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Why Resilience May Not Always Be a Good Thing: Lessons in Ecosystem Restoration from Glen Canyon and the Everglades

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I. INTRODUCTION

Ecosystem restoration is fast becoming the third major strategy of the modern environmental era, which began in the 1960s by seeking to mitigate the effects of conventional, exploitation-dominated resource management and then, in the 1970s, turned to pollution prevention and preservation of wildlife, recreational opportunities, and other multiple uses.[1] The goals of recent restoration plans are anything but simple. Those who seek to restore any ecosystem must deal with two separate problems. The first is a social problem, which is an attempt to define goals and objectives, or to develop a collective sense of what society wants. Closely tied to that articulation of "what we want" is the complex array of pre-existing and emerging social structures—laws, policies, and institutions that frame the options for achieving a vision of restoration. The second problem is scientific, in which experts attempt to lay out a range of ecological trajectories, structures (such as biological diversity), and functions that define possible restoration outcomes. Almost invariably, the first problem (what do we want?) overshadows the second problem (what can we get?) in implementation. As a result, both goals become difficult if not impossible to attain and, over time, both ecological and social restoration aspirations fail.

A key challenge for designers and managers of restoration plans is to recognize the interplay between, and constraints imposed by, *both* the sociopolitical and biophysical worlds. By weaving ecological principles and legal analysis together, we hope to shed light on the successes and failures of two landmark restoration projects: the Grand Canyon of the Colorado River and the Florida Everglades. These projects share common goals—to restore degraded habitat and to

1. ROBERT W. ADLER, RESTORING COLORADO RIVER ECOSYSTEMS: A TROUBLED SENSE OF IMMENSITY 7–11, 113–14 (2007) [hereinafter ADLER, TROUBLED SENSE]; Joseph L. Sax, *The New Age of Environmental Restoration*, 41 WASHBURN L.J. 1, 13 (2001).

maintain water supplies. They also share a common problem—making meaningful progress towards restoration goals. In the Grand Canyon, modest successes have been achieved through an adaptive management program that attempts to blend the social and ecological objectives. In the Everglades, however, the restoration approach has separated the ecological from the social, legal, and political domains, and as a result has accomplished very little.[2]

The successes and failures of these experiments in ecosystem restoration are a result of many factors. In this Article, we focus on three elemental ingredients. The first is the emerging system property of resilience, a concept that describes a more complex model of change and restoration than typical resource management goals related to maximizing social uses and achieving optimum yields of resource outputs. Resilience is a characteristic of both social and ecological systems. Resilience theory suggests that complex systems can exist in fundamentally different regimes, and resilience is the property that mediates transitions among those regimes. Hence resilience must be overcome when undertaking objectives that involve regime changes, such as an ecological restoration or a social transformation. In fact, a comparative analysis of the Grand Canyon and Everglades projects reveals that resilience may not always be a good thing, particularly when it exhibits itself as entrenched stakeholder interests or institutions that do not embrace change.

A second significant factor in achieving restoration goals is legislation and other legal requirements, which can either enable or constrain ecosystem restoration. The Grand Canyon Protection Act of 1992[3] and the Everglades restoration provisions of the Water Resources Development Act of 2000[4] specifically authorize restoration. At the same time, existing, generally applicable legislation, such as the Clean Water Act[5] and the Endangered Species Act,[6] remains in play and adds to the complexities of ecosystem restoration.

The third factor involves the administration of legislation through agencies' initiatives and public participation, particularly stakeholder involvement. Whether combative, collaborative, or somewhere in between, the participants' commitment to experimentation and adaptation in the implementation of a restoration plan has a profound influence on the speed and trajectory of restoration.

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2. *See* COMM. ON INDEP. SCIENTIFIC REVIEW OF EVERGLADES RESTORATION PROGRESS, NAT'L RESEARCH COUNCIL, PROGRESS TOWARD RESTORING THE EVERGLADES: THE SECOND BIENNIAL REVIEW (2008).
3. Grand Canyon Protection Act of 1992, Pub. L. No. 102-575, §§ 1801–1809, 106 Stat. 4600, 4669–73.
4. Water Resources Development Act of 2000, Pub. L. No. 106-541, § 601(b)(1)(A), 114 Stat. 2572, 2681.
5. 33 U.S.C. §§ 1251–1387 (2000).
6. 16 U.S.C. §§ 1531–1544 (2006).

The remainder of this Article is structured as follows. Part II discusses the concept of resilience and how it underpins notions of restoration and sustainability. National legislative goals and requirements related to these concepts are then described. Next, Part III takes a close look at the physical characteristics and specific legislative directives for the Everglades and the Grand Canyon. Part IV sets forth several "lessons learned" from these two restoration projects. Finally, Part V concludes with broader observations about restoration and resilience. Success is not possible, and failure may be inevitable, unless the science of ecology, environmental law, and public administration are calibrated to foster experimentation, learning, and adaptation in management strategies.

II. RESILIENCE THEORY, SUSTAINABILITY AND ECOSYSTEM RESTORATION

In common parlance, to restore is "to bring back to or put back into a former or original state."[7] More specifically, the National Research Council defines restoration as "returning an ecosystem to a close approximation of its condition prior to disturbance."[8] But how close must the approximation be? How will we decide? To the best of our knowledge, no existing restoration plan in the United States strives for full restoration to the original, pre-disturbance state but rather to a condition that resembles a more natural, functional state where both humans and non-human life can exist.[9] Thus, a health-based definition may be most useful in the ecological restoration context—"to bring back to a healthy and vigorous state."[10]

Restoration plans exist, and must succeed or fail, within three spheres: scientific, socioeconomic, and legal. Ecologists question, test,

7. WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY OF THE ENGLISH LANGUAGE UNABRIDGED 1936 (Philip Babcock Gove ed., 1971).

8. COMM. ON RESTORATION OF AQUATIC ECOSYSTEMS: SCI., TECH. & PUB. POLICY, NAT'L RESEARCH COUNCIL, RESTORATION OF AQUATIC ECOSYSTEMS: SCIENCE, TECHNOLOGY AND PUBLIC POLICY 2 (1992).

9. The Everglades Plan, for example, defines restoration as "the recovery and protection of the South Florida ecosystem so that it once again achieves and sustains those essential hydrological and biological characteristics that defined the undisturbed South Florida ecosystem." 33 C.F.R. § 385.3 (2008). The plan is not designed to "completely replicate the undisturbed South Florida ecosystem," but rather to restore the ecosystem to a condition that is "significantly healthier than the current system." *Id.* For details, see *infra* Part III.A.

10. Alyson C. Flournoy, *Restoration Rx: An Evaluation and Prescription*, 42 ARIZ. L. REV. 187, 189 (2000) (citing OXFORD ENGLISH DICTIONARY 756 (2d ed. 1989)). Professor Flournoy analyzes restoration challenges by drawing on metaphors from the medical profession: diagnosis, informed consent, holistic approaches to healing, refrain from action when harm would result ("First, do no harm"), ongoing assessment to avoid overdose or misapplication, and preventative medicine, including lifestyle changes, wherever possible. *Id.* at 213.

and develop an understanding of current (altered) and past (functional or perhaps natural) physical and biological processes in an ecosystem, while stakeholders and other members of the public develop values and prioritize socioeconomic restoration objectives.[11] Those values and priorities are expressed through law and legal institutions. Lawyers and law-makers, then, must determine whether the existing legal framework accommodates ecological learning, meaningful public participation, political action, and restoration success or, conversely, whether laws and legal institutions must adapt to the new restoration vision.[12]

The concepts of resilience, adaptive management, and sustainable development are explored below, followed by an assessment of related national legislative goals and requirements.

A. Resilience, Adaptive Management, and Sustainable Development

Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without changing into a qualitatively different state.[13] In other words, resilience describes the ability "to persist, buffer, and adapt to recurrent shocks without fundamentally changing, often unpredictably, into highly altered systems."[14] Resilience of linked social-ecological systems has the added capacity of humans to anticipate and plan for the future—the ability to build and increase the capacity for learning and to take advantage of feedback loops that foster adaptation.[15]

In many cases, the lack of ecosystem resilience manifests itself by transformation—a regime shift. In ecosystems, a regime or state is defined by a set of ecological processes and structures. Regime shifts have occurred in hundreds of ecosystems around the world, including lakes, grasslands, wetlands, and coral reefs.[16] Semi-arid rangelands that are overgrazed suddenly flip from a grass dominated regime to one with shrubs. Freshwater lakes alternate between a clear water

11. Duncan T. Patten, *Restoration of Wetland and Riparian Systems: The Role of Science, Adaptive Management, History, and Values*, 134 J. CONTEMP. WATER RESOURCES & EDUC. 9, 17 (2006).

12. Flournoy, *supra* note 10, at 212.

13. C.S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. ECOLOGY & SYSTEMATICS 1, 17 (1973).

14. Terence P. Hughes et al., *Adaptive Management of the Great Barrier Reef and the Grand Canyon World Heritage Areas*, 36 AMBIO 586, 586 (2007).

15. RESILIENCE AND THE BEHAVIOR OF LARGE SCALE SYSTEMS 3–6 (Lance H. Gunderson & Lowell Pritchard, Jr. eds., 2002).

16. Carl Folke et al., *Regime Shifts, Resilience and Biodiversity in Ecosystem Management*, 35 ANN. REV. ECOLOGY, EVOLUTION & SYSTEMATICS 557, 559–67 (2004).

state and a turbid water state.[17] Coral reef systems shift between coral domination and macro-algae domination.[18] The loss of resilience and ensuing flip in many of these cases can be traced to prior management efforts that stabilized or attempted to hold the system in a socially desired state, often for the purpose of promoting maximum yields of timber, forage, fish, or other natural resources.

In complex social-ecological systems, regimes can be defined by ecological states as well as social, political, and legal arrangements. Many times, the regime shifts in these systems are triggered by a collapse or crisis that results in a fundamentally new set of relationships. As with ecosystems, resilience is defined by how much variation the system can absorb before it changes regimes.

Restoration management generally strives to move a system from an undesired state to a more desirable one. Restoring the Everglades, the Grand Canyon, the Louisiana Coast, or the San Francisco Bay Delta involves creating new ecological and social regimes. Restoration is complex and requires the development of integrated solutions, not piecemeal tinkering. It is the great uncertainty that accompanies complex restorations that led to an approach called adaptive management.[19] Adaptive management strives to build capacity to anticipate environmental and social change and to inform decision-makers and stakeholders of alternative pathways and the potential consequences of choosing among those pathways.[20] There is wide consensus among ecologists that experimentation and adaptive management are necessary to achieve resilient ecosystems.[21]

In the context of restoration management (or moving the system from an undesired regime to another, more desirable one), the goal of a resilience-based approach is not equilibrium, nor is it optimum yield of ecosystem services and products.[22] Rather, the goals are learning, flexibility, and diversity. Connectedness and stability increase while the ecological capital of nutrients and biomass (or, in social systems, institutional networks and mutual trust) accumulate. Meanwhile, windows of opportunity open on a smaller scale within the system

17. MARTEN SCHEFFER, ECOLOGY OF SHALLOW LAKES, at xiv (1998); *see also* Mary Jane Angelo, *Stumbling Toward Success: A Story of Adaptive Law and Ecological Resilience*, 87 NEB. L. REV. (2009) (describing Lake Apopka's shift from clear to eutrophic state).

18. Terence P. Hughes, *Catastrophes, Phase Shifts, and Large-Scale Degradation of a Caribbean Coral Reef*, 265 SCI. 1547, 1547 (1994).

19. ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT 7–9, 19–20 (C.S. Holling ed., 1978).

20. Hughes et al., *supra* note 14, at 587.

21. *See infra* Part II.B.4.

22. Lance Gunderson & Stephen S. Light, *Adaptive Management and Adaptive Governance in the Everglades Ecosystem*, 39 POL'Y SCI. 323, 324 (2006).

through experimentation, but the results do not trigger cascading instability of the whole because of the resiliency of the whole.[23]

Although the concepts may sound similar, it is important to note that resilience thinking is a major departure from the conventional approach to natural resources management, which, under U.S. law, has been dominated by maximum yield objectives.[24] There is a strong relationship, however, between resilience and sustainable development, which has become a persistent theme in international environmental law. As such, approaches that incorporate resilience thinking go hand-in-hand with contemporary sustainable development goals.[25] This proposition is not necessarily self-evident. One might well ask whether development of our natural resources can occur in a fashion that is sustainable over time, given the physical limitations of our environment and the political impetus for maintaining and even expanding our economic well-being, and, if so, whether sustainable development is necessarily compatible with resilient ecosystems.

The 1987 Brundtland Report, *Our Common Future*, defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[26] In other words, "[s]ustainability is a relationship between dynamic human economic systems and larger, dynamic, but normally slower-changing ecological systems . . . in which the effects of human activities remain within bounds so as not to destroy the health and integrity of self-organizing systems."[27]

A management philosophy based on sustainable development reorients the use and allocation of natural resources from maximum yield objectives to approaches designed to ensure the availability of a diverse array of ecological resources and services for present and future generations.[28] Resource use and consumption occurs only in a time, place, and manner that allows regeneration and continuity into the future. The concept of sustainable development also strives for both intergenerational equity and distributive justice in the access to essential resources among human communities, be they wealthy or impoverished.[29]

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23. Resilience Alliance, Key Concepts: Resilience, http://www.resalliance.org/576.php (last visited Jan. 13, 2009).
24. *See infra* Part II.B.1.
25. Gunderson & Light, *supra* note 22, at 324.
26. WORLD COMM'N ON ENV'T & DEV., OUR COMMON FUTURE 43 (1987).
27. Bryan G. Norton, *A New Paradigm for Environmental Management*, *in* ECOSYSTEM HEALTH 25 (Robert Constanza et al. eds., 1992).
28. Sandra Zellmer, *A Preservation Paradox: Political Prestidigitation and an Enduring Resource of Wildness*, 34 ENVTL. L. 1015, 1038 (2004).
29. *Id.* On sustainable development objectives, see John C. Dernbach, *Sustainable Development: Now More Than Ever*, 32 Envtl. L. Rep. (Envtl. L. Inst.) 10,003, 10,012 (2002); Günther Handl, *Environmental Security and Global Change: The*

At its core, then, "[s]ustainability is the capacity to create, test, and maintain adaptive capability" so that social-ecological systems continue in predictable trajectories and avoid collapse.[30] By the same token, development is the process of creating, testing, and maintaining opportunity. Thus, sustainable development is not an oxymoron, but a logical partnership.

Resilience, though known more widely as an ecological concept than as a legal imperative, dovetails with sustainable development. A resilience approach helps to focus attention on the specific attributes or drivers of complex social-ecological systems and to craft guiding principles for human intervention to improve the long-term performance of the systems.[31] A resilience approach enables resource managers to categorize observed patterns, frame relevant questions, and apply insights gleaned from one system to the management of another.[32] Change is inevitable in complex systems, and resilience theory helps us learn, adapt, and manage *for* change, instead of *against* change.[33]

As described below, however, the nation's body of law tends to resist change and protect the status quo to avoid upsetting settled expectations of property owners, regulated entities, and the marketplace. Against this backdrop, promoting adaptation and overall resilience through ecosystem restoration is challenging, to say the least.

B. National Legislative Goals

National legislation governing water quality, biological conservation, and the production of resource outputs plays a significant role in restoration efforts. The basic playing field is dominated by maximum sustained yield ("MSY") concepts related to multiple use management

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Challenge to International Law, 1 Y.B. INT'L ENVTL. L. 3, 29 (1990); Graham Mayeda, *Where Should Johannesburg Take Us? Ethical and Legal Approaches to Sustainable Development in the Context of International Environmental Law*, 15 COLO. J. INT'L ENVTL. L. & POL'Y 29, 31–34 (2004); Michael McCloskey, *The Emperor Has No Clothes: The Conundrum of Sustainable Development*, 9 DUKE ENVTL. L. & POL'Y F. 153, 154 (1999).

30. C. S. Holling et al., *Discoveries for Sustainable Futures*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 403 (Lance H. Gunderson & C.S. Holling eds., 2002). For a description of instances throughout history where civilizations have collapsed when ecological regime shifts occurred, see JARED DIAMOND, COLLAPSE: HOW SOCIETIES CHOOSE TO FAIL OR SUCCEED (2005).
31. John M. Anderies et al., *Fifteen Weddings and a Funeral: Case Studies and Resilience-based Management*, 11 ECOLOGY & SOC'Y 1, 2 (2006).
32. *Id.* at 6.
33. *Id.* at 7; Ralf Yorque et al., *Toward an Integrative Synthesis*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 419–38 (Lance H. Gunderson & C.S. Holling eds., 2002).

of forest, fish, range resources, and water resources. Meanwhile, recent restoration efforts in the Everglades and the Grand Canyon are being driven by environmental protection laws of 1970s vintage, particularly the Clean Water Act ("CWA") and the Endangered Species Act ("ESA"), as well as a landmark in U.S. conservation law—the National Park Service Organic Act. Most recently, many of the resource management agencies have also begun to adopt adaptive management techniques through their regulations and informal guidelines.

1. Multiple Use, Maximum Sustained Yield Mandates

a. Fish, Forests, and Rangelands

Many natural resources and most public lands (other than national parks and congressionally-designated wilderness areas) are managed pursuant to maximum sustained yield principles.[34] The concept is perhaps most widely known and applied in the field of fisheries management, where it rapidly gained ascendancy during the post-World War II years.[35] According to ecologist P.A. Larkin in his 1976 keynote address to the American Fisheries Society, "the dogma was this: any species each year produces a harvestable surplus, and if you take that much, and no more, you can go on getting it forever and ever (Amen)."[36]

The dogma was embraced that same year by Congress in three separate statutes. First, in response to declining fish stocks domestically and worldwide,[37] Congress adopted a type of maximum yield requirement in the Magnuson-Stevens Fishery Conservation and Manage-

34. For a critique of the MSY doctrine as applied to public lands, see George Cameron Coggins, *Of Succotash Syndromes and Vacuous Platitudes: The Meaning of "Multiple Use, Sustained Yield" for Public Land Management*, 53 U. COLO. L. REV. 229 (1981) [hereinafter Coggins, *Succotash*].

35. *See* P.A. Larkin, *Epitaph for the Concept of Maximum Sustained Yield*, 106 TRANSACTIONS AM. FISHERIES SOC'Y 1, 1 (1977) ("The ten years following World War II were the golden age for the concept of maximum sustained yield.").

36. *Id.* The parallel concept of "optimum yield" has been described as "a deliberate melding of biological, economics, social, and political values designed to produce the maximum." *Id.* at 8 (quoting Philip M. Roedel, *A Summary and Critique of the Symposium on Optimum Yield*, *in* OPTIMUM SUSTAINABLE YIELD AS A CONCEPT IN FISHERIES MANAGEMENT (1975)). Maximum yield is generally thought to require higher production outputs than optimal yield. Tommy T.B. Koh, *The Exclusive Economic Zone*, 30 MALAYA L. REV. 1, 11 (1988). Optimal yield, however, can "almost certainly be used primarily as a way of justifying a political course of action." Larkin, *supra* note 35, at 8. Difficulties arise because both natural systems and social, economic, and political systems are so "sufficiently diverse and complex that there is no single, simple recipe for harvesting that can be applied universally." *Id.* at 9.

37. Carrie A. Tipton, Note, *Protecting Tomorrow's Harvest: Developing a National System of Individual Transferable Quotas to Conserve Ocean Resources*, 14 VA. ENVTL. L.J. 381, 386–87 (1995).

ment Act.[38] A principal objective of the Magnuson Act is the adoption of fishery management plans that will "achieve and maintain, on a continuing basis, the optimum yield from each fishery,"[39] while "minimiz[ing] adverse economic impacts" on fishing communities.[40] The Act defines optimum yield as the amount that provides the "greatest overall benefit to the Nation particularly with respect to food production and recreational opportunities" and which "is prescribed on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant social, economic or ecological factor."[41] Unfortunately, "as we all know, one cannot optimize for two things at the same time, let alone a dozen" (give or take a few).[42] In 1986, a blue ribbon panel convened by the federal government criticized the vagueness of the MSY concept, explaining that it "has been, and still is, a widely fluctuating guideline varied to suit the eyes of the beholder or the needs of special interests."[43] A stark example of the failures of MSY fisheries management can be seen off the coast of Florida, where many salt-water fish species are now in danger of extinction.[44]

As for public lands management, 1976 was also a banner year for the MSY concept for both timber and range resources. The National Forest Management Act of 1976 and the Federal Land Policy and Management Act ("FLPMA") of 1976 both built upon concepts articulated in an earlier statute, the Multiple-Use Sustained-Yield Act of 1960 ("MUSYA").[45] Sustained yield is defined by that Act as "the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land."[46] Earlier applications of this concept emphasized biophysical production constraints on specified renewable resources, such as timber,[47] to en-

38. 16. U.S.C. §§ 1801–1882 (2006). For an in-depth critique of the Magnuson Act, see Kristen M. Fletcher, *Fix It! Constructing a Recommendation to the Ocean Commission for the Future of Fisheries*, 8 ROGER WILLIAMS U. L. REV. 93 (2002).
39. 16. U.S.C. § 1801(b)(4).
40. *Id.* § 1851(a)(8)(B).
41. *Id.* § 1802(33) (defining "'optimum' with respect to the yield from a fishery").
42. Larkin, *supra* note 35, at 10.
43. Kirsten M. Batkin, *New Zealand's Quota Management System: A Solution To The United States' Federal Fisheries Management Crisis?*, 36 NAT. RESOURCES J. 855, 860 (1996) (citing NAT'L OCEANIC & ATMOSPHERIC ADMIN., FISHERY MANAGEMENT STUDY (1986)).
44. The Florida Environment, Salt Water Fish at Extinction Risk, http://www.florida environment. havecom/programs/fe01218.htm (last visited Jan. 13, 2009). As for nationwide declines in fisheries, see *infra* note 61.
45. 16 U.S.C. §§ 528–531.
46. *Id.* § 531(b) (defining "sustained yield of the several products and services").
47. Fred Bosselman, *A Role for State Planning: Intergenerational Equity and Adaptive Management*, 12 U. FLA. J.L. & PUB. POL'Y 311, 313 n.3 (2001); Barry Sadler, *Shared Resources, Common Future: Sustainable Management of Canada-United States Border Waters*, 33 NAT. RESOURCES J. 375, 376 (1993). Contemporaries

sure maximum production, with little or no regard to wildlife, recreation, or other values.[48] By adding a multiple-use component to the equation, however, Congress intended to expand the production-oriented focus of historic resource management.[49] Accordingly, the Multiple-Use Sustained-Yield Act defines multiple use as "[t]he management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people."[50] Congress also added a provision requiring that "due consideration"[51] be given to recreation, watersheds, fisheries, and wildlife, but gave little concrete guidance for resolving conflicts among uses, instead leaving vast discretion in the agency's hands.[52] The National Forest Management Act of 1976 placed parameters on agency discretion by requiring management plans for federal forests and grasslands and by specifying that the plans must provide for diversity of plant and animal resources, plus MSY, as well as public involvement and judicial review.[53]

Congress also required MSY management for Bureau of Land Management lands when it enacted FLPMA in 1976.[54] FLPMA expresses a national policy that public lands be managed "on the basis of multiple use and sustained yield."[55] Like the Multiple-Use Sustained-Yield Act of 1960, FLPMA defines "sustained yield" as "the achievement and maintenance in perpetuity of a high-level annual or regular

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and associates of President Theodore Roosevelt, a leader of the early twentieth century conservation movement, viewed sustainability as "foresight and restraint in the exploitation of the physical sources of wealth as necessary for the perpetuity of civilization and the welfare of present and future generations." SEAN DENNIS CASHMAN, AMERICA IN THE AGE OF THE TITANS: THE PROGRESSIVE ERA AND WORLD WAR I 78 (1988).

48. *See* Elli Louka, *Cutting the Gordian Knot: Why International Environmental Law is Not Only About the Protection of the Environment*, 10 TEMP. INT'L & COMP. L.J. 79, 113 (1996) (citing ALEXANDER S. MATHER, GLOBAL FOREST RESOURCES 185–97 (1990)).

49. Sierra Club v. Butz, [1973] 3 Envtl. L. Rep. (Envtl. Law Inst.) 20,292, 20,292–93 (9th Cir. Mar. 16, 1973); CHARLES F. WILKINSON & H. MICHAEL ANDERSON, LAND AND RESOURCE PLANNING IN THE NATIONAL FORESTS 285–87 (1987).

50. 16 U.S.C. § 531(a). This provision was subsequently carried over into the National Forest Management Act of 1976, which incorporates multiple use and MSY principles and which explicitly includes "outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness" among the recognized uses. *Id.* § 1604(e)(1).

51. *Id.* § 529.

52. *See* Strickland v. Morton, 519 F.2d 467, 469 (9th Cir. 1975) (stating that the Multiple-Use Sustained-Yield Act "breathe[s] discretion at every pore").

53. 16 U.S.C. §§ 1604(a), (c), (g)(3)(B), 1612.

54. Federal Land Policy and Management Act of 1976, Pub. L. No. 94-579, 90 Stat. 2745 (codified as amended at 43 U.S.C. §§ 1701–1782 and scattered sections of 15, 16, 30, 31, 40, 42 and 43 U.S.C.). For a discussion of the MSY doctrine as applied to BLM and other public lands, see Coggins, *Succotash*, *supra* note 34.

55. 43 U.S.C. § 1701(a)(7)–(8) (2000).

periodic output of the various renewable resources of the public lands consistent with multiple use."[56] "Multiple use," in turn, is defined as "a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources."[57] FLPMA also proclaims that the public lands should be managed "in a manner which recognizes the Nation's need for domestic sources of minerals, food, timber, and fiber," without causing unnecessary or undue degradation.[58]

Only one year after FLPMA, NFMA, and the Magnuson Act were enacted, Larkin declared that the concept of maximum sustained yield, at least as applied to fisheries management, was, or should be, dead.[59] He wrote an epitaph entitled "M. S. Y. 1930s–1970s":

> *Here lies the concept, MSY.*
> *It advocated yields too high,*
> *And didn't spell out how to slice the pie.*
> *We bury it with the best of wishes,*
> *Especially on behalf of fishes.*
> *We don't know yet what will take its place,*
> *But hope it's as good for the human race.*[60]

So what went wrong? Precipitous declines in fish stocks[61] can be attributed in large part to a failure of fisheries managers to appreciate the uncertainties of complex systems and to adapt their techniques in response to new learning.[62] According to Larkin, "[n]o one can deny that hypothetical animal populations can produce hypothetical maximum sustained yields, but the same cannot be said of real animal

56. *Id.* § 1702(h). This definition is almost identical to that found in the MUSYA. *See* 16 U.S.C. § 531(b) (defining "sustained yield of the several products and services" as "the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land").

57. 43 U.S.C. § 1702(c). This definition is similar to that found in the MUSYA, except that the FLPMA lists ten specific resources ("recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values") and expresses the goal of no impairment to land and resources. *Id.*

58. *Id.* §§ 1701(12), 1732(b).

59. Larkin, *supra* note 35, at 10.

60. *Id.*

61. *See* JOSH EAGLE ET AL., TAKING STOCK OF THE REGIONAL FISHERY MANAGEMENT COUNCILS 4 (2003), *available at* http://fisheries.stanford.edu/Stanford_Council_Report.pdf (noting that more than one-third of the nation's coastal fish stocks are "overfished"); Juliet Eilperin, *World Seafood Supply Could Run Out by 2048, Researchers Warn*, BOSTON GLOBE, Nov. 3, 2006, at A2 (warning of the demise of worldwide fisheries); *supra* note 44 and accompanying text (noting the decline of Florida's coastal fisheries).

62. *See* Fletcher, *supra* note 38, at 133 ("[T]he technology of catching fish overtook fisheries science, leaving stock assessment and ecosystem analysis behind as fisheries began to crash in regions across the United States.").

populations that are really being harvested."[63] He recommended a shift in management paradigms using newly minted adaptive management approaches: "consider[ ] much more sophisticated techniques for optimization and adaptive control in fisheries management"[64] because "[t]he world today is too complex for the rough justice of a guy on a horse with a six-shooter."[65]

The perceived demise of the MSY standard for public lands management soon followed, at least in academic commentary. In 1981, Professor George Coggins proclaimed that MSY was dying under its own weight.[66] Others have noted that MSY's time has passed, because the concept has failed to maintain "sustainable ecosystems supporting a variety of renewable resources"[67] and instead has caused extensive environmental degradation.[68] We explore resilience, sustainability, and adaptive management concepts as possible replacements for MSY below.[69]

b. Water Resources Development, Flood Control, and Floodplain Management

The Rivers and Harbors Appropriation Act of 1899 gives the Corps of Engineers broad authority to prevent obstructions to navigation and to promote the federal navigational servitude, including transportation improvement and flood control efforts on mainstems and

63. Larkin, *supra* note 35, at 3; *see id.* at 4 ("[F]or even a single species population it does not seem likely that an MSY based on the analysis of the historic statistics of a fishery is really attainable on a sustained basis. If there is an MSY, it is a yield associated with a high risk of recruitment failure in a population in which the less productive substocks have been depressed or eliminated.").

64. *Id.* at 3–4. More specifically, we should put "the fish first, the economics second, and the social problems a distant third—something we must resolve, and quickly, with sympathy and good sense." *Id.* at 10.

65. *Id.* at 10.

66. George Cameron Coggins, *The Changing Face of Federal Public Land and Resources Law: 1971 to 1999 and Beyond*, SE55 ALI-ABA 179, 188 (2000) (attributing the demise of MSY to the creation of wilderness areas and other "preservation zones," so that instead of many multiple uses there are really only two major use categories: commodity production and pleasure).

67. Michael C. Blumm, *Public Choice Theory and the Public Lands: Why "Multiple Use" Failed*, 18 HARV. ENVTL. L. REV. 405, 429 (1994).

68. Robert B. Keiter, *Public Lands and Law Reform: Putting Theory, Policy, and Practice in Perspective*, 2005 UTAH L. REV. 1127, 1162 (2005). *But see* Debra L. Donahue, *Federal Rangeland Policy: Perverting Law and Jeopardizing Ecosystem Services,* 22 J. LAND USE & ENVTL. L. 299, 332–33 (2007) (concurring that the concepts of multiple use and sustained yield have "failed to produce sustainable public land ecosystems," but arguing that "[t]he blame lies with the agencies, for failing to interpret the statutes rationally or in the public interest and for not incorporating contemporary ecological understanding into management prescriptions, and with the courts for not enforcing congressional intent in the governing legislation").

69. *See infra* Parts III–IV.

tributaries of navigable waters.[70] The Flood Control Act of 1936 ("FCA") explicitly recognizes federal responsibility for flood control measures nationwide.[71]

Although the nation has received significant benefits from the deployment of federal resources to prevent or mitigate flooding, it has also experienced significant detriments, fiscally, socially, and ecologically. The FCA affords the Corps broad-sweeping discretion to conduct any project it chooses whenever "the benefits to whomsoever they may accrue are in excess of the estimated costs."[72] Since 1936, the Corps has spent billions of dollars on dams, reservoirs, levees, and other structures for flood control and related purposes, many of which had minimal or even no benefits to the American public, and many of which had catastrophic effects on fish and wildlife species and hydrological function.[73]

In addition to the FCA, project-specific directives and appropriations are provided to the Corps through periodic Water Resources Development Acts, one of which provided the blueprint for Everglades restoration efforts.[74] Water resources development is also influenced by state laws governing the allocation and use of water quantities. For the Colorado River, this generally entails the "first in time, first in right" dictates of prior appropriation law, while in Florida and the rest of the East, it allows reasonable uses of water as authorized by riparian water law.[75]

2. *Integrity of Water Resources*

Throughout the United States, flow alterations caused by dams, flood control levees, channelization, and water diversions, along with sedimentation and nutrient pollution from non-point sources—particularly agriculture and construction sites—have significantly degraded the integrity of wetlands, rivers, and lakes. The CWA proclaims an ambitious congressional goal: "to restore and maintain the chemical,

70. 33 U.S.C. §§ 401, 407 (2000). In the West, the Bureau of Reclamation is charged with constructing and delivery of water from federal reclamation projects for irrigation and other purposes, including flood control, under the Reclamation Act of 1902. *See id.* §§ 371–390h; *infra* note 340 (describing Reclamation programs).

71. 33 U.S.C. § 701a.

72. *Id.*

73. Christine A. Klein, *On Dams and Democracy*, 78 OR. L. REV. 641, 679–81 (1999). For details, see Christine A. Klein & Sandra B. Zellmer, *Mississippi River Stories: Lesson from a Century of Unnatural Disasters*, 60 S.M.U. L. REV. 1471 (2007); *infra* notes 341–44 and accompanying text.

74. *See infra* notes 157–59 and accompanying text.

75. *See infra* Parts III.A (describing Florida water law), III.B (describing the law governing the Colorado River).

physical, and biological integrity of the Nation's waters."[76] This statute has been a primary driver in restoration efforts in the Everglades.

The key mechanism for accomplishing the CWA's goals is section 301, which prohibits "the discharge of any pollutant by any person" unless a permit is obtained.[77] The Act has two major permit programs. Section 404 controls discharges of dredged or fill materials by authorizing the Corps of Engineers to issue permits "for the discharge of dredged or fill material into the navigable waters at specified disposal sites."[78] The Environmental Protection Agency ("EPA") retains oversight and veto power over permits if "unacceptable adverse effect[s]" to the environment would result.[79] Individual permits are evaluated on a case-by-case basis, while general or nationwide permits may be issued for categories of activities that are similar in nature and have only minimal impacts.[80] To receive an individual permit, the project proponent must first demonstrate that there are no practical alternatives to the destruction of wetlands.[81] The agencies presume that a practical alternative exists if the project is not water-dependent. Second, steps must be taken to minimize the adverse effects of development on wetlands.[82] Finally, if damage to the wetlands cannot be avoided or minimized, the permittee must compensate for the damages by creating or purchasing replacement wetlands.[83]

The National Pollution Discharge Elimination System ("NPDES") permit program of CWA section 402 requires permits for "the discharge of any pollutant, or combination of pollutants" by any person.[84] The CWA defines "discharge of pollutant" as "any addition of any pollutant to navigable waters from any point source."[85] Both "pollutant" and "navigable waters" are defined quite broadly, but "point source" is a term of art meaning "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, . . . concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged."[86] The point source concept was developed so that pollution

76. 33 U.S.C. § 1251(a).
77. *Id.* § 1311(a).
78. *Id.* § 1344(a).
79. *Id.* § 1344(c).
80. *Id.* § 1344(e).
81. Memorandums of Agreement (MOA); Clean Water Act Section 404(b)(1) Guidelines; Correction, 55 Fed. Reg. 9210, 9212 (March 12, 1990).
82. 40 C.F.R. § 230.10(d) (2008) ("[N]o discharge of dredged or filled material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.").
83. *Id.* §§ 230.91(c)(2), 230.92.
84. 33 U.S.C. § 1342(a)(1).
85. *Id.* § 1362(12).
86. *Id.* § 1362(14). Agricultural stormwater discharges and irrigation return flows are excluded from the definition. *Id.*

from simple erosion or run-off could be distinguished from pollution that has been collected or originates from confined systems.

As a result of the NPDES program, chemical pollutants from point sources have been reduced significantly, but non-point source pollution remains virtually uncontrolled.[87] Programs directed at non-point source pollution, which includes a broad range of activities such as farming and construction run-off, are left to state and local efforts. Unlike the permitting provisions for point sources, the EPA lacks direct regulatory authority over non-point sources, but it may withhold funding for states that do not take timely steps to address non-point pollution.[88] In addition, states are required to establish water quality standards ("WQS"), which are comprised of designated uses for waterways within the state and standards sufficient to meet those uses. Waterways that do not meet WQS will be listed as impaired and total maximum daily loads ("TMDLs") must be set.[89] TMDLs are applied to point sources through the NPDES permit program, but mechanisms for applying them to non-point sources are unclear. As a result, the track record for WQS implementation has been unimpressive and the health of freshwater systems is continuing to decline.[90]

> Large numbers of urban watersheds remain chemically impaired because of pathogens, phosphorus, insecticides, herbicides, and toxics from municipal and industrial sources; and many rural watersheds remain chemically impaired as a result of nutrients, sediment, and agricultural chemicals. . . . Likewise, a recent assessment . . . of the National Research Council reported widespread hydrologic, geomorphic, and other impairment of riparian habitats, along with accompanying impacts to water quality and aquatic ecosystem health. The report documents as much as ninety-five percent loss of natural vegetation in some riparian areas, "indicating that riparian areas are some of the most severely altered landscapes in the country."[91]

Thus, despite the strengths of the CWA, restoration goals remain elusive in degraded waterways of the Everglades and elsewhere.[92] Achieving the goals of the CWA would require restoration and maintenance of "the entire aquatic ecosystem and the human and ecological communities that rely on it,"[93] but longstanding and deeply entrenched management approaches are designed and implemented in a

87. Robert W. Adler, *The Two Lost Books in the Water Quality Trilogy: The Elusive Objectives of Physical and Biological Integrity*, 33 ENVTL. L. 29, 49 (2003) [hereinafter Adler, *Two Lost Books*].

88. *Id.* at 47, 56.

89. 33 U.S.C. § 1313(d).

90. OLIVER A. HOUCK, THE CLEAN WATER ACT TMDL PROGRAM: LAW, POLICY, AND IMPLEMENTATION 5, 63 (2d ed. 2002).

91. Adler, *Two Lost Books*, *supra* note 87, at 49, 52. Adler also notes that "aquatic species are declining at a far more alarming rate than are terrestrial species." *Id.* at 50.

92. *See infra* Part III.A.

93. WILLIAM L. ANDREEN & SHANA CAMPBELL JONES, THE CLEAN WATER ACT: A BLUEPRINT FOR REFORM 52 (2008).

fashion that exploits water resources rather than restoring or maintaining their ecological integrity.[94]

3. *Biological Conservation and Park Lands*

The ESA sets forth a goal that is at least as ambitious as that found in the CWA: to conserve and recover imperiled species and their habitat in order to avoid extinction.[95] The Act is "notable both for its unequivocal prioritization of imperiled species and their habitats and for its simple and nearly uncompromising regulatory approach."[96]

Restoration plans, including the Grand Canyon and Everglades plans, are often stimulated by two key provisions of the ESA, both of which kick in once a species is listed as endangered or threatened.[97] First, federal agencies must consult with the Fish and Wildlife Service ("FWS")[98] to assure that their actions will not jeopardize the continued existence of the species or adversely modify their critical habitat.[99] This requirement entails both a procedural requirement to consult as well as a substantive duty to avoid jeopardy or adverse modification.[100] Agency decisions under the ESA must be based on the "best scientific . . . data available."[101] Second, the ESA prohibits any person from taking endangered species, either directly by hunting, harassing, or killing, or indirectly by altering habitat in a way that would harm the species.[102]

The protection of biological resources is also advanced by the National Park Service Organic Act of 1916, which is integral to the management of the Everglades and the Grand Canyon, where areas of the larger ecosystems have been designated as National Parks.[103] The Act specifies a dual management purpose of preservation and public use by requiring the Park Service to "conserve the scenery and the

94. *Id.*
95. 16 U.S.C. § 1531(b) (2006).
96. Sandra B. Zellmer, *A New Corps of Discovery for Missouri River Management*, 83 NEB. L. REV. 305, 319–20 (2004).
97. *See* 16 U.S.C. § 1533 (listing criteria).
98. Where marine species are involved, consultation duties are delegated to the National Oceanic and Atmospheric Administration-Fisheries.
99. 16 U.S.C. § 1536. To cause jeopardy is to lessen the likelihood of species' survival and recovery. 50 C.F.R. § 402.02 (2008) (defining "jeopardize the continued existence of").
100. Thomas v. Peterson, 753 F.2d 754 (9th Cir. 1985).
101. 16 U.S.C. §§ 1533(b)(1)(A), 1536(a)(2), (c)(1). For a thorough assessment of the "best available science" requirement, see Holly Doremus, *The Purposes, Effects, and Future of the Endangered Species Act's Best Available Science Mandate*, 34 ENVT'L L. 397 (2004) [hereinafter Doremus, *Mandate*].
102. 16 U.S.C. §§ 1538(a)(1), 1532(19); Babbitt v. Sweet Home Chapter of Cmtys. for a Greater Or., 515 U.S. 687 (1995) (upholding the EPA's interpretation of "harm" to include habitat modification).
103. 16 U.S.C. §§ 221, 410.

natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."[104] Similarly, acts governing the Everglades and the Grand Canyon direct that certain lands be set apart as public parks "for the benefit and enjoyment of the people."[105] Both are to be managed according to the Organic Act and specific directives applicable to each area.[106] In managing the Everglades, the Park Service is directed "to maintain the natural abundance, diversity, and ecological integrity of native plants and animals, as well as the behavior of native animals, as a part of their ecosystem."[107] By the same token, the Grand Canyon is to be managed to conserve the remarkable scientific and aesthetic values for which it was initially set aside as a National Monument in 1908.[108]

Although the MSY mandate does not apply within the parks themselves, it does apply to surrounding public lands. Thus, timber harvest, grazing, mining, water development, and other production-oriented management measures outside of the parks can have significant impacts on park resources.[109]

4. Adaptive Management

The origins of adaptive management theory can be traced to C.S. Holling and C.J. Walters.[110] Although the concept has gained significant traction in the physical and biological sciences, and has, of late, been given a good deal of attention in social and legal circles, there is

104. *Id.* § 1.
105. *Id.* §§ 410 (Everglades), 221 (Grand Canyon).
106. *Id.* §§ 410r-7(a), 222.
107. *Id.* § 410r-7(b). For congressional findings regarding the national and international significance of Everglades National Park, as well as the adverse effects of altered hydrologic conditions both within and outside of the park, see *id.* § 410r-5.
108. *See* Grand Canyon Protection Act of 1992, Pub. L. No. 102-575, § 1802, 106 Stat. 4600, 4669–70 (discussed at Part III.B, *infra*); Cameron v. United States, 252 U.S. 450, 455–56 (1920) (citing President Theodore Roosevelt's proclamation that the Grand Canyon "is an object of unusual scientific interest" and explaining that the canyon is "the greatest eroded canyon in the United States, if not in the world, is over a mile in depth, has attracted wide attention among explorers and scientists, affords an unexampled field for geologic study, is regarded as one of the great natural wonders, and annually draws to its borders thousands of visitors").
109. *See* William J. Lockhart, *External Threats to our National Parks: An Argument for Substantive Protection*, 16 STAN. ENVTL. L.J. 3 (1997) (discussing the inadequacy of legal authorities for protecting parks from external threats). The MSY concept is discussed *supra* Part II.B.1.
110. CARL WALTERS, ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES (1986); *see* A. Dan Tarlock, *Slouching Toward Eden: The Eco-Pragmatic Challenges of Ecosystem Revival*, 87 MINN. L. REV. 1173, 1197 (2003) (describing origins of adaptive management).

little by way of guidance from lawmakers. In United States federal and state law, "[f]ew statutes mention adaptive management and even fewer require it."[111] Even so, no other scientific principle "has so deeply permeated the practice on the basis of so little mention in the law."[112]

There is no generally applicable national legislation that requires adaptive ecosystem management. However, several departments and agencies have adopted administrative provisions related to adaptive management. The regulatory definition of adaptive management in wetlands regulation of the Corps of Engineers provides as follows:

> Adaptive management means the development of a management strategy that anticipates likely challenges associated with compensatory mitigation projects and provides for the implementation of actions to address those challenges, as well as unforeseen changes to those projects. It requires consideration of the risk, uncertainty, and dynamic nature of compensatory mitigation projects and guides modification of those projects to optimize performance. It includes the selection of appropriate measures that will ensure that the aquatic resource functions are provided and involves analysis of monitoring results to identify potential problems of a compensatory mitigation project and the identification and implementation of measures to rectify those problems.[113]

More specifically, the Corps's regulations for implementing the Everglades Plan call for adaptive management as a process for understanding the ecosystem and trying to improve the plan in response to new information.[114] Adaptive management is seen as a strategy to deal with uncertainty and "substantially improve the chance of success in achieving ecosystem goals."[115]

The Department of Interior's definition of adaptive management can be found in a Departmental Manual, which describes the concept as "a system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and, if not, facilitating management changes that will best ensure that outcomes are met or to re-evaluate the outcomes."[116] The

111. J.B. Ruhl, *Adaptive Management for Natural Resources—Inevitable, Impossible, or Both?*, *in* 54TH ANNUAL ROCKY MOUNTAIN MINERAL LAW INSTITUTE 11-1, 11-1 (2008).

112. *Id.*

113. 33 C.F.R. § 332.2 (2008).

114. *Id.* § 385.3.

115. COMPREHENSIVE EVERGLADES RESTORATION PLAN, COMPREHENSIVE EVERGLADES RESTORATION PLAN ADAPTIVE MANAGEMENT STRATEGY 1 (2006), *available at* http://www.evergladesplan.org/pm/recover/recover_docs/am/rec_am_stategy_brochure.pdf.

116. DEP'T OF THE INTERIOR, 516 DEPARTMENTAL MANUAL 4.16 (2005). Adaptive management provisions for fulfilling obligations under the National Environmental Policy Act were promulgated as a final rule in October 2008. Implementation of the National Environmental Policy Act (NEPA) of 1969, 73 Fed. Reg. 61,314 (Oct. 15, 2008) (codified at 43 C.F.R. pt. 46). A similar definition is found at 43 C.F.R. § 46.30 (2008).

Department has embraced adaptive management as an appropriate method of management in cases "where long-term impacts may be uncertain."[117] Interior agencies have committed themselves to, "[w]here feasible, implement adaptive management (AM) procedures into the NEPA planning and implementation processes."[118] In addition, in at least one of its listing decisions, the Fish and Wildlife Service has identified adaptive management as a feedback loop in the form of six specific steps: "assessment, design of management actions and associated monitoring and research, implementation of management according to the design, monitoring, evaluation of outcomes, and adjustment of management based on evaluation of initial management actions."[119]

Despite the agencies' willingness to consider adaptive management as a viable restoration tool, as noted above, very little by way of legally enforceable mandates to engage in adaptive management can be found in the regulations, much less in federal legislation. As a result, citizens that attempt to force agencies to undertake discretionary practices such as to monitor and incorporate new data into adaptive management practices may encounter virtually impenetrable judicial roadblocks.[120]

III. CASE STUDIES: THE EVERGLADES AND THE GRAND CANYON RESTORATION PROJECTS

The Florida Everglades and the Grand Canyon of the Colorado River are iconic ecosystems that symbolize the American landscape and, by extension, the spirit of the American people.[121] Both have been designated as world heritage sites because of their remarkable

117. 43 C.F.R. § 46.145.

118. *Id.*; *see also* Bureau of Land Management, National Environmental Policy Act Revised Implementing Procedures, 71 Fed. Reg. 4159, 4163 (Jan. 25, 2006).

119. Final Rule Designating the Greater Yellowstone Area Population of Grizzly Bears as a Distinct Population Segment, 72 Fed. Reg. 14,866, 14,869 (March 29, 2007) (to be codified at 50 C.F.R. pt. 17).

120. *See* Norton v. S. Utah Wilderness Alliance, 542 U.S. 55, 62–66 (2004) (rejecting claims that the Bureau of Land Management should take action to prevent damage to public lands caused by off road vehicle use and evidencing great deference to agency resource allocation decisions); Benzman v. Whitman, 523 F.3d 119, 131 (2d Cir. 2008) (dismissing an action by citizens who alleged that the EPA should have warned them about risks of exposure to dust released when the World Trade Center collapsed because no regulation required the EPA to take discrete action); Fund for Animals, Inc. v. Bureau of Land Mgmt., 460 F.3d 13, 21–22 (D.C. Cir. 2006) (dismissing claims related to the bureau's budget request, which set broad goals and strategies for its wild horses and burros program, as a non-binding, non-reviewable strategy).

121. Gunderson & Light, *supra* note 22, at 324.

biological, geological, and cultural features.[122] But a closer look beyond their extraordinary features reveals two highly managed social-ecological systems. Management goals have historically centered on providing water supplies to urban populations and agriculture and on protecting riparian residents from flooding. By the late twentieth century, ecological crises provoked by historic management practices posed a serious threat to biological, social, and cultural values. As a result, a political window of opportunity opened, which in turn stimulated federal and state legislative and administrative responses.

In both cases, Congress passed special legislation requiring certain restoration activities in the Everglades and in the Grand Canyon (below Glen Canyon dam). The legislation in both cases compels collaborative decision-making through multilateral stakeholder participation.[123] Restoration plans are driven not only by this special legislation, but also by the generally applicable national legislation described above,[124] which prohibits unregulated discharges of water pollutants and jeopardy to federally listed species and which mandates procedural safeguards through regular administrative processes.[125] The stakes are extremely high in both cases. The consequences of failure may put in jeopardy billions of dollars, critical water supplies, and dozens of wildlife and plant species.

A. The Everglades: Physical Condition and Legislative Framework

The South Florida Everglades was once comprised of about 3 million acres (4,000 square miles) of slow-moving water, wetlands, sawgrass, islands and hammocks of tropical hardwoods, dry prairies, limestone outcroppings, and a vast array of unique wildlife, fish, and bird species.[126] Today, the Everglades is about half of its original size

122. Both parks were designated as world heritage sites in 1979. *See* United Nations Educational, Scientific and Cultural Organization, World Heritage List, http://whc.unesco.org/en/list/75 (last visited Dec. 28, 2008); United Nations Educational, Scientific and Cultural Organization, World Heritage List, http://whc.unesco.org/en/list/76 (last visited Dec. 28, 2008); *cf.* FLA. STAT. ANN. § 373.4592(1)(a) (West 2005 & Supp. 2009) (proclaiming that the Everglades is irreplaceable and "is unique in the world and one of Florida's greatest treasures").

123. *See* Grand Canyon Protection Act of 1992, Pub. L. No. 102-575, § 1807, 106 Stat. 4600, 4672; Water Resources Development Act of 1996, Pub. L. No. 104-303, § 528(f), 110 Stat. 3658, 3770-73.

124. *See supra* Part II.B (describing, *inter alia,* the Clean Water Act and the Endangered Species Act).

125. *See, e.g.*, Administrative Procedure Act, 5 U.S.C. §§ 553, 706 (2006); National Environmental Policy Act of 1969, 42 U.S.C. § 4332(C) (2000).

126. COMM. ON RESTORATION OF THE GREATER EVERGLADES ECOSYSTEM, NAT'L RESEARCH COUNCIL, RE-ENGINEERING WATER STORAGE IN THE EVERGLADES: RISKS AND OPPORTUNITIES 1 (2005); Deborah M. Hussey Freeland, *Maieusis Through a*

due to human settlements and the flood-control structures constructed to maintain those settlements.[127] Flow alterations and pollution from urban and agricultural sources have transformed the region's vast "rivers of grass" into "isolated islands of degraded wetlands trapped between farms and housing developments."[128]

By the late 1980s, wetlands loss, declining populations of species, and widespread nutrient contamination were attracting national attention.[129] An $8 billion federal-state plan to re-plumb southern Florida and restore the Everglades, known as the Comprehensive Everglades Restoration Plan ("CERP" or the "Plan"),[130] was adopted in 2000. It is considered the "flagship" of ecological restoration plans and it is being emulated throughout the country and in numerous other countries.[131] The goal of the Plan is "getting the water right,"[132] which entails capturing one trillion gallons of rainwater, storing it in reservoirs and injection wells, and then distributing it to farms, residents, and the Everglades National Park in the right amounts at the right times.[133] As described below, the Plan is currently in the throes of implementation, with nearly a decade-long track record in place. The legacies of the past, in terms of preexisting

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Gated Membrane: "Getting the Science Right" in Public Decisionmaking, 26 STAN. ENVTL. L.J. 373, 403 (2007).

127. COMM. ON RESTORATION OF THE GREATER EVERGLADES ECOSYSTEM, *supra* note 126, at 1.

128. ANDREEN & JONES, *supra* note 93, at 43 (citing Andrea K. Gerlak & Tanya Heikkila, *Comparing Collaborative Mechanisms in Large-Scale Ecosystem Governance*, 46 NAT. RESOURCES J. 657, 665 (2006)).

129. Tanya Heikkila & Andrea K. Gerlak, *The Formation of Large-scale Collaborative Resource Management Institutions: Clarifying the Roles of Stakeholders, Science, and Institutions*, 33 POL'Y STUD. J. 583, 596 (2005).

130. Water Resources Development Act of 2000, Pub. L. No. 106-541, § 601, 114 Stat. 2572, 2680; *see* Mary Doyle, *Implementing Everglades Restoration*, 17 J. LAND USE & ENVTL. L. 59 (2001); Mary Doyle & Donald E. Jodrey, *Everglades Restoration: Forging New Law in Allocating Water for the Environment*, 8 ENVTL. LAW. 255, 276–81 (2002).

131. Gunderson & Light, *supra* note 22, at 332.

132. U.S. ARMY CORPS OF ENG'RS, JACKSONVILLE DIST., & SO. FLA. WATER MGMT. DIST., CENTRAL AND SOUTHERN FLORIDA COMPREHENSIVE REVIEW STUDY FINAL INTEGRATED FEASIBILITY REPORT AND PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT: INTRODUCTION 1-3 (1999), *available at* http://www.evergladesplan.org/docs/comp_plan_apr99/sect1.pdf [hereinafter RESTUDY: INTRODUCTION]. The Corps of Engineers and the South Florida Water Management District, which co-sponsor the Plan, maintain an official website at http://www.evergladesplan.org. The Plan includes various sections, with each one available at a separate internet site. To avoid cumbersome and confusing citations, these sections refer generally to RESTUDY and then provide a specific section and internet citation. Links for all sections are available at http://www.evergladesplan.org/pub/restudy_eis.aspx#mainreport.

133. Michael Grunwald, *A Rescue Plan, Bold and Uncertain: Scientists, Federal Officials Question Project's Benefits for Ailing Ecosystem*, WASH. POST, June 23, 2002, at A01 [hereinafter Grunwald, *Rescue Plan*].

and in some cases intractable expectations, infrastructure, laws, and policies, have proved a significant obstacle to restoration.

1. The C&SFP Canals and the Federal Restoration Plans

After the tropical storms of 1947 inundated ninety percent of southeastern Florida,[134] Congress authorized construction of the Central and Southern Florida Project ("C&SF Project") "for flood control and other purposes."[135] Pursuant to the C&SF Project, the Corps constructed three water conservation areas to serve as reservoirs and to mitigate saltwater intrusion into the freshwater supplies for east-coast communities and agriculture. Although the conservation areas were also intended to benefit fish and wildlife species,[136] the C&SF Project prioritized flood control.[137] Congress lauded the C&SF Project as "an excellent example of the coordination of improvements for flood control, water control, and related purposes with requirements for preservation of fish and wildlife."[138] As such, Congress believed that we could have it all—the C&SF Project would "restore the natural balance between soil and water," thereby sustaining human life as well as wildlife.[139]

The C&SF Project ultimately became a colossal plumbing system that extends over 18,000 square miles from Orlando to the Florida Keys. It is comprised of 1,000 miles of canals, 720 miles of levees, 16 pumping stations, and various other impoundments, structures, and operations designed to move freshwater to the sea in order to maintain drainage for agriculture and urban growth.[140] As a result, water levels are lower and annual flows have decreased, some lands within the Plan area became drier while others were flooded, habitats have been relocated or destroyed, and salinity levels have been altered.[141] The engineered compartmentalization and drainage of the Everglades caused severe losses in ecosystem area and water storage capacity, as well as increased water pollution and invasion by opportunistic exotic

134. H.R. Doc. No. 80-643, at 47 (1948); Restudy: Introduction, *supra* note 132, at 1-25.

135. Flood Control Act of 1948, Pub. L. No. 858, § 203, 62 Stat. 1175, 1176.

136. H.R. Doc. No. 80-643, at 42–43.

137. Hussey Freeland, *supra* note 126, at 413–14. Congress deemed "[o]verdrainage of certain lands" as "a serious problem which must be rectified." H.R. Doc. No. 80-643, at 34.

138. H.R. Doc. No. 80-643, at 56.

139. *Id.* at 33.

140. Programmatic Regulations for the Comprehensive Everglades Restoration Plan, 68 Fed. Reg. 64,200 (Nov. 12, 2003) (to be codified at 33 C.F.R. pt. 385); Restudy: Update and Background Fact Sheet, *available at* http://www.evergladesplan.org/docs/backgd.pdf.

141. Hussey Freeland, *supra* note 126, at 414.

species that thrive under altered conditions.[142] The declines in environmental conditions have been ascribed to changes in the amount of water that moves through the managed system and to changes in water quality, primarily an increase in the amount of phosphorous.[143]

Even before the C&SF Project was completed, problems began to emerge. In the 1960s, following a drought, Everglades National Park officials were concerned that the project would not deliver sufficient water to the park. This led to Public Law 91-282, which in 1970 guaranteed the park a minimum amount of water.[144] A decadal pattern followed in which the same amount of water was delivered each year, regardless of rainfall conditions.[145]

It was not long before environmental groups sued the Florida Department of Environmental Resources for failing to require the South Florida Water Management District ("SFWMD") to get a CWA permit for its operation of C&SF structures that discharged pollutants into Lake Okeechobee.[146] To mitigate the pollution problem, a Technical Advisory Council to the governor of Florida recommended a nutrient-removal program along with various measures to reduce phosphorus.[147] Even so, litigation against the State of Florida proliferated, resulting in both judicial decrees and settlement agreements intended to control pollution and improve the condition of the Everglades.[148]

142. RESTUDY: PROBLEMS AND OPPORTUNITIES 5-4, *available at* http://www.everglades plan.org/docs/comp_plan_apr99/sect5.pdf.

143. RESTUDY: SUMMARY, at iii, *available at* http://www.evergladesplan.org/docs/comp_plan_apr99/summary.pdf.

144. Stephen S. Light & Walter Dineen, *Water Control in the Everglades, a Historical Perspective, in* EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION 66 (Steven M. Davis & John C. Ogden eds., 1994).

145. *Id.*

146. *See* Friends of the Everglades, Inc. v. S. Fla. Water Mgmt. Dist., No. 02-80309, 2006 WL 3635465, at *22–23 (S.D. Fla. Dec. 11, 2006) (describing the 1970s litigation).

147. Stephen S. Light et al., *The Everglades: Evolution of Management in a Turbulent Environment, in* BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS 144 (Lance H. Gunderson et al. eds., 1995).

148. *See* S. Fla. Water Mgmt. Dist. v. Miccosukee Tribe of Indians, 541 U.S. 95, 112 (2004) (remanding the tribe's lawsuit to force the district to obtain a Clean Water Act permit for discharges from the C-11 Canal into Lake Okeechobee); United States v. S. Fla. Water Mgmt. Dist., 847 F. Supp. 1567 (S.D. Fla. 1992), *aff'd in part*, 28 F.3d 1563 (11th Cir. 1994) (approving the settlement of a federal enforcement action to redress SWFMD's movement of polluted water to Everglades National Park and the Loxahatchee National Wildlife Refuge); Miccosukee Tribe of Indians v. United States, No. 04-21448-CIV, 2008 WL 2967654 (S.D. Fla. July 29, 2008) (granting partial summary judgment against the EPA, setting aside the EPA's approval of Florida's water quality standards and enjoining the Florida Department of Environmental Protection from issuing permits for phosphorous discharges in the Everglades Protection Area); Friends of the Everglades, Inc. v. S. Fla. Water Mgmt. Dist., No. 02-80309, 2006 WL 3635465, at *22–23 (S.D. Fla.

Both the state and federal governments have continued to attempt to resolve the underlying water quality problems. In addition, concerns that tightly regulated deliveries were causing more harm than good to park resources, coupled with a flood in 1983, prompted Congress to relieve the constraints of Public Law 91-282 by authorizing a more flexible, iterative program that would allow managers to learn how to better manage water levels.[149] Meanwhile, the governor of Florida launched the "Save our Everglades" program, which consisted of a series of steps, including the formation of a collaborative effort called the Everglades Coalition.[150]

Beginning in 1988, a group of scientists, led by C.S. Holling, Carl Walters, Steve Davis, and Lance Gunderson, came together to synthesize understanding of the Everglades ecosystem—how it had changed and whether anything could be done to reverse the declines attributed to the C&SF project. There was a sense in the scientific community that decades of research had not resulted in any improvement in the ecosystem. As part of that effort, a series of adaptive environmental assessment workshops (the first phases of adaptive management) were held. The results of those workshops indicated that restoration of remaining parts of the Everglades was possible because there was sufficient water in the system to experiment, but that water required cleaning because the sources of water had been severely degraded.[151] That understanding laid the scientific framework for ecosystem restoration, which was carried forth by federal and state governments through separate planning efforts that focused on a review of the C&SF plan.

Building on these efforts, Congress authorized the South Florida Ecosystem Restoration Task Force in 1996,[152] and directed the Corps of Engineers to develop "a proposed comprehensive plan for the pur-

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Dec. 11, 2006) (describing an environmental groups' lawsuit to force SFWMD to obtain a CWA permit for discharges from various C&SF pumping stations into Lake Okeechobee). For an assesesment of the CWA litigation, see *infra* notes 275–86 and accompanying text.

149. River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970, Pub. L. No. 91-282, 84 Stat. 310.

150. Thomas T. Ankersen & Richard Hamann, *Ecosystem Management and the Everglades: A Legal and Institutional Analysis*, 11 J. LAND USE & ENVTL. L. 473, 528 n.357 (1996). The program was initiated by Governor Bob Graham in 1983 and continued through the administrations of subsequent governors Bob Martinez and Lawton Chiles. *Id.*

151. C.S. Holling et al., *The Structure and Dynamics of the Everglades System: Guidelines for Ecosystem Restoration*, *in* EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION 754–55 (Steven M. Davis & John C. Ogden eds., 1994).

152. *See* South Florida Ecosystem Restoration Task Force, Task Force Information Page, http://www.sfrestore.org/tf/index.html (last visited Jan. 13, 2009) (citing Water Resources Development Act of 1996, Pub. L. No. 104-303, § 528(f), 110 Stat. 3658, 3770-73).

pose of restoring, preserving, and protecting the South Florida ecosystem."[153] As a result, the Corps conducted the Central and Southern Florida Comprehensive Review Study ("Restudy"), which concluded that (1) the Everglades had lost half of its geographic area and seventy percent of its input flows, (2) water quality had deteriorated, largely due to excessive phosphorus, (3) at least sixty-eight of the Everglades' species had become endangered and habitats were still being lost, and (4) exotic species had invaded much of the Everglades, significantly altering the ecosystem.[154]

The Restudy acknowledged that much of the degradation in the Everglades is a direct result of the C&SF Flood Control Project,[155] and recommended the Comprehensive Everglades Restoration Plan in hopes of reversing adverse trends by making operational changes to the C&SF Project in order to restore the quantity, quality, timing, and distribution of water.[156] That Plan, described below, was adopted by Congress in the Water Resources Development Act of 2000 ("WRDA 2000").[157] By adopting the Plan, Congress intended to provide the necessary changes "to restore, preserve, and protect the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection."[158] The $8 billion cost of Everglades restoration is to be shared equally by the federal government and the non-federal sponsor, the SFWMD.[159]

The water management components of the Plan are replete with engineered devices—levees, canals, pumps, and their removal. The Plan includes over 60 individual components, including the creation of 217,000 acres of water storage and treatment areas and the removal of 240 miles of levees and canals.[160] Roughly eighty percent of the 1.1 million acre-feet of water per year to be generated by these activities is allocated to ecosystem recovery.[161]

Implementation of restoration projects has been exceedingly slow. A handful of pilot projects for water storage and reuse, designed to test some of the new technology, were authorized for immediate imple-

153. Water Resources Development Act of 1996, Pub. L. No. 104-303, § 528(b)(1)(A)(i), 110 Stat. 3658, 3767.
154. RESTUDY: KEY POINTS FACT SHEET, *available at* http://www.evergladesplan.org/docs/key.pdf.
155. RESTUDY: EXISTING CONDITIONS 3-1, *available at* http://www.evergladesplan.org/docs/comp_plan_apr99/sect3.pdf.
156. RESTUDY: UPDATE AND BACKGROUND, *supra* note 140.
157. Water Resources Development Act of 2000, Pub. L. No. 106-541, § 601(b)(1)(A), 114 Stat. 2572, 2681 [hereinafter WRDA 2000].
158. *Id.*
159. *Id.* § 601(c)(3).
160. Programmatic Regulations for the Comprehensive Everglades Restoration Plan, 68 Fed. Reg. 64,200, 64,200 (Nov. 12, 2003) (to be codified at 33 C.F.R. pt. 385).
161. RESTUDY: FACTS AND STATISTICS, *available at* http://www.evergladesplan.org/docs/facts.pdf.

mentation, but nearly a dozen others, including the Adaptive Assessment and Monitoring Program described below, were authorized subject to certain conditions, including the submission and approval of individual project implementation reports.[162] Actual construction of even the pilot projects was not scheduled to begin until 2003 or 2004, and the other projects were expected to wait a year or two after that.[163]

Adaptive management is to be accomplished through two primary mechanisms. First, Congress authorized a $100 million Adaptive Assessment and Monitoring Program for the first ten years of implementation.[164] In addition, it directed an independent scientific review panel to assess the Plan's progress in restoring the ecosystem and to report its findings to Congress every other year.[165] The Corps's Programmatic Regulations implementing WRDA 2000 acknowledge that "independent scientific review is crucial for ensuring that the best available science is used" in restoration.[166]

WRDA 2000 included an institutional mechanism for integrating "new information resulting from changed or unforeseen circumstances, [or] new scientific or technical information" into the Plan during implementation.[167] Specifically, programmatic regulations must be reviewed at least every five years in order to assimilate new information into Plan administration.[168] Thus, the Programmatic Regulations are considered "a central component in the adaptive assessment and management process on which success of the Plan . . . depends."[169]

The regulations also establish procedures for setting interim goals, or benchmarks, in evaluating the effectiveness of restoration efforts during Plan implementation.[170] Benchmarks are to include water quantity, quality, and timing and desired ecosystem responses. They

162. WRDA 2000 § 601(b)(2)(C)–(D); *infra* notes 164–71.
163. Phyllis McIntosh, *Reviving the Everglades*, NAT'L PARKS, Jan. 1, 2002, at 30, *available at* http://www.npca.org/magazine/2002/january_february/everglades.
164. WRDA 2000 § 601(b)(2)(C)(xi).
165. *Id.* The Panel was assembled by the National Academy of Sciences and produced its first report in 2006. *See* COMM. ON INDEP. SCIENTIFIC REVIEW OF EVERGLADES RESTORATION PROGRESS, NAT'L RESEARCH COUNCIL, PROGRESS TOWARD RESTORING THE EVERGLADES: THE FIRST BIENNIAL REVIEW (2006); National Academies, Current Projects System: Independent Scientific Review of Everglades Restoration Projects 2004-07 (2007), http://www8.nationalacademies.org/cp/projectview.?key=WSTB-U-03-04-A (last visited Jan. 13, 2009).
166. Programmatic Regulations for the Comprehensive Everglades Restoration Plan, 68 Fed. Reg. 64,200, 64,206 (Nov. 12, 2003) (codified at 33 C.F.R. pt. 385); *see also* 33 C.F.R. § 385.22(a) (2008) (creating an independent review panel).
167. WRDA 2000 § 601(h)(3)(C)(i)(II).
168. *Id.* § 601(h)(3)(E).
169. Hussey Freeland, *supra* note 126, at 423 (citing S. REP. NO. 106-362, at 56 (2000)).
170. 33 C.F.R. §§ 385.6, 385.38; *see* WRDA 2000 § 601(h)(3)(E).

are to be revised at least every five years if new information suggests that revisions are needed.[171]

Beyond engineered solutions and federal regulations, Everglades restoration has also required certain adaptations in Florida water law. As the result of a federal-state agreement required by WRDA 2000, the state of Florida must conduct its water use permitting process in a manner that precludes water arising from a Plan project from being allocated or "otherwise made unavailable" by the state until a sufficient amount is first reserved for ecosystem restoration.[172] A proviso in WRDA 2000 has the potential to erode the efficacy of this requirement, however, by protecting the existing water allocation regime created under Florida state law.[173] "Existing legal sources of water" are shielded by a clause that prohibits depletion by any modifications in the C&SF Project until alternative water sources are available.[174] In addition, "existing, legally recognized rights to flood protection" must be honored.[175] The Corps has struggled to define and identify just what activities or sources of water are considered "legally recognized" and therefore protected by WRDA.[176] This determination will turn on Florida state water law, described below.[177]

Threats to the species of the Everglades were addressed through a parallel track under the auspices of the ESA.[178] While the CERP was being formulated during the late 1990s, the Fish and Wildlife Service approved the South Florida Multi-Species Recovery Plan in an effort to mitigate threats to federally listed animal and plant species.[179] The Multi-Species Plan covers 26,000 square miles (67,000 kilometers) and includes specific recovery objectives for sixty-eight listed spe-

171. Hussey Freeland, *supra* note 126, at 424 (citing 33 C.F.R. § 385.38(b)(2)–(3), (b)(5)(i)).

172. WRDA 2000 § 601(h)(2); John T. Woolley & Gerhard Peters, The Am. Presidency Project, Comprehensive Everglades Restoration Plan Assurance of Project Benefits Agreement, http://www.presidency.ucsb.edu/ws/index.php?pid=73225&st=&st1 (last visited Jan. 13, 2009) (providing the text of the agreement).

173. Hussey Freeland, *supra* note 126, at 420.

174. WRDA 2000 § 601(h)(2)(B)(i).

175. *Id.* § 601(h)(5)(B); S. REP. No. 106-362, at 57 (2000).

176. 33 C.F.R. §§ 385.36(a) (requiring Project Implementation Reports to include analyses regarding whether existing legal sources would be eliminated or transferred), 385.5(a)(2)(vi) (2008) (directing the development of guidance for determining whether an existing legal source of water will be eliminated or transferred as a result of Plan implementation). The Corps's regulations provide that, "[u]ntil guidance is issued, issues involving existing legal sources of water should be resolved on a case-by-case basis considering all [relevant] factors." *Id.* § 385.36(c).

177. *See infra* Part III.A.2.

178. *See supra* Part II.B.3.

179. U.S. FISH & WILDLIFE SERV., SOUTH FLORIDA MULTI-SPECIES RECOVERY PLAN (1999), *available at* http://www.fws.gov/verobeach/images/pdfLibrary/execsum.pdf.

cies, such as minimum numbers of individuals and of populations, as well as large-scale community level restoration objectives, including habitat conservation and restoration of ecological linkages.[180] Limiting factors for the viability of all species covered in the plan include "upland and wetland habitat loss, fragmentation, and degradation, resulting from urbanization, agriculture or other land-use conversions, wetland drainage and alteration of hydrology, invasion of exotic species, fire suppression, soil subsidence, degradation of water quality, and increased levels of contaminants."[181] The FWS concluded that one-fourth of the species covered by the Multi-Species Plan "are dependent upon implementation of the CERP for survival and recovery, and many others will benefit significantly as a result of this restoration effort."[182] If all goes as planned, the agency anticipates that, in the next two decades of implementation, over a dozen species will be removed from the endangered species list.[183]

The CERP and the Multi-Species Plan have committed Everglades managers to adaptive management principles, but the jury is still out on restoration accomplishments.[184] There are two primary criticisms, which we explore in detail below.[185] First, the CERP devotes too much attention to the use of ever more heroic engineering techniques to expand water supplies and ensure flood control for South Florida's exploding population. In addition, both the CERP and the Multi-Species Plan give low priority to the improvement of necessary sheet water flows to the Everglades, and too much emphasis to maintaining stakeholders' economic interests, which place a chokehold on experimentation, learning, and adaptation.[186] As a result, the CERP remains in a planning mode. Nearly a decade after the enabling law was passed, there has been much discussion in the scientific, management, and legal community about what project should be pursued. In a 2007 review, however, the Government Accountability Office observed that no CERP projects had been completed and that the only progress was attributed to a few, select CERP-related projects.[187] These related projects are mostly pilot programs to understand nutrient removal in abandoned agricultural fields that have become wet-

180. *Id.* at ix–x.
181. *Id.* at ix.
182. *Id.* at xi.
183. *Everglades: Multiple Species Recovery Project Announced as Part of Restoration Effort*, [1999 File Index] 30 Env't Rep. (BNA), No. 4, at 178 (May 28, 1999).
184. Michael Voss, *The Central and Southern Florida Project Comprehensive Review Study: Restoring the Everglades*, 27 ECOLOGY L.Q. 751, 761–62 (2000).
185. *See infra* Part IV.A.2.
186. Grunwald, *Rescue Plan*, *supra* note 133, at A01.
187. U.S. GOV'T ACCOUNTABILITY OFFICE, SOUTH FLORIDA ECOSYSTEM: RESTORATION IS MOVING FORWARD BUT IS FACING SIGNIFICANT DELAYS, IMPLEMENTATION CHALLENGES, AND RISING COSTS (2007), *available at* http://www.gao.gov/highlights/d07520high.pdf.

lands. While adaptive management experiments were designed as early as 1993, there have yet to be any such experiments conducted in the system.[188]

2. Florida State Water Law

Everglades restoration is also influenced by Florida water law. The Florida legislature adopted one of the nation's most comprehensive water codes in 1972, with the goal of providing more certainty for water users while retaining the flexibility to adjust water uses to reflect new conditions or changed priorities and to foster greater integration of planning and regulation to protect Florida's water resources.[189] The Florida Water Code authorizes certain "reasonable-beneficial uses," defined as "the use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest."[190] The State Department of Environmental Protection ("DEP") maintains oversight of the Act's implementation.[191] The five regional water management districts are also granted authority for managing water resources within their watersheds, and this includes regulating almost "any use of water that involves withdrawing or diverting it."[192]

Instream flows are protected by a statutory provision that directs each water management district to establish "minimum flow for all surface watercourses in the area," defined as "the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area."[193] The DEP's Water Resource Implementation Rule specifies that water management plans shall, where economically and environmentally feasible, promote water supply but also protect natural systems in three key ways: (1) establish minimum flow levels to protect water resources and the environmental values associated with marine, estuarine, freshwater, and wetlands ecology; (2) mitigate adverse impacts resulting from prior alteration of natural hydrologic patterns; and (3) utilize natural water

188. Gunderson & Light, *supra* note 22, at 324.

189. Water Resources Act of 1972, FLA. STAT. ANN. § 373.013–.201 (West 2005) (providing the current version of the law, as amended).

190. FLA. STAT. ANN. § 373.019(16) (West 2005). In considering applications for consumptive use of water, the District is required to determine "whether the use of water is efficient, whether there is a need for the water requested, and whether the use is for a legitimate purpose. The inquiry focuses on the impact of the use on water resources and existing legal users." Marion County v. Greene, No. 5D07-1239, 2008 WL 2937828, at *3 (Fla. Dist. Ct. App. Aug. 1, 2008).

191. FLA. STAT. ANN. § 373.026.

192. FLORIDA WATER RESOURCES ATLAS 306 (Edward A. Fernald & Elizabeth D. Purdum eds.,1998); *see* FLA. STAT. ANN. § 373.069 (creating water management districts).

193. FLA. STAT. ANN. § 373.042(1)(a).

management systems rather than channelization or other physical alteration of natural rivers, streams, and lakes.[194] The courts have been willing to give these provisions "teeth." In response to litigation brought by a citizens' group, which sought to compel a water management district to establish minimum flows and to prevent it from issuing additional consumptive permits until minimums were established, a Florida court held that the Code *requires* water districts to establish minimum flows and levels; it does not merely suggest that they do so.[195]

In addition, the Water Code gives the districts and the DEP discretion to reserve water from amounts sought in permit applications "in such locations and quantities, and for such seasons of the year, as . . . may be required for the protection of fish and wildlife or the public health and safety."[196] This provision has only rarely been utilized, however, perhaps because the statute also provides that reservations may not diminish existing permitted uses.[197] This caveat, along with the provision of WRDA that protects existing water uses, constrains restoration options and makes the Florida system operate to some extent like prior appropriation systems of the Colorado River and the rest of the western United States, where those who are first in time (senior users) enjoy legally protected rights that take priority over the needs of other users and, arguably, even the ecosystem itself.[198]

B. The Grand Canyon: Physical Condition and Legislative Framework

As John Wesley Powell proclaimed over one hundred years ago, "[t]he elements that unite to make the Grand Canyon the most sub-

194. FLA. ADMIN. CODE ANN. r 62-40.310(4) (effective 2005).

195. Concerned Citizens of Putman County for Responsive Gov't, Inc. v. St. Johns River Water Mgmt. Dist., 622 So. 2d 520 (Fla. Dist. Ct. App. 1993).

196. FLA. STAT. ANN. § 373.223(4) (West 2005 & Supp. 2009).

197. *Id.*; *see* Ass'n of Fla. Cmty. Developers v. Dep't of Envtl. Prot., 943 So. 2d 989, 991 (Fla. Dist. Ct. App. 2006) (upholding Proposed Rule 60-40.474 specifying when reservations may be made for the protection of fish and wildlife or for public health and safety); Mary Jane Angelo, *Integrating Water Management and Land Use Planning: Uncovering the Missing Link in the Protection of Florida's Water Resources?*, 12 U. FLA. J.L. & PUB. POL'Y 223, 230 n.49 (2001) (citing FLA. ADMIN. CODE ANN. r. 40C-2.301 and noting that, as of 2001, the reservation provision had only been utilized once, when in 1994 the St. Johns River District reserved water to protect the fish and wildlife of Paynes Prairie State Preserve near Gainesville).

198. *See* Christine A. Klein, *On Integrity: Some Considerations For Water Law*, 56 ALA. L. REV. 1009, 1051 (2005) (noting that provisions of Florida law that protect existing uses are "incongruous with the riparian practice of granting water rights in accordance with the public interest, rather than temporal priority"); *infra* notes 347–49 (describing users' expectations under western water law).

lime spectacle in nature are multifarious and exceedingly diverse."[199] The Grand Canyon was created over the past 6 to 10 million years, primarily by erosion as the Colorado River moved through the Colorado plateau. It sits in the middle stretch of the Colorado River, a section that begins downstream of the Glen Canyon dam and ends at Lake Meade, the reservoir for the Hoover Dam. This stretch of river flows through lands that are operated by the U.S. National Park Service as the Glen Canyon National Recreation Area and the Grand Canyon National Park. Tribal lands also border the river.[200]

The last dam built on the Colorado River was the Glen Canyon dam. This and other dams were constructed to control annual variability in water flow and to generate electricity. The dams provide water storage and enable regulation of flows to meet the Law of the River, which allocates water among seven states, and an international treaty that guarantees delivery of water to Mexico.[201]

After the dam was closed in 1962, the river ecosystem underwent a regime shift. The river was historically characterized by extreme floods, large sediment loads that colored the water red (hence the origin of the name, colorado, or "blushing," river), and seasonally large fluctuations in temperature.[202] Today, for hundreds of kilometers downstream of Glen Canyon Dam, the altered system has relatively stable flow, clearer water, and a near-constant temperature year-round. These physical changes in turn have led to unforeseen ecosystem shifts, such as the loss of seven species of native fish, the endangerment of four others, and a reduction of habitat diversity.[203]

In 1992, Congress passed the Grand Canyon Protection Act.[204] The Act directs the Secretary of Interior to operate Glen Canyon Dam "in such a manner as to protect, mitigate adverse impacts to, and improve the values" of Grand Canyon National Park.[205] Congress was not writing on a blank slate when it took action in 1992; rather, it passed the Act upon a backdrop of over a half-century of legislation and litigation. In recognition of the extant legal framework, Congress directed the Secretary to perform the duties of the Grand Canyon Pro-

199. JOHN WESLEY POWELL, CANYONS OF THE COLORADO 394 (Argosy-Antiquarian, Ltd. 1964) (1895).

200. These facts and others about the Grand Canyon can be found online. National Park Service, Grand Canyon: Frequently Asked Questions, http://www.nps.gov/grca/faqs.htm (last visited Jan. 13, 2009). Facts about the Glen Canyon restoration plan are also available online. Glen Canyon Institute, Frequently Asked Questions About Restoring Glen Canyon, http://www.glencanyon.org/aboutgci/faq.php (last visited Jan. 13, 2009).

201. *See infra* note 208.

202. Hughes et al., *supra* note 14, at 589.

203. *Id.*

204. Grand Canyon Protection Act of 1992, Pub. L. No. 102-575, §§ 1801–1809, 106 Stat. 4600, 4669–73 [hereinafter GCPA 1992].

205. *Id.* § 1802(a).

tection Act "in a manner fully consistent with and subject to" the Law of the River.[206] Complicating matters further, the Act also specifies that nothing in it "is intended to affect in any way—(1) the allocations of water secured to the Colorado Basin States by any compact, law, or decree; or (2) any Federal environmental law, including the Endangered Species Act."[207]

The Law of the River—the 1922 Colorado River Compact and subsequent amendments and judicial decrees[208]—governs the activities of the federal agencies that manage the Colorado River, as well as those of the seven states, numerous Indian tribes, and private parties that use its waters.[209] The Compact allocated the river's water between the four states of the upper Colorado River Basin and the three states of the lower Basin, while judicial decrees and other facets of the Law of the River, including the doctrine of prior appropriation as applied within each of the Basin states, prioritize those water rights.[210]

The Colorado River Project Act of 1956[211] authorized the construction and operation of the Glen Canyon Dam, primarily to store water for use by the upper Basin or for delivery to the lower Basin.[212] Congress specified that, in addition to satisfying water rights, the Dam was to provide hydroelectric power as a secondary purpose.[213] Today, Glen Canyon Dam operates at less than its design capacity and pro-

206. *Id.* § 1802(b).

207. *Id.* § 1806.

208. The Law of the River consists of international treaties, interstate compacts, federal statutes and regulations, judicial decisions, and contractual agreements. It includes the Colorado River Storage Project Act of 1956, 43 U.S.C. §§ 620–620(o) (2000); the Colorado River Basin Project Act of 1968, 43 U.S.C. §§ 1501–1556; the Act of April 6, 1949, ch. 48, 63 Stat. 31 (1949) (granting consent of the United States to the Upper Colorado River Basin Compact of 1948); The Treaty on the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, U.S.-Mex., Feb. 3 1944, 59 Stat. 1219; and the Supreme Court's decrees in *Arizona v. California*, 547 U.S. 150 (2006) and *Arizona v. California*, 376 U.S. 340 (1964).

209. JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES: CASES AND MATERIALS 799 (4th ed. 2006).

210. 70 CONG. REC. 324 (1928) (providing the full text of the Compact). In particular, article III(d) provided that "[t]he States of the Upper Division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any period of ten consecutive years." *Id.* at 325; *see also* Arizona v. California, 373 U.S. 546, 554 (1963) (explaining that the prior appropriation doctrine gives the one who first appropriates water and puts it to beneficial use a right to continue to divert and use that quantity of water against all junior users).

211. 43 U.S.C. §§ 620-620(o) (2000).

212. Robert W. Adler, *Restoring the Environment and Restoring Democracy: Lessons from the Colorado River*, 25 VA. ENVTL. L.J. 55, 80 (2007) [hereinafter Adler, *Lessons*].

213. *Id.* at 80–81.

vides only a very small percentage of the electricity on the western power grid.[214]

Water supply and hydropower are not the only considerations for Colorado River managers. In the past decade, numerous Colorado River species have been listed as endangered or threatened. Of particular concern are four fish species: the Colorado pikeminnow; razorback sucker; humpback chub; and bonytail. As in the Everglades, the Lower Colorado River is covered by a Multi-Species Conservation Program.[215] The Program's goal is relatively modest. It does not strive for full species recovery, but merely to "conserve habitat and work toward the recovery of threatened and endangered species."[216] Indeed, full recovery may well be impossible, given the explicit mandate in the Program to "accommodate present water diversions and power production and *optimize opportunities for future water and power development*, to the extent consistent with the law."[217] Moreover, during the 50-year life of the Program, if it turns out that additional measures are needed to protect the species, the federal agencies are required to "adopt those actions or measures that will have the *least effect upon the [p]ermittees and the respective constituents served by the [p]ermittees*."[218] The Program enabled the FWS to issue a single incidental take permit to over forty different stakeholders in Arizona, California, and Nevada, including federal and state agencies, power companies, irrigation districts, and cities.[219] Under the controversial "No Surprises" rule, this permit prohibits the FWS from imposing the costs of any additional restrictions on the use of land, water, or natural resources to protect the listed species on the permittees.[220]

To effectuate its goals of protecting Grand Canyon Park and the endangered fish species, while satisfying the Law of the River and providing hydropower, the Grand Canyon Protection Act of 1992 specifies

214. Glen Canyon Institute, *supra* note 200. Although its capacity is 1,320 megawatts, enough to serve 1.3 million residential customers, on average, Glen Canyon Dam generates only 451 megawatts, serving the needs of over half a million customers, compared to Hoover Dam, which generates 1,840 average megawatts. *See id.*; Glen Canyon Dam Adaptive Mgmt. Program, Hydropower, http://www.gcdamp.gov/keyresc/hydropower.html (last visited Jan. 13, 2009).

215. LOWER COLO. RIVER MULTI-SPECIES CONSERVATION PROGRAM, FINAL HABITAT CONSERVATION PLAN: VOLUME II (2004), *available at* http://www.lcrmscp.gov/publications/VolumeII.pdf.

216. *Id.* at 1–3.

217. *Id.* (emphasis added); *see* ADLER, TROUBLED SENSE, *supra* note 1, at 180 (describing weaknesses of the Program).

218. LOWER COLO. RIVER MULTI-SPECIES CONSERVATION PROGRAM, *supra* note 215, at 490 (emphasis added).

219. ADLER, TROUBLED SENSE, *supra* note 1, at 180.

220. LOWER COLO. RIVER MULTI-SPECIES CONSERVATION PROGRAM, *supra* note 215, at 490; *see infra* notes 302–07 and accompanying text (describing the No Surprises rule).

that management decisions must be guided by a collaborative process that engages representatives of the various stakeholder groups.[221] In addition, the Secretary of Interior is directed to establish monitoring programs "in consultation with" other federal agencies, the seven Colorado River states, American Indian tribes, environmental organizations, power providers, and recreation interests.[222] To satisfy these requirements, the Secretary established the Glen Canyon Dam Adaptive Management Program ("AMP"), which is comprised of a twenty-five member federal advisory committee—the Adaptive Management Work Group (AMWG)—and several scientific and technical advisory committees.[223] Research needs are met in part by the Grand Canyon Monitoring and Research Center, which is a "well-resourced, formal information gathering and assessment apparatus . . . charged with the scientific monitoring and research of the Colorado River ecosystem."[224]

The establishment of the collaborative AMP is an experiment in adaptive governance. Adaptive governance is a process by which science, policy, and decision making interact in formal (legal and institutional) structures and informal processes to break gridlock in the management of natural resources.[225] Adaptive governance describes the social, legal, and political structures that allow for the process of adaptive management to be practiced.[226] But adaptive management was never envisioned as a mechanism to resolve complex social uncertainties, such as trying to resolve conflicts between power generation and endangered species. In the case of the AMP, the Secretary thought that perhaps these contestations of values could be resolved or at least addressed in a situation where all parties (and their concomitant values) could agree on a set of experiments rather than attempt to resolve conflicting value sets. Accordingly, the AMP emphasizes "long-term monitoring and research protocols that seek repeated monitoring and, if necessary, adjustment of regulatory restrictions to account for new information or changed circumstances that arise during implementation."[227]

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221. GCPA 1992 §§ 1803(b), 1804(c)(3).
222. *Id.* §§ 1803(b), 1804(c)(3), 1805(a), (c).
223. *Id.*; *see infra* Part IV.A.1 (describing the deliberative processes and challenges of the AMWG). As a formal advisory group, the AMWG must conduct open meetings and comply with other requirements of the Federal Advisory Committee Act, 5 U.S.C. App. 2 § 10 (2006).
224. Alejandro E. Camacho, *Beyond Conjecture: Learning About Ecosystem Management from the Glen Canyon Dam Experiment*, 8 NEV. L.J. 942, 955 (2008) [hereinafter Camacho, *Conjecture*].
225. *See generally* RONALD D. BRUNNER ET AL., ADAPTIVE GOVERNANCE: INTEGRATING SCIENCE, POLICY, AND DECISION MAKING (2005) (analyzing the adaptive governance aspect of programs developed to address natural resource issues).
226. Gunderson & Light, *supra* note 22, at 325.
227. Camacho, *Conjecture*, *supra* note 224, at 954.

In the mid-1990s, the need for turbine upgrades to Glen Canyon Dam provided the opportunity for a series of experimental flood releases from the dam as part of the AMWG's efforts to learn more about the downstream ecosystem and ostensibly guide future dam operations.[228] After much study and deliberation, the AMWG has engaged in two high flow experiments and another two significant test flows in the past decade.[229] These experiments have been praised by many as successful examples of exactly the kind of adaptive implementation that is needed in natural resource management.[230] The AMWG is not without its critics, however, and we address their arguments below.[231]

IV. LESSONS LEARNED

Our analysis of the Everglades and Glen Canyon restoration efforts reveals three broad observations: (1) adaptive governance and consensus-based management are not the same thing, and the latter can sabotage rather than promote restoration initiatives; (2) heavy reliance on engineered solutions increases the likelihood of failure; and (3) a continuing commitment to adaptive management is critical in achieving restoration success. In keeping with these observations, our overarching take-away lesson is that restoration plans should focus on restoring natural hydrological and biological processes by which ecosystems maintain resilience.[232] In other words, rather than seek to recover discrete resources to prescribed levels—maximum water supplies, optimal power output, and the like—and rather than freezing conditions at some predetermined, socially desirable state, restoration efforts should seek to restore natural *processes*.[233] This approach has two key virtues. First, the restoration of natural processes will require less ongoing, human management over the long run. At least equally important, restoring natural processes will allow ecosystems to evolve over time, just as they did before the occurrence of major artificial disturbances.[234]

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228. *Id.* at 956.

229. Adler, *Lessons*, *supra* note 212, at 100–01.

230. *See, e.g.*, Holly Doremus, *Adaptive Management, the Endangered Species Act, and the Institutional Challenges of "New Age" Environmental Protection*, 41 WASHBURN L.J. 50, 78–79 (2001) [hereinafter Doremus, *New Age*]; Vicky J. Meretsky et al., *Balancing Endangered Species and Ecosystems: A Case Study of Adaptive Management in Grand Canyon*, 25 ENVTL. MGMT. 579 (2000); Bernice Wuethrich, *Deliberate Flood Renews Habitat*, 272 SCI. 344, 344–45 (1995).

231. *See infra* Part IV.A.1.

232. *See* ADLER, TROUBLED SENSE, *supra* note 1, at 241 (advocating restoration of ecological processes on the Colorado River).

233. *Id.*

234. *Id.* at 243.

A. Consensus-Based Management Can Obstruct Restoration Progress

Adaptive governance entails flexibility to learn and to make changes in response to lessons learned. By contrast, consensus-based management requirements, which typically require managers to reach consensus with a multitude of participants with competing interests, thereby satisfying all (or at least most) stakeholders in a collaborative management effort, often leads to sacrificing environmental needs. Most ongoing restoration programs have an elemental, yet often unspoken, trait in common—"they seek to restore natural ecosystem characteristics and functions while preserving the basic interests of those who use the river for economic benefits."[235] This forces restoration managers to engage in a delicate, possibly futile, high wire act, as they strive to preserve the "legal and political structure that doles out the . . . water and power values while minimizing the long-term environmental impacts of that system."[236]

Consensus-based management does have its advantages, but it should be used to complement not substitute for adaptive governance. Participation in decision-making and on-the-ground management can build both knowledge and trust among stakeholders.[237] In addition, deliberation can lead to the shared understanding needed to prepare for change, mobilize resources, and self-organize, thereby building robustness and adaptive capacity in the group or institution.[238]

The governing rules of the Glen Canyon AMP dictate that consensus (not a simple majority) of the working group is needed before a recommendation can be made to the Secretary. This leads to restriction and conservatism, both with respect to the experiments that are proposed and the measures that are actually implemented.

> Almost every existing or proposed restoration strategy has impacts on other river uses and values, which trigger opposition from various user groups, delays in implementing effective restoration methods, and sometimes complete policy gridlock . . . . Where potentially effective solutions to one problem might adversely affect other uses and values, the manner and extent to which we have insisted on collaborative process and full consensus among interest groups can do more to preserve the status quo than to promote effective, innovative solutions.[239]

Yet somehow the AMP program has managed to identify a set of ecologically based management goals and objectives, and it has conducted several important adaptive experiments involving both water

235. *Id.* at 14.
236. *Id.*
237. Per Olsson et al., *Shooting the Rapids: Navigating Transitions to Adaptive Governance of Social-Ecological Systems*, 11 ECOLOGY & SOC'Y 18, 4–6 (2006), *available at* http://www.ecologyandsociety.org/vol11/iss1/art18/.
238. Anderies et al., *supra* note 31, at 5.
239. ADLER, TROUBLED SENSE, *supra* note 1, at 268.

releases and predator control.[240] In contrast, in the Everglades, there is little or no evidence of any trust or spirit of collaboration. Rather it appears to be the opposite—an atmosphere of distrust and unyielding adherence to individual or agency agendas. We attempt to parse through the lessons of each to determine why the Glen Canyon AMP has made progress while the Everglades CERP has not.

1. Adaptive Management on the Grand Canyon

The emphasis on scientific information gathering provided by the Glen Canyon AMP is considered "particularly robust as compared to other regulatory programs."[241] The scientific institutions and researchers at work in the Grand Canyon "are very capable of studying any scientific or technical questions that the AMWG considers relevant to making long-term resource management decisions."[242] The tremendous pool of expertise brought to bear on the Grand Canyon's resources and the trust that has developed among researchers has enabled several significant experiments to be conducted, and river managers have learned from them and adapted their approaches to some extent.

A few critics have described these experiments as a "wasted opportunity" because the Glen Canyon AMP does not mandate when information gleaned from such experiments must be used to adjust the management protocols.[243] Granted, there is no explicit mandate, and the experimentation that occurred may not have exhibited the length and breadth of experimentation that scientists may have wanted. But nonetheless, experiments have been done that have transformed the way the system is managed. This is the very heart of adaptive management and, in turn, resilience.

The primary impediment to making the most of the opportunities created by experimentation on the Grand Canyon is Congress's unwillingness to articulate clear ecological priorities among conflicting societal values. As a result, federal agencies have been extremely reluctant to disturb expectations fostered by the Law of the River, to the benefit of hydropower interests and holders of water rights.[244]

The AMP articulates the ambitious, and perhaps impossible, goal not only to "[m]aintain power production capacity and energy genera-

240. Hughes et al., *supra* note 14, at 590.
241. *Id.*
242. Camacho, *Conjecture*, *supra* note 224, at 955.
243. *Id.* at 956. Camacho further argued that "[t]he full value of this information for natural resource management at the Glen Canyon Dam and more generally . . . is substantially hindered by the uncertainty of the regulatory program." *Id.* at 957.
244. Mary Christina Wood, *Reclaiming the Natural Rivers: The Endangered Species Act as Applied to Endangered River Ecosystems*, 40 ARIZ. L. REV. 197, 225 (1998) (describing reluctance to disturb expectations fostered by the Law of the River on the Colorado and other river basins).

tion," but also to increase it "where feasible and advisable, within the framework of the Adaptive Management ecosystem goals."[245] It also specifies a hierarchy to be utilized whenever a restoration action might benefit some resources while adversely affecting others: first, try actions that help all resources; second, try actions that help some resources and are neutral to others; and, finally, "as a last resort," take actions that benefit some resources while minimizing negative impacts on others.[246]

Reaching consensus is virtually impossible because of the lack of clear guidance from Congress, which fosters gridlock due to the AMWG's almost mutually exclusive objectives of hydropower, irrigation, urban development, preservation of fish species, and other ecological needs.[247] A National Academy of Sciences-National Research Council review panel criticized the government's attempt to exploit so many resource values simultaneously, while providing so few clear guideposts on which values or resources should be prioritized when necessary to break an impasse.[248] According to the National Research Council, the program's pluralistic approach fails to prioritize management objectives and, more fundamentally, fails to reflect a coherent restoration vision for the system.[249] Instead of resolving the conflicting mandates of the Law of the River and the ESA, the 1992 Act includes "a host of confusing and conflicting directives . . . that have led to extensive delays and to this day cause considerable confusion."[250]

Professor Adler agrees that restoration efforts have been "hampered by the futile assumption that all uses and values of the Grand Canyon ecosystem can be maximized simultaneously."[251] He adds that, "the programs purport unrealistically to be all things to all resources, that is, to comply fully with environmental restoration goals while still accommodating all existing water, power, and other objectives."[252]

The AMWG has been given a lead role in reconciling conflicting values.[253] However, some critics argue that the AMWG "does little to

245. ADLER, TROUBLED SENSE, *supra* note 1, at 166.
246. *Id.*
247. *Id.*
248. COMM. ON GRAND CANYON MONITORING & RESEARCH, NAT'L RESEARCH COUNCIL, DOWNSTREAM: ADAPTIVE MANAGEMENT OF GLEN CANYON DAM AND THE COLORADO RIVER ECOSYSTEM 59, 61–62 (1999).
249. *Id.* at 63; *see* ADLER, TROUBLED SENSE, *supra* note 1, at 166 (stating that the program "assumes falsely that all uses and interests can be accommodated equally, rather than having to make some difficult choices").
250. Camacho, *Conjecture*, *supra* note 224, at 947; *see also* Adler, *Lessons*, *supra* note 212, at 85 ("[T]he new law could be used in an introductory philosophy text as an example of circular logic.").
251. ADLER, TROUBLED SENSE, *supra* note 1, at 167.
252. *Id.* at 243.
253. Camacho, *Conjecture*, *supra* note 224, at 944.

thwart [agency] capture [by hydropower and irrigation interests] or increase the Secretary's accountability."[254] Notably, the AMWG makes recommendations to the Secretary, which the Secretary is free to ignore or reject, without explanation,[255] in effect allowing "both the AMWG and Secretary to evade responsibility for reconciling the competing use priorities of the Colorado River or other difficult decisions regarding management of the dam."[256] As a result, one well-heeled interest group has regularly prevailed in the AMWG process—hydroelectric power.[257] If this trend continues, environmental interests and other stakeholders will have little incentive to expend their limited resources on the AMWG process.[258]

A committee of the AMWG acknowledged that several of the AMP's goals "are in apparent conflict with one another" and that many stakeholders "have never committed to defining or achieving specific resources objectives or desired future resource conditions."[259] After a full decade, "quantifiable targets have not been established for . . . priority resources (humpback chub, sediment, and cultural resources)."[260] As such, the AMP promises both a collaborative and an adaptive approach to decision-making, but the requirement for collaboration without the establishment of clear ecological priorities by Congress has inhibited restoration prospects for the Grand Canyon.

In addition to the lack of clear ecological priorities, the need to reach consensus with a stakeholder group can also inhibit meaningful experimentation and adaptation. Critics observe that the AMP tends to become "bogged down in stakeholder politics."[261] No doubt, delays caused by horse-trading and other types of political maneuvering "present serious barriers to learning."[262]

> Most scientists . . . do not design experiments under the watchful eyes of a large stakeholder committee that must decide how each experiment will affect their interest before it can proceed. When years of discussion occur between

254. *Id.* at 951.
255. *Id.* at 952.
256. *Id.*
257. *See id.* at 959 (observing that states and tribes often side with hydro-power interests out of a concern for the "expedient availability of economical energy."); *see also* ADLER, TROUBLED SENSE, *supra* note 1, at 243 ("In reality, restoration consistently takes second place to development.").
258. Camacho, *Conjecture*, *supra* note 224, at 959–60; *see id.* at 960 n.100 (noting that an environmental participant of the AMWG recently broke free of the groups' constraints by suing the Bureau of Reclamation for violating the Endangered Species Act and National Environmental Policy Act).
259. *Id.* at 949 (quoting AD HOC GROUP, MGMT. WORK GROUP, REPORT AND RECOMMENDATIONS TO THE SECRETARY'S DESIGNEE 5 (2007), *available at* http://www.usbr.gov/uc/rm/amp/amwg/mtgs/07may22cc/attach_03a.pdf [hereinafter AD HOC GROUP REPORT]).
260. *Id.*
261. ADLER, TROUBLED SENSE, *supra* note 1, at 167.
262. *Id.* at 166.

> iterations, and when experiments may not proceed if they affect other uses such as water and power, the science part of adaptive management bogs down. . . . The environmental window within which to conduct the experiment might open and close before a stakeholder or other process is completed.[263]

Even with these political restraints, the AMP has nonetheless proved successful at conducting some adaptive management experiments by employing a process designed to alleviate the uncertainties inherent in managing such complex ecosystems. As such, the AMP has used experimental water releases to test understanding about complicated water and sediment dynamics. The releases so far have taught scientists and managers that their previous model about the source of sand for sandbar replenishment was incorrect.[264] Another important finding, which has changed management actions, is that insufficient sediments remain in the river to continue to replenish the beach habitats throughout the canyon.[265] Hence, the experimental flood program has been modified to be triggered only when new sediments enter the Colorado from the Paria River, and to seek strategies that would reestablish sediment transport from upstream sources.[266]

Despite the willingness to engage in some experimentation, endangered fish species have made minimal gains under the Colorado River Multi-Species Conservation Program. Remnant populations persist throughout the Canyon,[267] but the fate of those populations is contested; some believe that these populations are small but stable, while others suggest that they are continuing to decline.[268] In either case, it is clear that the native fish populations are susceptible to a number of factors—water temperature, predation by introduced salmonids, particularly trout and other game fish,[269] and altered habitat. Some level

263. *Id.* at 166–67. Of course, as anyone who has ever had a proposal reviewed by the National Science Foundation or by another federal funding agency knows, experiments are indeed sometimes designed under the watchful eyes of external committees, but the program officers of those agencies have no direct personal or monetary stake in the outcome.

264. THEODOR S. MELIS ET AL., U.S. GEOLOGICAL SURVEY FACT SHEET 2007-3020: RESEARCH FURTHERS CONSERVATION OF GRAND CANYON SANDBARS (2007), *available at* http://pubs.usgs.gov/fs/2007/3020/fs2007-3020.pdf.

265. ADLER, TROUBLED SENSE, *supra* note 1, at 100; Doremus, *New Age*, *supra* note 230, at 78; *see also* Camacho, *Conjecture*, *supra* note 224, at 956–57 (conceding that "these experiments have revealed important information, particularly regarding the sediment and nutrient dynamics of the ecosystem downstream from the Glen Canyon Dam").

266. TIMOTHY J. RANDLE ET AL., COLORADO RIVER ECOSYSTEM SEDIMENT AUGMENTATION APPRAISAL ENGINEERING REPORT (2007), *available at* http://www.gcmrc.gov/library/reports/physical/Fine_Sed/Randle2007.pdf.

267. ADLER, TROUBLED SENSE, *supra* note 1, at 178.

268. SW. BIOLOGICAL SCI. CTR., U.S. GEOLOGICAL SURVEY, THE STATE OF NATURAL AND CULTURAL RESOURCES IN THE COLORADO RIVER ECOSYSTEM 36–49 (2005), *available at* http://www.gcmrc.gov/products/score/2005/pdf/score_2005.pdf [hereinafter SCORE].

269. *Id.* at 36–37.

of consensus can also be reached regarding the resilience of the endangered species—it has shrunk.[270] Consensus can also be reached on the issue of non-native species, which appear to be increasing in populations and which pose significant predation and other threats to the native species.[271] The ability of the AMP to mobilize, conduct, and analyze a predator control program is an indication of a successful adaptive management program.[272] However, the ultimate efficacy of species recovery programs in the Grand Canyon remains uncertain.

In summary, consensus-based management can be a serious obstacle for adaptive management and restoration prospects. Requiring consensus agreement in terms of what recommendations are made to the Secretary has limited the extent of adaptive management experiments that could have been undertaken. It has created a rather conservative set of experimental actions, from water releases to predator control. But it has not *prevented* them from occurring, as is the case in the Everglades.

2. *Everglades—Caught in a Quagmire and Unable to Move*

While restoration successes in the Grand Canyon remain elusive, at least there have been a set of experimental management actions from which learning has occurred. This is in sharp contrast to the Everglades, where massive amounts of money have not been able to overcome bureaucratic inertia. Unlike the Glen Canyon AMP, the Everglades restoration process has been managed and coordinated by a much less formal structure. Everglades restoration has been guided by largely parallel efforts by the state and federal governments, with coordination by the Corps of Engineers. The resulting leadership vacuum has led the National Research Council to conclude that, if the problems of insufficient political leadership continue to plague research and management efforts in the Everglades, "the Restoration Plan could become an abbreviated series of disconnected projects that ultimately fail to meet the restoration goals."[273]

The Everglades restoration effort continues to be characterized by ever more planning rather than any on-the-ground action. The initial ideas for restoration of the wetlands date back well over two decades. Yet, after many planning and administrative programs as well as an

270. Lance Gunderson, *Resilience, Flexibility and Adaptive Management—Antidotes for Spurious Certitude?*, 3 CONSERVATION ECOLOGY art. 7 (1999), http://www.consecol.org/vol3/iss1/art7/. Current plans are attempting to restore some of that resilience through the development of supplemental breeding programs.

271. SCORE, *supra* note 268, at 36.

272. Hughes et al., *supra* note 14, at 589.

273. *Accelerate Pace of Everglades Restoration*, MIAMI HERALD, Oct. 4, 2008, at 20A (providing excerpts from COMM. ON INDEP. SCIENTIFIC REVIEW OF EVERGLADES RESTORATION PROGRESS, *supra* note 2).

abundance of resources, the ecosystems continue to founder with little or no progress. Even though it is mandated by federal legislation, the social-ecological system has failed to adopt an adaptive management approach. That is, time after time experiments have been proposed, but never implemented. This inability to act indicates a pathological type of resilience or a trap,[274] and the CERP remains in a political straight jacket. The reasons for this pathology are unclear, but can be related to a lack of trust and an unwillingness among the group charged with implementing CERP to make any real attempts at the experimentations needed to discover the path to restoration.

Granted, one measure of restoration success can be seen in the removal of anthropogenic phosphorous from the system. However, it took a federal Clean Water Act lawsuit to stimulate this accomplishment.[275] Even so, while phosphorous levels have dropped significantly, they are still too high to prevent the continued degradation of the Everglades. "Cattails were still spreading like a tumor . . . so the Everglades [were] still dying—just a bit slower than before."[276] When compliance deadlines were missed, the parties found themselves back in federal court. Expressing frustration at Florida's continuing failures to prevent phosphorous exceedances in and around the Everglades, the court found that the state was in violation of the court-ordered consent agreement and also remarked that the state's promises to improve water quality were void of any real commitment: "Essentially, the [South Florida Water Management] District is stating 'all is well' and nothing more needs to be done except further meetings and studies."[277] The following year in a separate suit brought by the Friends of the Everglades and other environmental groups, the court found that, "[t]o date, very little progress has been made in constructing any of the CERP projects."[278] In fact, the judge explicitly noted that there is "no guarantee" that the federal-state cost-shared projects "will ever be implemented."[279] Although Florida had authorized SFWMD to issue $1.8 million in bonds to "accelerate" eight of the CERP projects, in large part because of the "slow progress of the

274. Gunderson & Light, *supra* note 22, at 324.

275. United States v. S. Fla. Water Mgmt. Dist., 373 F. Supp. 2d 1338, 1347 (S.D. Fla. 2005) (describing CWA action initially lodged by the U.S. in 1988 and a settlement agreement between the parties and the Miccosukee Tribe in 1991); *see supra* notes 146–48 and accompanying text (describing CWA citizens' suits).

276. *See* MICHAEL GRUNWALD, THE SWAMP: THE EVERGLADES, FLORIDA, AND THE POLITICS OF PARADISE 358 (2006) [hereinafter GRUNWALD, SWAMP].

277. *S. Fla. Water Mgmt. Dist.*, 373 F. Supp. 2d at 1347.

278. Friends of the Everglades, Inc. v. S. Fla. Water Mgmt. Dist., No. 02-80309, 2006 WL 3635465, at *28 (S.D. Fla. Dec. 11, 2006).

279. *Id.* at *28.

CERP," the court pointed out that there is no legally binding requirement that "mandates completion of the Acceler8 projects."[280]

In 2008, in yet another case brought by the Miccosukee Tribe, another federal district court opinion found that the EPA had ignored the requirements of the Clean Water Act for satisfying water quality standards when it approved the state's revised schedule for cleaning up phosphorous-laden water flowing into the Everglades from Lake Okeechobee.[281] At issue were changes to the Everglades restoration program approved by Florida lawmakers and then-Governor Jeb Bush in 2003. According to the court, Florida "violated its fundamental commitment and promise to protect the Everglades" by relaxing rules limiting the amount of phosphorus in the Everglades ecosystem, and the EPA, for its part, turned a "blind eye" to the state's lower standards.[282] A goal of ten parts per billion had been set, with a deadline of 2006. In an effort to satisfy this requirement, the SFWMD began building special treatment marshes to filter the polluted runoff in water flowing south. "But in 2003, the sugar industry pushed a bill through the Legislature that replaced the 2006 deadline with a gradual schedule of benchmarks that don't begin until 2016."[283] The court described the new law as "an adroit legislative effort to obscure the obvious,"[284] in creating "an escape clause that allows non-compliance."[285] As a result of these delays and others, the cost of the CERP is now estimated at $10.9 billion, and completion is not anticipated until the 2030s or 2040.[286]

The latest chapter in this saga further complicates Everglades restoration. In July 2008, it was announced that U.S. Sugar Corporation would sell its holdings in the Everglades Agricultural Area ("EAA") to the state of Florida.[287] The state has agreed to purchase nearly 188,000 acres of land on the eastern and southern shores of Lake Okeechobee.[288] The decrease in sugar production will likely diminish phosphorous inputs. Yet if the sugar fields were to be replaced with

280. *Id.* at *29.
281. Miccosukee Tribe of Indians v. United States, No. 04-21448-CIV, 2008 WL 2967654 (S.D. Fla. July 29, 2008).
282. *Id.* at *1.
283. Scott Hiaasen & Evan Benn, *Judge: Glades Cleanup Ignored*, MIAMI HERALD, July 30, 2008, at 2B.
284. *Miccosukee Tribe*, 2008 WL 2967654 at *15.
285. *Id.* at *20.
286. Thomas F. Armistead, *Cash and Commitment Rescue Everglades Replumbing: Proof of Program's Success Remains Decades Away*, 8 SOUTHEAST CONSTRUCTION 50 (2008), *available at* http://southeast.construction.com/features/archive/0806_Feature4.asp.
287. Peter N. Spotts, *Game-changer in the Everglades*, CHRISTIAN SCI. MONITOR, July 2, 2008, at 13.
288. *Id.* Florida planned to purchase land, equipment, rail lines, and sugar mills for around $1.75 billion. *Id.* However, a shrinking state budget is likely to scale

urban development or other types of agriculture, an even greater nutrient management problem may arise.

Along with the CWA litigation and the recent sugar buy-out, the ESA continues to play a role in restoration efforts as well, but its accomplishments to date have been somewhat less tangible. Populations of the American crocodile in Florida have improved,[289] but other listed species continue to struggle and new species have been added to the list.[290] The National Research Council recently concluded that, despite the existence of the South Florida Multi-Species Recovery Plan, "no scientifically credible plan exists for managing multiple species at risk in South Florida."[291] It explained that a "stronger conceptual basis for multi-species planning and management" is needed, and recommended that "the Department of the Interior should lead the development of a South Florida multi-species adaptive management strategy to accompany the South Florida Multi-Species Recovery Plan."[292]

The Multi-Species Plan was intended to be a "living document, with the flexibility to accommodate changes identified through further research and to be compatible with adaptive management strategies."[293] However, in the Everglades, as in the Grand Canyon and elsewhere, it is difficult, if not impossible to experiment with endangered taxa.[294] Ecological resilience is needed for experimentation; it

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back the scope of the deal significantly. Damien Cave, *Everglades Restoration Plan Shrinks*, NEW YORK TIMES, Apr. 1, 2009, at A18.

289. *See* Endangered and Threatened Wildlife and Plants; Reclassifying the American Crocodile Distinct Population Segment in Florida from Endangered to Threatened and Initiation of a 5-Year Review, 70 Fed. Reg. 15,052, 15,952 (Mar. 24, 2005) (to be codified at 50 C.F.R. pt. 17) ("[S]ince its listing in 1975, the American crocodile population in Florida has more than doubled, and its distribution has expanded.").

290. Several species have been listed since the adoption of the Multi-Species Plan, perhaps most notably the elkhorn and staghorn corals. Endangered and Threatened Species: Final Listing Determinations for Elkhorn Coral and Staghorn Coral, 71 Fed. Reg. 26,852 (May 9, 2006) (to be codified at 50 C.F.R. pt. 223). These listings, in particular, "bring[ ] into sharp relief the intertwined relationship of water quantity and water quality in southern Florida," and, as such, could have significant impacts on Everglades restoration efforts. Robin Kundis Craig, *Acropora spp.: Water Flow, Water Quality, and Threatened Florida Corals*, 22 NAT. RESOURCES & ENV'T 8, 8 (2007).

291. *Accelerate Pace of Everglades Restoration*, *supra* note 273; *see* COMM. ON INDEP. SCIENTIFIC REVIEW OF EVERGLADES RESTORATION PROGRESS, *supra* note 2, at 99 ("The . . . Plan . . . provides practically no guidance on how to manage trade-offs among species, to set priorities, or to deal with regulatory requirements and conflicts.").

292. *Id.*; *see supra* notes 178–83 (describing the recovery plan).

293. DAWN JENNINGS, MULTI-SPECIES RECOVERY PLAN USES HOLISTIC, ECOSYSTEM APPROACH ¶ 6 (2003), http://sofia.usgs.gov/sfrsf/plw/msrp.html.

294. *See* J.M. Volkman and W. E. McConnaha, *Through a Glass, Darkly: Columbia River Salmon, The Endangered Species Act, and Adaptive Management*, 23

provides the buffer against mistakes, so if there is no resilience, then one cannot adaptively manage populations.[295] Perhaps for this reason, the FWS's track record with respect to adaptive implementation of recovery and habitat conservation plans is not terribly good. FWS regulations allow both the agencies and the developers "to avoid meaningful participation and to ignore adaptation."[296] Interested stakeholders (other than the developer) are relegated "to a narrow and late role," with opportunities for participation arising only *after* the FWS and the developer have negotiated the significant substantive components of the plan. The FWS admits that placing discretion in the hands of the developer limits stakeholder involvement in the development of many HCPs and "inhibit[s] experimental design and thus the effectiveness of the adaptive-management approach."[297]

Further diminishing the opportunities for adaptive management, compliance monitoring is typically "deficient, if not entirely absent, and subsequent adaptation of HCPs to integrate new information or changed circumstances acquired during implementation is even rarer."[298] The FWS's regulations require HCPs to specify the monitoring measures to be used during plan implementation to ensure the permit's terms and conditions are met,[299] but "neither the ESA nor the implementing regulations specify *who* must conduct the monitoring, leaving considerable discretion to the negotiating parties to shape an HCP's monitoring program."[300] Between the lack of adequate implementation funding and the lack of oversight, monitoring programs have almost invariably fallen short of adaptive management goals.

> The most exhaustive empirical study to date on the science of HCPs found that monitoring plans usually are nonexistent or inadequate as a tool for compliance. Only half of the forty-three HCPs analyzed contained clear descriptions of effects-and-effectiveness monitoring programs. Furthermore, only 5 percent adopted a monitoring strategy sufficient to evaluate the success of the

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ENVTL. L. 1249 (1993) (discussing adaptive management and the attempts to aid salmon recovery).

295. Gunderson, *supra* note 270.

296. Alejandro E. Camacho, *Can Regulation Evolve? Lessons From a Study in Maladaptive Management*, 55 UCLA L. REV. 293, 297 (2007) [hereinafter Camacho, *Evolve*].

297. *Id.* at 331 n.233 (citing Notice of Availability of a Final Addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process, 65 Fed. Reg. 35,242, 35,252 (June 1, 2000)).

298. *Id.* at 298. Likewise, in the implementation stage, "most HCPs rely exclusively on applicant self-reporting and limited Services oversight," largely because the decision whether to employ independent peer review during HCP implementation is left to the developer's discretion. *Id.* at 316.

299. 50 C.F.R. §§ 17.22(b)(3) (endangered species; permits for scientific purposes, enhancement of propagation or survival, or for incidental), 17.32(b)(3) (2008) (threatened species; permit conditions).

300. Camacho, *Evolve*, *supra* note 296, at 325 (emphasis added).

> HCP—that is, the plan's effects on the listed species or overall habitat, or the effectiveness of mitigation strategies.[301]

Finally, and perhaps most problematic for adaptive management objectives, the No Surprises rule places the burden on the FWS if unforeseen circumstances arise during HCP implementation.[302] Given the long life of many HCPs[303] and the uncertainties surrounding the species' response to any given development proposal (much less the cumulative effects of other development proposals and preexisting development) and the species' ability to cope with new threats or changing circumstances, unforeseen circumstances are almost certain to arise at some point during the HCP's lifespan.[304] Yet the No Surprises rule gives the FWS "a strong financial disincentive to engage in adaptation."[305] Similarly, the Colorado River Multi-Species Conservation Program offers "more legal certainty to those responsible for the ongoing harm"—the irrigators and hydroelectric power operators—"than it does to the protected species."[306] It places all of the risk of uncertainty on the species or on the federal government, not on the stakeholders who benefit from status quo operations.[307]

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301. *Id.* at 326 (citing PETER KAREIVA ET AL., NAT'L CTR. FOR ECOLOGICAL ANALYSIS & SYNTHESIS WORKING GROUP, USING SCIENCE IN HABITAT CONSERVATION PLANS 28–29 (1999) and describing a study initiated by the American Institute for Biological Studies).

302. 50 C.F.R. §§ 17.22(b)(5), 17.32(b)(5). For additional details about the No Surprises program, see Fred P. Bosselman, *The Statutory and Constitutional Mandate for a No Surprises Policy*, 24 ECOLOGY L.Q. 707, 722–23 (1997).

303. Many HCPs span fifty years. Karin P. Sheldon, *Habitat Conservation Planning: Addressing the Achilles Heel of the Endangered Species Act*, 6 N.Y.U. ENVTL. L.J. 279, 307 (1998). The South Florida Multi-Species Plan has a twenty-year lifespan. U.S. FISH & WILDLIFE SERV., *supra* note 179, at xi. As a recovery plan, rather than an HCP, the Multi-Species Plan does not itself include an incidental take permit but instead guides subsequent permit issuance.

304. *See* COMM. ON RESTORATION OF THE GREATER EVERGLADES ECOSYSTEM, *supra* note 126, at 7 (describing uncertainties implicated by the Comprehensive Everglades Plan, including uncertain historical hydrologic conditions, uncertainties related to the natural variability of ecological systems and model applications, and uncertain ecosystem responses to climate change and other changing system processes).

305. Camacho, *Evolve*, *supra* note 296, at 332. Unforeseen circumstances are "quite common in the HCP context given the substantial uncertainty typically present when an HCP is approved." *Id.*

306. ADLER, TROUBLED SENSE, *supra* note 1, at 180.

307. *Id.* at 182; *see* Camacho, *Evolve*, *supra* note 296, at 332 (stating that the No Surprises rule "places the financial burden on the Services if unforeseen circumstances arise during implementation requiring alterations to the HCP. Thus, in addition to providing applicants the incentive to limit adaptation from the outset, the HCP program's regulations furnish the Services with a strong financial disincentive to engage adaptation beyond the few circumstances provided for in the initial HCP.").

As noted above, the success of the South Florida Multi-Species Plan is closely tied to the successful implementation of the CERP.[308] The CERP itself is flawed, however, both because of compromises made to ensure passage and because of the influence of stakeholder politics in implementation. In the days leading up to the congressional vote, "[t]here was intense pressure to stay 'on message,' to stop quibbling over details, to avoid discrediting CERP."[309] Even a leading national environmental group, the Audubon Society, declared that "'we will continue to seek improvements in the bill to increase restoration benefits—as long as they do not endanger its enactment.'"[310] The plan under consideration, however, was the same plan that Everglades National Park scientists had said "'does not represent a restoration scenario for the southern, central and northern Everglades.'"[311] As a result, the final version of CERP failed to guarantee no harm, much less affirmative improvements, to the Everglades;[312] rather it merely ensured that "no one's level of water supply or flood control would be reduced" and "[n]obody's ox would be gored by CERP."[313] As a result, rather than curing south Florida's growth addiction, CERP feeds it.[314]

Everglades officials point to the Kissimmee River restoration as a leading example of federal efforts to coordinate conservation efforts on multi-jurisdictional lands and waters.[315] In 1971, as part of the C&SF project, a 100-mile meandering river was straightened into a fifty-mile canal, causing thousands of acres of wetlands to dry up, over ninety percent of the waterfowl to disappear, native fisheries to crash,

308. *See supra* notes 182–83 and accompanying text.

309. GRUNWALD, SWAMP, *supra* note 276, at 341.

310. *Id.*

311. *Id.* A staff member of the park's science team told reporters that CERP, as enacted, "would do next to nothing for the environment: . . . the emperor has no clothes." *Id.* at 343–44 (citing Robert Johnson, as quoted in Michael Grunwald, *In Everglades, a Chance for Redemption,* WASH. POST, Sept. 14, 2000, at A1).

312. *Id.* at 341; *see supra* note 110, at 1181 (noting concern that restoring flows to Everglades National Park may compromise ecologically important tree islands in the Central Everglades and increase turbidity in Central Florida Bay).

313. GRUNWALD, SWAMP, *supra* note 276, at 343.

314. *Id.* at 366. "The project aims to supply enough water to help the region double its population, which will increase the demands on aquifers and wetlands that prompted the project in the first place." *Id.* Within the first decade, CERP is expected to store enough water to support six million more south Florida residents. *Id.* at 321.

315. SANDRA POSTEL & BRIAN RICHTER, RIVERS FOR LIFE: MANAGING WATER FOR PEOPLE AND NATURE 64, 197 (2003) (describing implementation of and potential benefits from adaptive management in Kissimmee River restoration); Michael Grunwald, *An Environmental Reversal of Fortune: The Kissimmee's Revival Could Provide Lessons for Restoring the Everglades,* WASH. POST, June 26, 2002, at A01 [hereinafter Grunwald, *Environmental Reversal*] (describing successes of the Kissimmee project, and its potential as a precedent for the more ambitious Everglades restoration effort).

and tons of contaminated runoff to blast its way into Lake Okeechobee.[316] Following a series of scientific studies in the 1970s through the early 1980s, which documented this environmental degradation, the Corps submitted a plan to restore the river in the mid-1980s. The plan was rejected by Congress as too expensive.[317] The state of Florida, led by then-Governor Graham, stepped into the breach and assumed responsibility for Kissimmee restoration. Working through the South Florida Water Management District, scientists and engineers approached this restoration using adaptive management principles.[318] Models were built to help guide questions of what experiments should be done in the field. After a series of experiments on how the meandering river might be restored, while still maintaining transportation and flood control objectives, the managers and scientists demonstrated the feasibility of restoration. In 1999, the Corps began to backfill a portion of the canal, raze two of its six control structures, and purchase floodplain properties from willing sellers.[319] The benefits to the river were "instant and obvious"—wading birds and sportfish are thriving and water quality has improved significantly.[320] The interesting part of this story is that, other than reverse engineering, the Corps played little or no part in the adaptive restoration of the Kissimmee. Instead it was the leadership within the state—particularly the Governor and the water management district—that led to restoration successes.

The Kissimmee project has taken place on a relatively small scale, but it has already been looked to as precedent for more ambitious restoration plans in the United States and elsewhere.[321] Officials from around the world—Brazil, Japan, Hungary, and England, to name a few—have taken field trips to the Kissimmee to observe its newly emerged sandbars, thriving fisheries, and marshes.[322] Closer to home, however, some federal officials have questioned whether the successes on the Kissimmee provide a realistic example for the Everglades restoration. A Corps employee expressed skepticism that the Everglades plan could possibly replicate the success of the Kissimmee

316. Grunwald, *Environmental Reversal*, *supra* note 315, at A01.
317. Light et al., *supra* note 147, at 141–44.
318. *Id.*
319. *Around the Corps: Kissimmee River Work*, 24 ENGINEER UPDATE 15 (September 2000); Grunwald, *Environmental Reversal*, *supra* note 315.
320. Grunwald, *Environmental Reversal*, *supra* note 315.
321. GRUNWALD, SWAMP, *supra* note 276, at 358.
322. *Id.* at 357. Federal and state politicians have predicted that the Everglades CERP will become the restoration blueprint for the San Francisco Bay, the upper Mississippi River, and the Great Lakes, as well as the Danube and Nile Rivers, the Pantanal of Brazil, and the Black, Baltic, and Aral Seas. *Id.* at 367. Meanwhile, the World Bank points to the CERP as a "paradigm of sustainable development, a worldwide guide for resolving the water conflicts that could dominate twenty-first-century geopolitics." *Id.*

project, noting that the Everglades plan is "a multipurpose water project instead of a restoration project, led by engineers instead of scientists, tightening human control of nature instead of removing barriers and letting nature heal itself."[323]

3. *Observations: Avoid Spurious Certitude*

One of the key lessons learned from both the Everglades and the Glen Canyon Dam restoration projects is that "providing ad hoc, vague directives for experimental, collaborative regulatory processes invites delay and indecision to the detriment of those resources harmed by inaction."[324] Although collaborative stakeholder groups can provide guidance to restoration scientists and managers "about the kinds of issues to study and the kinds of risks that are acceptable in formulating and conducting adaptive management experiments," restoration plans, to be successful, must be unfettered from rigid consensus building requirements and free to experiment "without constant micromanagement."[325]

Many managers and stakeholders assume that enough is known about how to restore complex systems, and hence the obstacles to restoration can be described as a lack of political will, a failure of agencies to implement statutory requirements for ecological integrity and species recovery, or shortcomings in the design or composition of the collaborative processes and groups involved. Yet, the etiology of particular restoration failures are much more complicated and characterized by large amounts of uncertainty. Seeking "spurious certitude" cannot be the ultimate goal, but it is precisely what most regulated entities and other stakeholders want.[326] If scientists cannot predict outcomes with a great degree of certainty, experimentation will not take place. As a result, both restoration plans (especially the Everglades plan) seem to be stuck on modeling and data collection, not resolving uncertainties and learning through active experimentation.[327] And restoration continues "to founder on the shoals of special interests."[328]

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323. *Id.* at 358 (quoting district employee Lou Toth in a 2002 statement to the Washington Post).

324. Camacho, *Conjecture*, *supra* note 224, at 953.

325. ADLER, TROUBLED SENSE, *supra* note 1, at 168.

326. Gunderson & Light, *supra* note 22, at 328; *see* Tarlock, *supra* note 110, at 1173, 1198 (observing that managers and stakeholders expect adaptive management to be a "quick fix" to mitigate the most adverse environmental effects rather than to accomplish sustainable management of ecosystems).

327. Gunderson & Light, *supra* note 22, at 329.

328. *Id.* at 332.

B. Delegating the Task to a Multiple-Use Engineer-Dominated Agency May Be a Recipe for Failure

Our nation's leaders have long exhibited a tendency to place undue confidence in the "rational" discipline of engineering to solve our environmental problems.[329] Engineered solutions reflect the laws of mathematics and physics, and are evidenced by tangible, concrete outcomes (both literally and figuratively).[330] As such, they seem immutable to decision-makers and the public. In contrast, under the scientific method utilized in ecology, biology, and other earth sciences, a thesis may only stand until subsequent revelations push it aside.[331] Uncertainty is the name of the game. In the hurly-burly of ecosystem management, this often means that ecologists and biologists, charged with protecting endangered species and ecological function, get short shrift.[332]

Reliance on engineering is deeply embedded in federal water management because it is deeply embedded in the mindset of the Corps of Engineers, which was the first federal agency to involve itself in water-related affairs.[333] But engineering cannot solve all of our problems, nor can it be utilized as the sole or even predominant solution to restoration problems. Indeed, engineering can be counterproductive. According to the Society for Ecological Restoration International, an ecosystem is restored "when it contains sufficient biotic and abiotic resources to continue its development *without further assistance or subsidy*. It will sustain itself structurally and functionally. It will demonstrate resilience to normal ranges of environmental stress and disturbance."[334]

Achieving this restoration goal in the Grand Canyon would require the restoration of natural processes in significant portions of broad,

329. A. Dan Tarlock, *A First Look at a Modern Legal Regime for a "Post-Modern" United States Army Corps of Engineers,* 52 U. KAN. L. REV. 1285, 1315–16 (2004) [hereinafter Tarlock, *First Look*].

330. Sandra Zellmer, *A Tale of Two Imperiled Rivers: Reflections from a Post-Katrina World*, 59 FLA. L. REV. 599, 611 (2007) [hereinafter Zellmer, *A Tale*] (citing Oliver Houck, *Can We Save New Orleans?*, 19 TUL. ENVTL. L.J. 1, 55 (2006)).

331. For an in-depth look at the role of science in endangered species protection, see Doremus, *Mandate*, *supra* note 101, at 409–11.

332. Zellmer, *A Tale*, *supra* note 330, at 611–12.

333. U.S. Army Corps of Engineers, A Brief History: Improving Transportation, http://www.usace.army.mil/History/Pages/Brief/03-transportation/transport.html (last visited Jan. 13, 2009). Its authorities were expanded by subsequent enactments and by Executive Order. COMM. TO ASSESS THE U.S. ARMY CORPS OF ENG'RS WATER RES. PROJECT PLANNING PROCEDURES, NAT'L RESEARCH COUNCIL, NEW DIRECTIONS IN WATER RESOURCES PLANNING FOR THE U.S. ARMY CORPS OF ENGINEERS 11, 15–16 (1999).

334. SOC'Y FOR ECOLOGICAL RESTORATION INT'L SCI. & POLICY WORKING GROUP, THE SER INTERNATIONAL PRIMER ON ECOLOGICAL RESTORATION § 3 (2004), *available at* http://www.ser.org/pdf/primer3.pdf (emphasis added).

shifting riparian zones, which would, in turn, "require a partial retreat from the water's edge."[335] This is precisely the opposite of what is happening on the ground. On the lower Colorado, for example, the Corps of Engineers issued over 150 permits for dredging, filling, and other activities that alter or destroy riparian habitat to facilitate docks, boat ramps, subdivisions, and the construction or maintenance of flood control structures in a period of less than three years in the mid-1990s.[336] Meanwhile, according to an investigative report by the St. Petersburg Times, the Corps "approves more permits to destroy wetlands in Florida than any other state. . . . Between 1999 and 2003, it approved more than 12,000 wetland permits and rejected one."[337]

If the Grand Canyon experience is any indication, agencies within the Department of Interior are doing a better job of ecosystem restoration. There are at least two plausible reasons for this. For one thing, there are numerous agencies housed within the Department, ranging from agencies with biological expertise (the FWS) and broad-based scientific underpinnings (the U.S. Geological Survey) to preservation and recreation agencies (the National Park Service) to commodity-oriented agencies (the Bureau of Reclamation and Bureau of Land Management). Each of these agencies has a voice in the Secretary's office as well as with the Department's in-house attorney, the Solicitor of the Interior. As a result, conflicting positions within the Interior may be more likely to be aired, discussed, and ironed out before they ossify, and agencies within the Interior may be more culturally acclimated to compromise than a military-oriented, engineering agency like the Corps of Engineers. In addition, each of the resource management agencies within the Interior has relatively clear parameters placed on their management discretion. The FWS and the Park Service must conserve federally listed species and National Park resources, respectively, from jeopardy and impairment,[338] while the Bureau of Land Management must not only provide for optimum yields of range and timber resources, but must also give priority to areas of critical environmental concern and prevent unnecessary or undue degradation of the public lands under its jurisdiction.[339] The Bureau of Reclamation

335. ADLER, TROUBLED SENSE, *supra* note 1, at 242. Adler notes that this restoration goal would require "acceptance that private property rights do not apply to public, or 'unownable,' resources within the land-water transition zone." *Id.*; *see* Klein & Zellmer, *supra* note 73 (calling for a new vision of property at the water's edge).

336. ADLER, TROUBLED SENSE, *supra* note 1, at 56 (citing U.S. FISH & WILDLIFE SERV., BIOLOGICAL AND CONFERENCE OPINION ON LOWER COLORADO RIVER OPERATIONS AND MAINTENANCE—LAKE MEAD TO SOUTHERN INTERNATIONAL BOUNDARY 116 (1997)).

337. Craig Pittman & Matthew Waite, *They Won't Say No*, ST. PETERSBURG TIMES, May 22, 2005, at 1A.

338. *See supra* Part II.B.3.

339. 43 U.S.C. §§ 1712, 1732(b) (2000).

is charged with constructing and delivering water from federal reclamation projects, but it too has been charged with several significant restoration projects as well.[340] When agencies disagree, the "buck stops" at the Secretary's office for resolution.

By comparison, the Corps's discretion to proceed with a project whenever benefits "to whomsoever they accrue" exceed costs has left the American public with hundreds of dams, levees, and other structures justified only by "inflated and methodologically unsound benefit-cost analysis techniques."[341] An example can be found in the National Research Council's indictment of the misguided cost-benefit methodology used by the Corps to justify replacing locks and dams on the upper Mississippi.[342] Decisions are often based on "political vote trading in Congress," rather than principled reasoning and evidence, and "the 'iron triangle'—consisting of the Corps, powerful Congressional committee chairs, and local project proponents—reduce[s] the executive branch's role to screening out the least justified projects . . . rather than budgeting for an optimum set of projects derived via a carefully developed planning process."[343] Moreover, judicial intervention has only rarely curbed the Corps's activities; deference to the agency runs high, in large part because of the lack of legislative parameters.[344]

C. Adaptive Management is a Key Ingredient

Adaptive management requires a sustained commitment to experimentation from managers and stakeholders, many of whom would much prefer finality and certainty. The National Research Council

340. *See* Reed D. Benson, *Dams, Duties, And Discretion: Bureau of Reclamation Water Project Operations and the Endangered Species Act*, 33 COLUM. J. ENVTL. L. 1 (2008) (describing changes in reclamation practices compelled by ESA requirements); Bureau of Reclamation, Mission Statement, http://www.usbr.gov/main/about/mission.html (last visited Jan. 13, 2009) (describing the agency's mission).

341. Daniel McCool, *The River Commons: A New Era in U.S. Water Policy*, 83 TEX. L. REV. 1903, 1906 (2005) [hereinafter McCool, *River Commons*] (citing COMM. TO ASSESS THE U.S. ARMY CORPS OF ENG'RS WATER RES. PROJECT PLANNING PROCEDURES, *supra* note 333, at 67–78); *see also* Oliver Houck, *Unfinished Stories*, 73 U. COLO. L. REV. 867, 939 (2002) ("In-depth and documented reports of . . . cost-benefit manipulations, false reporting, employees terminated for honesty, and humiliating servility to whatever Congress wants funding appear regularly in the media . . . with little effect."); Tarlock, *First Look*, *supra* note 329, at 1315 (critiquing the Corps's decision-making).

342. McCool, *River Commons*, *supra* note 341, at 1918–19.

343. Tarlock, *First Look*, *supra* note 329, at 1304.

344. *See, e.g.*, Marsh v. Or. Natural Res. Council, 490 U.S. 360, 378 (1989) (upholding the Corp's decision even though the court might have decided otherwise on its own); *In re* Operation of Mo. River Sys. Litig., 421 F.3d 618 (8th Cir. 2005) (upholding the Corps's operation of dams on the Missouri River); *see also* Houck, *Unfinished Stories*, *supra* note 341, at 939 ("Immune from the president and in large part from the courts, . . . there is no reason, fiscal, environmental, or otherwise, that appears able to stop them").

has consistently concluded that adaptive management is an important component of river restoration and ecosystem management.[345] Indeed, "[a]daptive management is most sorely needed when the resource is suffering under the status quo, we do not fully understand why or what changes will most effectively remedy the situation, and we are under heavy economic or political pressure to minimize changes to the status quo,"[346] such as the Colorado River and Florida Everglades.

The highly political nature of many regulatory decisions can be a significant impediment to adaptive measures. Maintaining a commitment to adaptive management techniques may be especially difficult when deeply entrenched legal rights or interests are concerned. Water users on western rivers like the Colorado River have expectations, and in some cases vested property rights, in the use of water from the river and its tributaries under prior appropriation water laws.[347] Although riparian systems in the eastern states tend to look less like property rights, water users in Florida received congressional assurances that their expectations, or "existing legal sources" of water, would not be depleted by CERP implementation.[348] In both cases, decision-makers can be reluctant to experiment and take advantage of feedback loops for fear of resistance from vested interests.[349]

Adaptive management may also be hindered by legal obstacles posed by the ESA, which requires consultation for all discretionary federal actions that may adversely affect a listed species or its critical habitat.[350] Adaptive management requires sufficient flexibility in applicable management mandates and sufficient resilience in ecological resources in order to experiment. Endangered or threatened taxa do not have such resilience and so it is difficult to conduct experiments in which the outcome can just as easily cause further endangerment as it

345. WATER SCI. & TECH. BD., NAT'L RESEARCH COUNCIL, THE MISSOURI RIVER ECOSYSTEM: EXPLORING THE PROSPECTS FOR RECOVERY 4 (2002).

346. Doremus, *New Age*, *supra* note 230, at 71.

347. *See* Sandra B. Zellmer & Jessica Harder, *Unbundling Property in Water*, 59 ALA. L. REV. 679 (2008) (explaining the protection of senior water uses under the western prior appropriation doctrine and concluding that rights to use water typically do not exhibit all of the facets of legally protected "takings" property but could be considered property for due process or other purposes).

348. *See supra* note 174 and accompanying text.

349. *See supra* notes 189–98, 208–10 and accompanying text (describing water rights in Florida and on the Colorado River). Regulatory curtailment of private property rights can trigger claims for compensation under the Fifth Amendment. *See, e.g.*, Tulare Lake Basin Water Storage Dist. v. United States, 49 Fed. Cl. 313 (2001) (siding with water users when the Bureau of Reclamation curtailed contract allowances from a reclamation project in order to provide flow for endangered species).

350. 16 U.S.C. § 1536(a) (2006).

can result in recovery. In this instance, managers should seek to restore resilience and decrease vulnerability of species.[351]

In cases where adaptive management has been successful, strong leadership has emerged. That leadership has supported an adaptive approach and allowed for successful learning. Leadership is not singular, and indeed relies on multiple individuals who have helped guide the system through uncharted scientific, social, and political waters. In the Kissimmee River, it was the Governor of Florida, the director of the water management district, and the project manager who filled these roles.[352] More broadly, however, since the passage of the CERP authorization in 2000, leadership has been absent from the Everglades, to the extreme detriment of CERP implementation. The Glen Canyon AMP benefited from the strong leadership of the Secretary of Interior as well as the willingness to take lead roles by other individual and institutional actors in the system, including the Director of the Grand Canyon Monitoring and Research Center, the Directors of the Bureau of Reclamation and the National Park Service, and the Superintendent of Grand Canyon National Park. It is this type of leadership that has allowed adaptive management to proceed, as limited as it has been. Thus, leadership that supports and allows flexible and adaptive approaches that actively probe uncertainties of complex resource issues is a key ingredient of adaptive governance and of restoration success.

V. CONCLUSION: A RESTORATION RX[353]

It will likely take broad-sweeping, generally applicable national legislation, such as an Ecosystem Restoration Act, to shake loose the existing maximum sustained yield mindset of natural resources management and replace it with adaptive, resilience-informed approaches. We do not see this symposium Article as the appropriate forum for prescribing any particular set of statutory reform provisions. Based on the lessons explicated above, however, we do see it as a vehicle for making the following "big picture" suggestions regarding principles to be followed:[354]

(1) Adapt and learn. Adopt adaptive management objectives and processes that require experimentation, monitoring, and learning from feedback loops.

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351. *See supra* notes 267–71 and accompanying text.

352. *See supra* notes 315–20 and accompanying text.

353. Alyson Flournoy deserves the credit for coining this phrase in her article *Restoration Rx: An Evaluation and Prescription*, *supra* note 10, at 188.

354. These points are derived in part from Zellmer, *A Tale*, *supra* note 330, at 628–29 (describing features of a proposed Interior Rivers Ecosystem Act that would constitute a comprehensive organic act for the Corps of Engineers).

(2) Live within our means. Prioritize measures that promote ecological resilience and societal flexibility, rather than measures that may seem economically desirable for the short-term but are unsustainable in the long run. Rather than relying on engineered devices to restore degraded ecosystems, strive to restore and maintain natural function.

(3) Enhance institutional leadership and adaptive governance. Provide the Corps and management agencies within the Department of Interior with ecologically based priorities, continuing monitoring responsibilities, and oversight through probing judicial review, along with a secure funding source for ongoing monitoring and adaptation. Collaborative stakeholder programs should be used to make decisions about societal values and priorities "but not to micromanage program implementation in ways that render those goals and choices impossible to attain."[355]

That said, we do not recommend wholesale dismantling of existing statutes governing endangered species recovery, National Park System management, and pollution control, but we do believe that some regulatory reform may be required to ensure adaptive implementation of these statutes to better achieve their explicit goals. By contrast, extant Flood Control Acts require a complete overhaul to mandate adaptive management and ecological restoration, and to move the Corps of Engineers away from the unbounded cost-benefit analysis currently in place. As described in other articles by one of these authors, a comprehensive organic act to govern the Corps's activities would be far more beneficial, in terms of ecosystem management and restoration as described in this Article, than the existing hodgepodge collection of flood control provisions and Water Resources Development Acts.[356]

Whether existing requirements are supplemented, modified, or rescinded, new legislation will require more than just a mandate that adaptive management be pursued. Stating that adaptive management should guide restoration in both the Everglades and Grand Canyon legislation has proved to be only marginally successful. Indeed, it has generated a few successes in the Grand Canyon and virtually none in the Everglades. Perhaps a beginning would be to have better legislative guidance on social values and priorities and fewer constraints on the scientific processes that underpin adaptive manage-

355. ADLER, TROUBLED SENSE, *supra* note 1, at 269.

356. *See* Zellmer, *A Tale*, *supra* note 330, at 628–29 (arguing that comprehensive organic legislation is needed); Klein & Zellmer, *supra* note 73, at 1535–37 (seeking a comprehensive reform of federal flood control requirements).

ment. Legal vehicles should enhance flexibility, learning, and adaptive approaches, rather than reinforce pathologically resilient institutions and ecosystems. There is little time to wait.