implementation of the law by elected officials to delegation of authority to administrative agencies or appointed governing bodies, they dilute the direct connection between the elected official and the voters affected by regulation. As the administrative state has grown, administrative law governing the process by which agencies or appointed bodies take action has developed to fill this gap in direct accountability. The direct accountability gap increases with the scale of governance (Esty 2006). Thus, local agencies may have a higher perception of legitimacy in a river basin than federal or international entities. As the scale is reduced to the local level, fewer formal protections are needed to assure accountability to the regulated public. The introduction of flexibility to water resource management to allow adaptive management can challenge traditional sources of legitimacy, thus presenting a barrier to adoption of new approaches. To achieve acceptance of governance that implements adaptive management, administrative law becomes a tool for enhancing legitimacy.

Daniel Esty (2006) outlines five sources of legitimacy applicable to administrative entities in addition to the democratic process, three of which will be addressed here: (1) results-based: legitimacy derived from the fact that decisions are based on objective expertise and the results can be determined to be good; (2) order-based: legitimacy based on the fact that rules are clear, stable, and publicly available; and (3) deliberative: legitimacy based on the inclusion of a public dialogue in the process of decision making. The following discussion will use these sources of legitimacy to discuss the components necessary for adaptive implementation. A more thorough discussion of legitimacy and its relation to management for resilience is the topic of articles by Cosens (2010, 2013) and will be relied upon here.

(1) *Results-based legitimacy* reliant on an agency's scientific expertise began in the United States with Gifford Pinchot's call for scientific, federal management of the forests and establishment of the National Forest Organic Act in 1897 (§§ 473–478, 479–482, 551, as amended in 1905, 1911, 1925, 1962, 1964, 1968 and 1976). The infusion of science into decision making has at its very core the belief that the process will be more objective and the results better. However, reliance on scientific expertise is increasingly questioned as a source of legitimacy, as agency

science shows vulnerability to politicization (Wagner 1995; Doremus and Tarlock 2005; Ruhl and Salzman 2006; O'Reilly 2007; Cosens 2008). Recent environmental and natural resources laws impose requirements for use of "best available science" (e.g., Safe Drinking Water Act of 1974), as trust for objective science-based decision making without legally imposed criteria has eroded (Wagner 1995; Doremus and Tarlock 2005; Ruhl and Salzman 2006; O'Reilly 2007; Cosens 2008). However, it is not clear that such requirements are sufficient to address the growing politicization of agency science in the United States.

Adaptive implementation, if properly formulated, can actually provide a new approach to results-based legitimacy and stem the tide of politicized science (Camacho 2009). Adaptive implementation requires that the results of an agency action be monitored and that the action be adjusted based on the monitoring. Although substantial resources may be allocated to studying a problem in the process of developing a solution, data is rarely gathered to verify the results of a particular action, such as implementation of certain tillage practices to reduce sedimentation, once it is taken (Shabman et al. 2007; Camacho 2009). Furthermore, even if data were collected following agency action, agencies rarely have the authority to modify the action without going back through the rule-making process or, in some cases, without new legislation.

Reluctance to provide authority for flexible implementation lies, in part, in failure to characterize monitoring as an essential component of program implementation and failure to tie adjustment based on monitoring to agency accountability. By imposing a requirement that progress toward a particular goal, such as meeting water quality standards, must be accounted for and adjustment made in the face of new data, the use of science to achieve the goals of an interest group rather than the goal of a statute can be reduced. In this way, legitimacy is served by adaptive implementation. By placing funding for monitoring at the center of measures to assure agency accountability rather than as an add-on study, legitimacy is served by adaptive implementation.

(2) *Order-based legitimacy* captures the concepts of stability and finality, or at least predictive capability, regarding application of the law. It can be found in the move from administrative action on a case-by-case basis to rule making. By promulgating rules to govern implementation of laws passed by Congress, agencies are more likely to apply

the law equally and uniformly to the regulated community. In addition, procedures governing rule making require notice and allow comment on proposed rules prior to finalization (Administrative Procedure Act of 1946), thus assuring public input and public notice on how a law will be implemented. In recent years, the move to negotiated rule making combines aspects of order-based legitimacy and deliberative legitimacy; it will be discussed below as a recommended aspect of adaptive implementation. Increasing adaptive capacity while retaining the benefits of the rule-making process requires inclusion of monitoring and adjustment within the rule itself. By maintaining a process of notice and comment, or negotiated rule making in the process of adjustment, legitimacy may still be served. However, a larger problem is the possibility of instability resulting from more flexible management of resources relied on for economic pursuits, such as hydropower, commercial fishing, and irrigation.

The expectations that rules will be stable and that finality can be achieved may present the most significant barriers to authorization of the flexibility needed to implement adaptive implementation. The desire for finality lies at the core of the desire to use implementation of "best management practices" as a proxy for achieving water quality standards. The communication gap between those advocating adaptive implementation/management, and those seeking finality is fundamental to many legal battles concerning natural resources and the environment and can be characterized as a basic conflict between science and law. In simple terms, science is a search for the truth (a process), whereas litigation is a search for finality (resolution) (Cosens 2008). Scientific inquiry has no statute of limitations, no concept of res judicata. Scientific methodology is a process of disproving what was formerly thought to be true, of re-investigating questions thought solved, of re-interpreting information in light of new discoveries. In contrast, civil litigation is designed to finalize a dispute, to provide a forum where, no matter how flawed the inquiry, a peaceful final resolution of a dispute can be achieved. Similarly, the current process of rule making is designed to visit the issue once and then proceed under a final rule rather than to re-examine and adjust to the results of the rule's implementation.

The finality of civil litigation serves those with economic interests in the resource by providing stability for investment, whereas science serves those concerned with sustaining the resource itself by continuing the search for the true impacts of human action on the ecological system. But a re-examination of what is actually happening in natural resources and environmental law suggests that, despite the goals of civil litigation, finality is not being achieved. The fact that one side (the environmental side) of these issues seeks equal treatment for goals not served by the civil litigation (a true understanding of human impacts on the environment) destabilizes the system. Once a court provides a final answer, the issues will be revisited with another legal theory. Once the judicial system is exhausted, the issues will be revisited in the legislature. Once the political system is exhausted, the issues will be addressed through civil disobedience. Thus, while the process of civil litigation works well to help people resolve issues of liability for personal injury or for interpretation of a contract, it may not be the best approach when the viability of an ecosystem and the economies dependent on it are at issue. It is this reality, that the current system is not providing what people seek, that encourages a more incremental and collaborative approach.

Legitimacy in the incremental approach of adaptive implementation will require affording equitable treatment to both the economic need for finality and the progress toward the true system understanding needed to address environmental concerns. Some current examples suggest that management relying on monitoring for adjustment uses a biological time frame when the management action is developed by a science-based agency (e.g., USGS Patuxent Wildlife Research Center, basing monitoring on biological goals) and social time frames when the action is negotiated (e.g., Snake River Water Rights Settlement 2004, placing a thirty-year time frame on a biological opinion to provide stability for water users in the region). Yet to foster ecological resilience while maintaining legitimacy, both ecological and social time frames must be considered when setting the pace of incremental change. In addition, short-term human interests that tend to coincide with the elections cycle must not control the pace, yet must be factored in when seeking new approaches to management.

(3) *Deliberative legitimacy* is reflected in the growing expectation and provision for public comment in numerous aspects of agency decision making, from the requirement of notice and comment in rule making to the increasing use of public meetings to gain support for a decision.

In the United States, the passage of the National Environmental Policy Act (NEPA) of 1969, can be considered the major turning point in public involvement in agency decision making (Hirt and Sowards 2011). Unlike the requirements of the Administrative Procedure Act that meetings and records be open to the public (which is certainly an important aspect of legitimacy), NEPA imposes the affirmative duty on agencies to develop, analyze, and provide to the public for comment, information on the environmental impact of major federal actions. (NEPA § 4332). Although NEPA does not impose any substantive requirement to choose the most environmentally sustainable alternative (*Vermont Nuclear Power Corp. v. NRDC* 1978), it arms the public with the information necessary to participate in shaping the decision through the political process. In that context, it is one factor in local capacity building.

Adaptive implementation provides an excellent opportunity to employ some of the newer methods of public involvement (Bingham 2009). It lends itself to use of a procedure similar to negotiated rule making, in which the agency collaborates with the regulated community and interested parties (e.g., a watershed committee) to develop a rule for reaching decisions on incremental changes in management. Small-scale (spatial and temporal) impacts may be reflected best in local knowledge, thus a more collaborative process may improve the knowledge base for the decision. A more collaborative approach to management could also make use of the interagency networks discussed above in the context of response scale to allow coordination of adaptation and avoid unintended consequences of agency action. In addition, the network approach may be necessary to allow for manageable public input on jurisdictionally complex water basins.

While adaptive implementation in the face of uncertainty presents a theoretical approach to managing the uncertainty associated with understanding the water quality and sources of pollution to our water resources, without careful attention to the legitimacy of the decision making that imposes it (i.e., adaptive governance), adaptive implementation will remain a theoretical approach. By assuring that decisions involving the goals of water management and choices in making incremental change are based on and incorporate (1) adequate monitoring and scientific analysis (results-based legitimacy); (2) notice and opportunity for input to decision making and management changes based on a time frame that takes both the biological and social needs into account (order-based legitimacy); and (3) capacity building and development of collaborative processes at the scale of the water system to be managed (deliberative legitimacy), adaptive implementation can move from theory to impact.

Conclusion

Despite almost forty years of management under the federal CWA, the goal of full-use attainment in the nation's aquatic systems remains elusive. Fragmentation of authority among federal, tribal, state, and local jurisdictions, and uncertainty in both the characterization of water bodies and responses to management actions to improve water quality are primary barriers to achieving and maintaining the full array of ecosystem services possible from the nation's water bodies. Efforts to integrate water management and regulation must proceed against the very real backdrop of the existing fragmented system. Not only is it a purely academic exercise to contemplate design of governance and implementation of regulation starting from a clean slate, in seeking resilience in the social-ecological systems involved, modularity and functional redundancy in authority is beneficial. Rather than propose a new system, this chapter recommends integration through network formation. This will require (1) evaluation of existing informal networks among authorities, (2) removal of barriers to the smooth functioning of networks, (3) provision of authority where existing networks are absent, and (4) assistance where necessary to build local capacity.

Progress to reduce uncertainty and improve return on investment in efforts to restore healthy aquatic systems requires a reframing of the dialogue surrounding regulatory implementation and agency accountability. Resources spent on monitoring results must be viewed as a long-term investment by attaching a dollar value to information and providing the authority for adjustment of regulation as new information becomes available that changes our understanding of system behavior and as societal needs evolve. The short-term expenditure on collection of data will lead to efficiency in identification of appropriate measures and will reduce the current politicization of agency science by assuring that constant progress toward statutory goals is achieved. It is a necessary investment not only in our own future but as a legacy for our children.

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