

LEGAL BARRIERS TO THE RESTORATION OF AQUATIC SYSTEMS AND THE UTILIZATION OF ADAPTIVE MANAGEMENT

INTRODUCTION

In large part, modern environmental law is based on the outdated assumption of ecology that there exists only one state of balance in nature—one state of equilibrium.¹ What has clearly emerged over the past twenty-five years of operating under laws that reflect this static view of nature, such as the Endangered Species Act (ESA) and sections of the Clean Water Act (CWA), is that multiple states of equilibrium exist and ecosystems are dynamic, rather than static.² This new fundamental understanding of ecology poses significant problems for the management of ecosystems and the regulation of activities that affect them. Ecosystem dynamics create the need to manage resources in the face of uncertainty because we are unable to know or understand all of an ecosystem's processes and the external influences which produce its dynamic character.³ Current legal and institutional frameworks do not recognize dynamic systems and are unable to manage these systems in the face of ever-present uncertainty.⁴

Uncertainty is prevalent in managing the environment because governmental agencies are charged with regulating activities or substances that create risk to public health or the environment.⁵ However, proving the risks of specific activities or substances is often difficult, if not impossible.⁶ Herein lies the basic conflict between the goal of protecting and restoring the environment and operating within the current regulatory framework of environmental law.⁷

Agencies are typically faced with the binary decision-making process of inaction or goal-oriented choices dictated by modern environmental laws. Agencies would do better to utilize a more flexible form of management that recognizes uncertainty and the need to adapt to changing knowledge.⁸ Unless agencies are able to move toward a management approach that is compatible

1. See A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121, 1122 (1994).

2. See *id.* at 1129; see also C.S. Holling, *The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change*, in SUSTAINABLE DEVELOPMENT OF THE BIOSPHERE 292, 296 (1986).

3. See Timothy H. Profeta, *Managing Without a Balance: Environmental Regulation in Light of Ecological Advances*, 7 DUKE ENVTL. L. & POL'Y F. 71, 75 (1996).

4. See Tarlock, *supra* note 1, at 1135; see also Profeta, *supra* note 3, at 73.

5. See Alyson C. Flourmoy, *Legislating Inaction: Asking the Wrong Questions in Protective Environmental Decisionmaking*, 15 HARV. ENVTL. L. REV. 327, 327-28 (1991).

6. See *id.*

7. See *e.g.*, Tarlock, *supra* note 1, at 1123; Flourmoy, *supra* note 5, at 328; Alyson C. Flourmoy, *Preserving Dynamic Systems: Wetlands, Ecology, and Law*, 7 DUKE ENVTL. L. & POL'Y F. 105-06 (1996).

8. See Flourmoy, *supra* note 5, at 360-61.

with dynamic ecological systems, the pattern of resource use that has plagued resource management will continue. This "pathology" has been identified by several authors, but is best described by C.S. Holling:

If natural levels of variation in system behavior are reduced through command-and-control, then the system becomes less resilient to external perturbations, resulting in crisis and surprises [This occurs] when resource management agencies, through initial success with command and control, lose sight of their original purposes, eliminate research and monitoring, and focus on efficiency of control. They then become isolated from the managed systems and inflexible in structure . . . through overcapitalization, society becomes dependent . . . and ignores the underlying ecological change or collapse that is developing.⁹

The recognition that managing institutions need to break from this approach in order to be effective raises the question of how this could be accomplished given current legal and institutional structures. The legal challenge is to maintain enough flexibility for institutions to manage systems that are in a constant state of flux, while providing the legal certainty required to satisfy procedural and substantive due process.¹⁰ The question this Note explores is whether enough flexibility currently exists or if substantial legal change is needed.

Part I describes the historical approach to resource management using the Newfoundland cod fishery collapse and the demise of the Florida Everglades ecosystem as examples. These examples demonstrate the inherent weakness of command-and-control approaches in maintaining natural system functions. Part II explains the concept of adaptive management and its growing acceptance as the new paradigm in resource management and restoration. Part III provides a detailed examination of the Everglades Nutrient Removal Project to illustrate the legal obstacles faced in the implementation of adaptive management. Finally, Part IV explores possible avenues for implementing adaptive management, given the current state of regulations, and offers insight into what must be done to fully reap the professed benefits of adaptive management.

9. C.S. Holling & Gary K. Meffe, *Command and Control, and the Pathology of Natural Resource Management*, 10 CONSERVATION BIOLOGY 328 (1995). (Professor C.S. Holling, the Arthur R. Marshall, Jr., Professor in Ecology at the University of Florida, Fellow of the Royal Society of Canada, and recipient of the Austria Cross of Honor for Arts and Sciences, edited the cornerstone text ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (1978) and is considered the father of the concept of adaptive management).

10. See Profeta, *supra* note 3, at 96.

I. THE COMMAND-AND-CONTROL PATHOLOGY: A LOSS OF SOCIAL AND ECOLOGICAL RESILIENCE

Adaptive management is currently heralded as the best technique to maintain and restore ecosystems.¹¹ The concept has evolved in large part because of the evident failure of past methods of resource management to manage forests, grazing lands, and fisheries.¹² C.S. Holling found that:

any attempt to manage ecological variables . . . inexorably led to less resilient ecosystems, more rigid management institutions, and more dependent societies . . . the very success of management seemed to set the condition for [resource and social] collapse. In each case the goal was to control a target variable . . . whose normal fluctuations imposed problems and periodic crisis [on people].¹³

This historical management process has led to more spatially homogenized ecosystems and systems that quickly shift or "flip" into degraded states because of disturbances.¹⁴ These degraded systems can no longer absorb human or natural disturbances—they have lost their "resilience."¹⁵ Resilience is the system's ability "to maintain its structure and patterns of behavior in the face of disturbance."¹⁶ Resilience is not the ability of a system to return quickly to an equilibrium state after disturbance—that is stability.¹⁷

The loss of resilience has occurred in marine, terrestrial, and aquatic systems across the continent. The harvest of timber in the Northern Boreal Forest, of cod in the waters off the Newfoundland coast, the diversion of water for power in the Columbia River basin, and agricultural and urban development in South Florida that has reduced the natural fluctuations in our ecosystems.¹⁸ Early success at reducing variables and maximizing resource

11. See, e.g., Tarlock, *supra* note 1; A. Dan Tarlock, *Environmental Law: Ethics or Science?*, 7 DUKE ENVTL. L. & POL'Y F. 193 (1996); Flournoy, *supra* note 5; John M. Volkman & Willis E. McConnaha, *Through a Glass Darkly: Columbia River Salmon, The Endangered Species Act, and Adaptive Management*, 23 N.W. SCH. L. LEWIS & CLARK C. ENVTL. L. 1249 (1993); Profeta, *supra* note 3.

12. See C.S. Holling, *What Barriers? What Bridges?*, in BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS 3, 6-7 (Lance H. Gunderson, et al. eds., 1995).

13. See *id.* at 6-7.

14. See *id.* at 8.

15. See *id.*

16. See Holling, *supra* note 2, at 296.

17. See *id.*

18. See Holling, *supra* note 12, at 10; see also Warren T. Coleman, *The Newfoundland Cod Fishery: A Loss of Social, Institutional and Ecological Resilience* (1995) (unpublished manuscript, on file with the Dept. of Zoology, U. Fla.).

utilization fueled the creation of resource extractive, economically dependent societies.¹⁹ It also ingrained political and governmental agency behavior and decreased the ability of natural and human systems to cope with crisis or surprise.²⁰ The following examples illustrate this pathology.

A. *The Newfoundland Cod Fishery Collapse*

In the recent case of the Newfoundland cod fishery collapse, agency and political rigidity resulted in overly optimistic estimates of fishery recovery following the creation of the Exclusive Economic Zone.²¹ This fueled a massive national investment into large scale, intense fishery harvest and away from more local, inshore harvest practices.²² When the inevitable collapse of the fish stock occurred, the cause of which is still disputed,²³ the social effect was felt by native fishermen who had previously been able to cope with natural fluctuations in yearly cod harvests.²⁴ These native fishermen, who always diversified their occupations to find other sources of income in years of low cod harvesting, were forced into large scale fishing operations not designed to cope with natural or human induced fluctuations in the fishery.²⁵ The Canadian government and the Department of Fisheries and Oceans eliminated this historical social resilience by perpetuating a myth of a recovering fish stock—a myth they erroneously embraced as fact—by fueling economic investment to reap the harvest of the stock that never recovered.²⁶

The Department of Fisheries and Oceans and the government also failed to acknowledge the uncertainty that comes with management of a resource such as a marine ecosystem, where knowledge is limited due to the system's

19. See Holling, *supra* note 12, at 8.

20. See *id.*

21. See Coleman, *supra* note 18, at 31 (Canada established a 200 mile zone of exclusive jurisdiction of Canadian waters, commonly known as the Exclusive Economic Zone (EEZ) that prohibited foreign fleets from fishing Canadian waters. This was in part a response to the economic collapse of the cod fishery that resulted from intense foreign cod harvest. This exclusive control over Canadian waters helped fuel optimism that Newfoundland could rebuild their cod stocks and become the sole economic beneficiaries of the resource).

22. See *id.* at 29, 31.

23. See generally Coleman, *supra* note 18; see also Loren Kellogg, *Atlantic Cod: Reorganization or Return?* (1995) (unpublished manuscript, on file with the Dept. of Zoology, U. Fla.) (stating that there are many theories that have been suggested for the cod fishery collapse which can be separated into two general categories: those associated with overfishing and those associated with changes in environmental conditions).

The moratorium on cod fishing in Newfoundland continues today and is not expected to be lifted for perhaps decades, resulting in a loss of a way of life and culture for many Newfoundland fishing communities. See Bill McKibben, *Hello, I Must Be Going*, *OUTSIDE*, Dec. 1997, at 58-62.

24. See Coleman, *supra* note 18, at 36.

25. See *id.* at 36-37.

26. See *id.*

inherent complexity.²⁷ Instead, they followed the pathology described by Holling in which "policies and management apply fixed rules for achieving constant yields, independent of scale, [which] lead to systems that increasingly lack resilience and break down in the face of disturbance that could previously be absorbed."²⁸ Holling's words describe not only the pattern that engulfed Newfoundland coastal society, but a pathology that destroyed the once bountiful cod fishery.

B. The Destruction and Restoration of the Everglades

The Everglades hydrologic system begins in the Central Florida Kissimmee chain of lakes near Orlando, flows into Lake Okeechobee, and then spreads southward into the Everglades.²⁹ The system extends approximately 500 kilometers from north to south and 100 kilometers from east to west,³⁰ with rainfall being the watershed's primary hydrologic input.³¹ Eighty percent of the rainfall occurs from mid-May through October, clearly delineating a wet and dry season.³²

Analysis of the Everglades case has produced four identifiable eras marking governmental and social response to natural surprise events that shaped the steady erosion of the natural system's resilience.³³ From the turn of the century to the mid 1940's, the era of "Cut'n Try" focused on efforts to drain the Everglades to produce farmland and control the natural flooding process.³⁴ This effort, led by then Governor Bonaparte Broward, included the creation of canals to control flooding.³⁵ However, natural events such as the

27. See *id.* at 42.

28. C.S. Holling et al., *Comparing Ecological and Social Systems*, AMBIOS (Journal of the Swedish Academy of Sciences, forthcoming 1998).

29. See Stephen S. Light & J. Walter Dineen, *Water Control in the Everglades: Historical Perspective*, in EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION 47, 51 (Steven M. Davis & John C. Ogden eds., 1994). The Everglades was once a subtropical wetland ecosystem of over one million acres in size. It is popularly described as the "River of Grass" because of Marjory Stoneman Douglas' landmark book that drew attention to the early plight of the ecosystem. Today this vast wetland is roughly half its former size with only one-fifth being held in Everglades National Park. Located in the southern portion of Florida, there has been unending pressure exerted upon the ecosystem as a result of the rapid increase in population and the associated need for water and water control. The story of how the Everglades was altered reflects the human desire to control a once wild system for the exclusive benefit of people who moved to the region.

30. See Stephen S. Light et al., *Evolution of Management in a Turbulent Ecosystem*, in BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS 103, 107 (Lance H. Gunderson et al. eds., 1995).

31. See *id.*

32. See *id.*

33. See *id.* at 116-19; see also Light & Dineen, *supra* note 29, at 53-83.

34. See Light et al., *supra* note 30, at 117; see also Light & Dineen, *supra* note 29, at 54.

35. See Light & Dineen, *supra* note 29, at 54-55.

flood of 1903 and hurricanes in 1926 and 1928 thwarted these efforts, destroying agricultural crops and taking people's lives.³⁶ Following these events, the Army Corps of Engineers erected the Hoover dike around Lake Okeechobee to control lake flooding.³⁷

The second era followed the most severe droughts on record in 1944 and 1945.³⁸ In 1947, Florida experienced unusually wet spring and summer seasons and was then hit with two hurricanes.³⁹ Another hurricane followed in 1948.⁴⁰ The Army Corps of Engineers initiated a federal project called the Central and South Florida Project for Flood Control that would forever alter the natural dynamics of the "River of Grass" known as the Everglades.⁴¹ The implementation of that project was referred to as "Turning Green Lines to Red," and so titled the era.⁴² The Central and South Florida Project for Flood Control sought to control the natural system and its annual fluctuations by partitioning the Everglades into areas for agriculture (Everglades Agricultural Areas or EAAs) and water conservation (Water Conservation Areas or WCAs), creating a system of levees around the agricultural areas south of Lake Okeechobee, and channelizing the Kissimmee River into a highly mechanized water delivery system.⁴³

As a result, "ignorance of . . . predrainage conditions was profound . . . the intent of the project would deprive the southern Everglades of 50% of the water inflows it had received in primeval times."⁴⁴ In the 1960s it became evident to Everglades National Park officials that managing water resources in central and southern Florida, while trying to maintain the natural ecological system of the Everglades (and its resilience), was a highly complex if not impossible task.⁴⁵ To the rest of the state, "the seemingly inexhaustible bounty of the region propelled South Florida even faster toward the direction of unrestrained growth [both in terms of agriculture and urban development]."⁴⁶

The third era, beginning in 1970, is called "No Easy Answers" because acknowledgment of water quality and water quantity problems arose on the heels of an extreme drought and prompted a search for better management

36. See Light et al., *supra* note 30, at 120.

37. See *id.* at 122.

38. See *id.* at 125.

39. See *id.*

40. See *id.*

41. See *id.* at 130.

42. See Light & Dineen, *supra* note 29, at 58.

43. See *id.* at 125-26.

44. *Id.* at 130-31.

45. See *id.* at 131.

46. *Id.* at 132.

methods.⁴⁷ Governor Reubin Askew, feeling political pressure to take action, convened a meeting of resource managers, policy makers, and interest group representatives to discuss the problems.⁴⁸ What emerged was the need for a new institution to replace the old Flood Control District, empowered with the necessary authority to develop and implement a comprehensive land and water use plan.⁴⁹ The South Florida Water Management District (SFWMD) was created pursuant to the Water Resources Act, which directed the agency to develop a plan as rapidly as possible.⁵⁰ Unfortunately, the 1978 plan was "focused on traditional structural solutions . . . and embraced more of an instrumental role of providing water when needed and removing water if too much occurred The plan showed little deference to natural system fluctuations."⁵¹ During this period growing water quality problems also emerged in Lake Okeechobee and the lower Kissimmee River Valley due to eutrophication.⁵² "The channelization of the Kissimmee . . . an intolerable ecological insult in its own right," was the suspected culprit, "sluicing sewage from Orlando directly to Lake Okeechobee."⁵³ This era was based on "the presumption [or myth] that institutions could be perfected and that resource problems could be solved [Thus] the agency pursued traditional failsafe, technological-fix strategies underpinned by the myth of comprehensive water control."⁵⁴

The last era, "Repairing the Everglades," continues today.⁵⁵ The extreme drought of 1981, followed by a flood in 1983, created a sense of severe crisis.⁵⁶ Governor Bob Graham responded by creating the "Save Our Everglades" (SOE) program.⁵⁷ The program's goal was to restore the Everglades to turn of the century conditions by the year 2000.⁵⁸ However, the program did not acknowledge the nutrient loading problems in Lake Okeechobee, the WCAs or the EAAs.⁵⁹ The SFWMD took action by

47. See *id.* at 132-33.

48. See *id.* at 133.

49. See *id.*

50. See FLA. STAT. ch. 373.036, 373.069 (1977).

51. Light et al., *supra* note 30, at 138.

52. See Louis A. Toth, *Principles and Guidelines for Restoration of River/Floodplain Ecosystems—Kissimmee River, Florida*, in REHABILITATING DAMAGED ECOSYSTEMS 49, 54-5 (John Cairns, Jr. ed., 1995).

53. Light et al., *supra* note 30, at 135 (citation omitted).

54. *Id.* at 139 (citation omitted).

55. *Id.* at 142.

56. *Id.*

57. See *id.*; see also Light and Dineen, *supra* note 30, at 48-49; 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).

58. See Light et al., *supra* note 30, at 142.

59. See *id.*

beginning restoration of the Kissimmee River. The SFWMD subsequently obtained approval from the Army Corps of Engineers for a large scale restoration of the "ecological integrity" of the system, the first Corps program to expressly seek restoration as its goal.⁶⁰ Concerns also shifted toward ending the eutrophication of Lake Okeechobee after a large algae bloom occurred on the lake in 1986.⁶¹ This prompted more legislation that established mandatory phosphorus reduction in the lake and a study of the effects of nutrients on the vegetation in the WCAs.⁶² The study concluded that "the diversion of nutrient-laden waters from the EAA had seriously damaged the biological integrity of the Everglades and, if left unchecked, could eventually damage the park."⁶³

The threat of eutrophication to the park and the Loxahatchee National Wildlife Refuge loomed large.⁶⁴ In 1988 a surprise occurred: the federal government filed suit against the SFWMD alleging that the state had violated water quality standards and water quality agreements between the state and the federal government.⁶⁵ The parties reached a settlement in 1991, but only after the expenditure of two years time and tens of millions of public and private dollars.⁶⁶ The agreement created a timetable for nutrient reduction and was followed by state legislation creating the Everglades Protection Act.⁶⁷ These state and federal actions prompted more legal action by farmers.⁶⁸ To avoid years of additional litigation, the SFWMD, state and federal governments, and agricultural interests reached a mediated agreement.⁶⁹ The basic plan, which continues today, calls for the creation of 42,000 acres⁷⁰ of manmade stormwater treatment areas (STAs) to filter agricultural runoff

60. See *id.* at 143.

61. See *id.* at 144. See also G.H. Snyder & J.M. Davidson, *Everglades Agriculture: Past, Present, and Future*, in EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION 85, 111 (Steven M. Davis & John C. Ogden eds., 1994).

62. See Light et al., *supra* note 30, at 144.

63. *Id.* at 145.

64. The Loxahatchee National Wildlife Refuge is located east of the Everglades Agricultural Area which lies to the south of Lake Okeechobee in the center of the state. The Loxahatchee National Wildlife Refuge is also synonymous with the area known as Water Conservation Area One. This area serves as the recipient of the water filtered by the Everglades Nutrient Removal Project referred to later in this note. See *id.* at 145-46.

65. See *United States v. South Fla. Water Management Dist.*, 922 F.2d 704, 706-07 (11th Cir. 1991).

66. See *United States v. South Fla. Water Management Dist.*, 28 F.3d 1563, 1568 (11th Cir. 1994); Light et al., *supra* note 30, at 145.

67. See *Everglades Forever Act*, FLA. STAT. ch. 373.4592 (1994).

68. See *United States v. South Fla. Water Management Dist.*, 847 F. Supp. 1567, 1569 (S.D. Fla. 1992); Light et al., *supra* note 30, at 145.

69. See Light et al., *supra* note 30, at 146.

70. See S. FLA. WATER MGMT. DISTRICT, EVERGLADES 1997 ANNUAL REP. 15; FLA. STAT. ch. 373.4592 (4)(a) (1994).

before it makes its way into what remains of the Everglades.⁷¹ This unfinished chapter in the Everglades' history continues to be written. However, the "fundamental conflicts among population, development, and ecosystem services remain unreconciled."⁷²

The major institutional problem illustrated by the Everglades case is that institutions fail "to learn (i.e. adapt to change) from experience and new information or knowledge."⁷³ Instead, they tend to follow a command-and-control paradigm that reduces the variation in a system's behavior and allows successful exploitation of and harvest from the system, much like the pathology described earlier in the Newfoundland Cod fishery collapse.⁷⁴ This approach "dampen[s] extremes of ecosystem behavior . . . to attain a predictable flow of goods and services or to reduce destructive . . . behavior of those systems."⁷⁵ The inevitable problems that arise from this command-and-control approach are the result of perturbations to the system which can no longer be absorbed and ultimately translate into events of crisis and surprise.⁷⁶ Another vivid example of such a pathology is the channelization of the Mississippi River which is controlled by locks and levees to "benefit agriculture, shipping and floodplain development."⁷⁷ Although the natural periodic flooding of the river has been reduced, the river and social system that depend upon it retain little resilience to extreme storm events such as the devastating flooding of 1993.⁷⁸

In addition to the command-and-control approach applied to resources by managing institutions, there is an equally destructive pathology that occurs within managing institutions and agencies themselves.⁷⁹ These institutions are successful in their initial attempts to "command-and-control" the natural system for human utilization.⁸⁰ Agencies then concentrate their efforts on increasing the efficiency of controlling the system or harvesting its resources instead of the original social and economic purpose.⁸¹ Focus shifts from "research and monitoring . . . to internal agency goals of cost efficiency and institutional survival."⁸² The result is "growing isolation of agency personnel

71. See FLA. STAT. ch. 373.4592 (4)(a) (1994).

72. Light et al., *supra* note 30, at 151 (citation omitted).

73. *Id.* at 157.

74. See Holling & Meffe, *supra* note 9, at 329.

75. *Id.*

76. See *id.* at 330.

77. See *id.* at 331.

78. See *id.*

79. See *id.*

80. See *id.*

81. See *id.*

82. *Id.*

from the systems being managed and insensitivity to public signals of concern . . . growing institutional myopia and rigidity."⁸³

C. Managing "Adaptively"

It is critical to understand and to identify this pathology because it has led to the demise of so many managed ecosystems. When this understanding is accomplished, the solution is obvious, though not simple: manage systems in a manner that maintains and restores resilience.⁸⁴ The road toward breaking the old pathology and moving toward more productive management requires adopting the principles of adaptive management.⁸⁵ Adaptive management requires:

- integrated policies, not piecemeal ones
- flexible, adaptive policies, not rigid locked-in ones
- management and planning for learning, not simply for economic or social product
- monitoring designed as part of active interventions to achieve understanding and to identify remedial response, not monitoring for monitoring's sake
- investment in eclectic science, not just in controlled science
- citizen involvement and partnership to build "civic science," not public information programs to inform passively.⁸⁶

While this laundry list appeals to common sense in the modern era of resource management, little of it has been practiced or even attempted until recently. However, the acceptance of adaptive management is growing quickly in academic and governmental circles.⁸⁷ The concept comes from the primary works of C.S. Holling and Carl Walters in 1978 and 1986 respectively.⁸⁸ In the legal field, academics view adaptive management in

83. *Id.*

84. *See id.*

85. *See* Holling, *supra* note 12, at 9; *see also* J.B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean Up the Environment by Making a Mess of Environmental Law*, 34 HOUS. L. REV. 933, 996-97 (1997).

86. Holling, *supra* note 12, at 9.

87. *See, e.g.*, Bruce P. Van Haveren et al., *Restoring the Ecological Integrity of Public Lands*, 52 J. SOIL & WATER CONSERVATION 226 (1997); U.S. ARMY CORPS OF ENGINEERS, PLANNING AND EVALUATING RESTORATION OF AQUATIC HABITATS FROM AN ECOLOGICAL PERSPECTIVE, IWR Report 96-EL-4 (D. Yazzo et al. eds., 1996) [hereinafter U.S. ARMY CORPS OF ENGINEERS]; Tarlock, *supra* note 1; Profeta, *supra* note 3; Flourmoy, *supra* note 5; Volkman & McConnaha, *supra* note 11; Ankersen & Hamann, *supra* note 57; Ruhl, *supra* note 85.

88. *See* ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (C.S. Holling ed., John Wiley & Sons) (1978); CARL WALTERS, ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES (1986) (discussing the ecological underpinnings of spatially and temporally structured ecosystem hierarchies and the cyclical functioning of these ecosystems to demonstrate why adaptive management focuses on maintaining and restoring the ecological functions of systems).

terms of how resource management should be conducted. A typical view is expressed by the National Research Council-National Academy of Sciences report cited by Professor Tarlock:

Adaptive planning and management involve a decision making process based on trial, monitoring, and feedback. Rather than developing a fixed goal and an inflexible plan to achieve the goal, adaptive management recognizes the imperfect knowledge of interdependencies existing within and among natural and social systems, which requires plans to be modified as technical knowledge improves⁸⁹

This management approach is quickly being recognized and applied in varying degrees by governmental agencies charged with managing our natural resources.⁹⁰ These include the National Forest Service, the U.S. Fish and Wildlife Service, the U.S. Department of Interior, the Bureau of Reclamation, the U.S. Army Corps of Engineers, and the Bureau of Land Management.⁹¹ These agencies are using adaptive management to further restoration efforts of critical ecosystems, such as the Pacific Northwest Forests, the Colorado River, and the Everglades, because the focus in restoration is precisely what adaptive management seeks to accomplish—the restoration and maintenance of a system's resilience. Large scale restoration efforts require the acceptance of uncertainty and the need to learn by doing, as well as a commitment to long-term monitoring of progress toward the restoration of ecosystem functions.⁹² Therefore, current restoration efforts are the perfect candidates for utilizing adaptive management. Unfortunately, given current legal and institutional structures, the implementation of adaptive management is often problematic.

Adaptive management has most often been employed in large scale, highly complex resource projects involving huge numbers of stakeholder groups, both public and private. The use of adaptive management in projects of this scope has typically been mandated by judicial or legislative mechanisms. In large part, this suspends traditional legal blockades to the utilization of adaptive management by imposing new ground rules for resource management. This Note focuses on those situations where adaptive management has not been mandated and seeks to address the conflict between adaptive management and existing environmental laws typically found at the

89. Tarlock, *supra* note 1, at 1140.

90. See U.S. ARMY CORPS OF ENGINEERS, *supra* note 87, at 4-7,4-8; see also Tarlock, *supra* note 1, at 1143; Profeta, *supra* note 3, at 92-93; Ruhl, *supra* note 85, at 996 n.255.

91. See *id.*

92. See Profeta, *supra* note 3, at 73-75.

most basic levels of resource management. Adaptive management should be useful in the context of environmental permitting (the individual level) in order to be successfully employed in larger, more complex resource issues.

The legal challenge to implementing adaptive management is finding a balance between providing flexibility in order to allow for "adapting" management as information is gained about the system, while simultaneously satisfying procedural due process and providing finality.⁹³ Adaptive management seeks to embrace uncertainty while environmental law and the need for due process fundamentally reject it.⁹⁴

Can adaptive management work within our current legal framework? Using the Everglades Nutrient Removal Project (ENR), an expressly adaptive management project, Part II explores the difficulties encountered in implementing an adaptive management strategy in the process of obtaining permits under the Clean Water Act and the Endangered Species Act. Areas of potential progress and those in need of serious reform are also identified. Following this exploration, Part III examines recommendations on how to reconcile adaptive management with current environmental law.

II. THE EVERGLADES NUTRIENT REMOVAL PROJECT: AN EXAMPLE OF CONFLICT

The ENR is an approximately four thousand acre man-made wetland, the largest in the world, located on the northwest border of the Loxahatchee National Wildlife Refuge.⁹⁵ Its purpose is to reduce total phosphorus loads entering the refuge; help minimize imbalances in Everglades flora and fauna; and serve as the test model for the implementation of a similar system, ten times larger, utilizing similar technology.⁹⁶ The larger system, known as the Stormwater Treatment Areas (STAs), was the result of a mediated settlement in 1992⁹⁷ and was incorporated into the Everglades Forever Act of 1994.⁹⁸ The ENR employs a "fundamentally adaptive strategy" because it is being used to test the validity of the STA concept for nutrient removal.⁹⁹ After its third year of operation, the ENR has greatly exceeded expectations by

93. See Tarlock, *supra* note 1, at 1140.

94. See *id.*; Profeta, *supra* note 3, at 94.

95. See S. FLA. WATER MGMT. DISTRICT, THE EVERGLADE NUTRIENT REMOVAL PROJECT—YEAR TWO SYNOPSIS (1997).

96. See *id.*

97. See *United States v. South Fla. Water Management Dist.*, 847 F. Supp. 1567 (S. D. Fla. 1992).

98. See *generally* FLA. STAT. ch. 373.4592(4)(a) (1994).

99. See Light et al., *supra* note 30, at 146.

reducing phosphorus concentrations to twenty-two parts per billion, far lower than the long-term target of fifty parts per billion.¹⁰⁰

The South Florida Water Management District (SFWMD), the agency operating the ENR and the six future STAs, is currently in the process of acquiring the remaining land needed for the STA project, securing the necessary permits required for construction and operation, and proceeding with the construction of some STA units.¹⁰¹ While the STA project moves forward, the ENR project continues to generate controversy—debate that may be seen in similar form during the permitting of the STAs or other Adaptive Management projects around the country.¹⁰²

The ENR project is currently operating on an interim order granted by the United States Environmental Protection Agency (EPA). The EPA granted this Interim Order after the Miccosukee Indians and the Friends of the Everglades challenged the initial National Pollutant Discharge Elimination System (NPDES) permit.¹⁰³ Specifically, they challenged the issuance of the permit based on whether the experimental ENR provided the assurances that water quality standards would be met.¹⁰⁴ The Indian tribe did not challenge the state and federal permits required for the construction of the ENR.¹⁰⁵

The NPDES permit challenge clearly illustrates the problems inherent in trying to implement an adaptive management project within the current permitting framework.¹⁰⁶ Ironically, this is the same process regardless of whether a project is a development project or, as in this case, a restoration project. Thus, the basic conflict was that federal NPDES permitting required that the SFWMD prove that the water quality standards of the CWA would be met by the ENR.¹⁰⁷ However, the ENR was designed to test this very hypothesis: how well could a man-made wetland treat nutrient laden

100. See S. FLA. WATER MGMT. DISTRICT, EVERGLADES 1997 ANNUAL REP. 10.

101. See *id.* at 19-27.

102. Interview with Keith Rizzardi, Counsel for the South Florida Water Management District, in W. Palm Beach, Fla. (Nov. 14, 1997); Interview with Gary Goforth, Chief Consulting Engineer with the Everglades Construction Project, in W. Palm Beach, Fla. (Nov. 13, 1997).

103. See S. FLA. WATER MGMT. DISTRICT, *supra* note 95, at 2; Light et al., *supra* note 30, at 146; Ankersen & Hamann, *supra* note 57, at 497.

104. See Ankersen & Hamann, *supra* note 57, at 497.

105. See Interview with Gary Goforth, *supra* note 102. At the time of permitting for the ENR, the State of Florida, pursuant to the Clean Water Act, had not taken over authority for permitting of the National Pollutant Elimination Discharge System permitting program. Therefore, the ENR construction permit (§ 404 of the CWA) was approved by the Army Corps of Engineers, while the operational permit (§ 402 of the CWA) needed approval by EPA.

The Everglades Forever Act of 1994 establishes a unique permitting system for the Everglades Construction Project (the Stormwater Treatment Areas) in order to streamline the permitting process. See FLA. STAT. ch. 373.4592 (1994).

106. See Ankersen & Hamann, *supra* note 57, at 497.

107. See *id.* at 496.

stormwater runoff?¹⁰⁸ The EPA subsequently issued the NPDES permit which required hydrologic monitoring, research on optimization of nutrient removal, extensive water quality monitoring and reports, vegetation monitoring, parasite monitoring, and a mercury research program.¹⁰⁹ However, the legal challenges in this case have resulted in the permitting process becoming a significant impediment to agencies carrying out adaptive management projects. This effect promises to become more commonplace. Implementers will be thwarted by the burden of proving the future certainty of water quality compliance required to obtain a permit. In addition, the agencies must be prepared for the gridlock they will experience due to legal challenges brought on the basis of the issuance of the permits.

Adaptive management projects that seek to restore the functions of ecosystems to maintain their resilience will almost always be moving toward an improvement in conditions of the ecosystem. Yet these projects are scrutinized under the same process as development projects which rarely seek improvement of the environment as their primary goal. Fortunately, in the case of the ENR, the EPA realized the purpose behind the project and issued the interim order based on the understanding that water conditions were designed and expected to improve.¹¹⁰ However, it would be unrealistic to believe that permitting proceedings will tend toward permits being granted, because few projects possess the tremendous political momentum of the ENR; nor do all projects actually improve environmental quality despite their stated goals to do so.

A more typical example might involve the proposed removal of a dam and the re-establishment of the natural river course and flow.¹¹¹ Removal of a dam could be subject to permitting pursuant to the CWA under sections 401, 402, 404, or all three.¹¹² The causes for concern in dam removal involve the release of built up sediments causing water quality problems and excessive

108. See *id.*

109. See THE EVERGLADES NUTRIENT REMOVAL PROJECT—YEAR TWO SYNOPSIS, *supra* note 96, at 2; U.S. Environmental Protection Agency, Permit No. FL 0043885.

110. See Interview with Gary Goforth, *supra* note 102.

111. See Kelly L. Hartley, *In Fighting a Dam Disaster, They Helped Make History*, NAT'L WILDLIFE, Dec.–Jan. 1998, at 66; *Removing the Edwards Dam: A Victory for Rivers*, FLY FISH AMERICA, Nov.–Dec. 1997, at 41; Ro Trent Vaselaar, *Opening the Flood Gates: The 1996 Glen Canyon Dam Experiment*, RESTORATION & MGMT NOTES 119 (Winter 1997). Currently there are efforts to have dams decommissioned upon evaluation of license renewals. There are also several initiatives to remove dams or alter water flows primarily to improve aquatic and surrounding upland habitat. Recently, the Clyde River No. 11 dam was removed in Vermont and experimental water deliveries from the Glen Canyon dam were delivered to the Colorado River, both efforts to restore hydrologic functions to the natural riverine systems.

112. See 42 U.S.C. §§ 1341, 1342, 1344 (1994). Dam removal can be subject to the state certification process (§ 401), dredge and fill permitting because of sediment removal that may be necessary (§ 404), NPDES discharge permitting because of sediment released upon dam removal and deconstruction (§ 402), or possibly a combination of these permitting requirements depending on the circumstances.

turbidity, as well as potential issues with damaging the rearing habitat of endangered species, the reclamation of the floodplain area of the previous reservoir, and the potential increase in adjacent land being flooded during natural storm events. Any one of these issues could remove the flexibility needed to adaptively manage the restoration of a river body due to legal challenges that may be brought against permitting the removal of the dam.

Those hydrologic projects that attempt adaptive management as well as require CWA permits may also encounter conflicts with the ESA. A perfect example of the problems encountered with adaptive management and the ESA is illustrated by activities in the Columbia River Basin.¹¹³ There, a resolution of the conflict between hydropower and wild salmon population restoration through the utilization of adaptive management has been hampered by the listing of several Snake River salmon species.¹¹⁴ The ESA does not forbid experimentation with listed species as long as a "taking" is not involved. However, the ability to convince people that "risking harm to a species on the brink of extinction, while embracing the scientific method's root principle that failure . . . may be necessary in order to learn," would seem slim, and probably in most people's minds, wrong.¹¹⁵ Instead, the listing of Snake River salmon, or any species, will require "a cautious approach to adaptive management . . . [with] bold testing . . . central to the original concept of adaptive management . . . [making it] unlikely to fit comfortably into the endangered species era."¹¹⁶

The increasing use of Habitat Conservation Plans (HCPs)¹¹⁷ pursuant to the ESA is also problematic.¹¹⁸ Some HCPs provide landowners with a "no surprises" guarantee that protects them from having to go beyond any of their agreements with the government in the future—the idea that "a deal is a deal." Adaptive management is precluded because as understanding of an area

113. See, e.g., Volkman & McConnaha, *supra* note 11 (suggesting the difficulties encountered with utilizing adaptive management in the face of ESA non-experimentation provisions); but cf. Ludwik A. Teclaff & Eileen Teclaff, *Restoring River and Lake Basin Ecosystems*, 34 NAT. RESOURCES J. 905, 912 (1994) (explaining that the removal of two dams on the Elwha River is motivated primarily for the restoration of habitat listed anadromous species; also explaining that flexibility in the natural system exists to allow for the short term sedimentation loading that will accompany removal of the dams).

114. See Volkman & McConnaha, *supra* note 11, at 1267.

115. *Id.* at 1261.

116. *Id.* at 1267.

117. HCPs are agreements between a federal agency and landowners that allow landowners to carry on economic activities that may result in the "incidental take" of an endangered species through a permit, but in return requires certain conservation measures to be taken by the landowner. These conservation measures are outlined in an HCP prepared by the landowner and might include the setting aside of habitat or paying for the acquisition of habitat elsewhere. See Michael Lipske, *Giving Rare Creatures a Fighting Chance*, NAT'L WILDLIFE, Feb.-Mar. 1997, at 16-17.

118. See A. Dan Tarlock, *Federalism Without Preemption: A Case Study in Bioregionalism*, 27 PAC. L.J. 1629, 1649 (1996).

covered by an HCP progresses and suggests alternative management strategies, those strategies may not be allowed under the negotiated HCP.¹¹⁹ The only option available is to negotiate an HCP that incorporates "adaptive management provisions."¹²⁰ These provisions might have the effect of souring the deal for landowners who are seeking release from future liabilities and expense. However, HCPs without flexible provisions to account for future adaptive management may prove harmful to the endangered species they seek to protect.

Lance Gunderson, a leading practitioner and academic in the field of adaptive management, suggests that the techniques can be implemented in areas where enough flexibility in the natural system exists to allow the "experimentation" of adaptive management to proceed.¹²¹ In the case of conflict between the ESA and adaptive management, he pointed to the controversy regarding the snail kite, a listed bird found in the Everglades, and the flooding of its habitat as part of an adaptive management experiment. In this enough flexibility existed in the natural system to allow the use of adaptive management.¹²² Gunderson also believes that in the Columbia River basin adaptive management could be implemented on smaller scales, where the threat to a listed species is not serious.¹²³ He added that the implementation of adaptive management can only succeed where flexibility is found not only in the natural system, but also in the political and social systems as well.¹²⁴ Such flexibility would be necessary in the social system to correctly implement adaptive management within the context of HCPs. The remaining question is whether enough flexibility exists in the legal system to allow adaptive management to be utilized. There are many views

119. See *id.* at 1649; see also *Environmentalist Questions Effect of 'No-Surprises' on Species Act*, INSIDE ENERGY WITH FEDERAL LANDS, available in 1996 WL 8697161.

120. John Kostyack, *Reshaping Habitat Conservation Plans for Species Recovery: An Introduction to a Series of Articles on Habitat Conservation Plans*, 27 ENVTL. L. 755, 763-64 (1997) See also Donald C. Baur & Karen L. Donovan, *The No Surprises Policy: Contracts 101 Meets the Endangered Species Act*, 27 ENVTL. L. 767, 779 (1997); Jon R. Luoma, *Habitat Conservation Plans: Compromise or Capitulation?*, AUDUBON, Jan.-Feb. 1998, at 41.

121. See Telephone Interview with Lance Gunderson, Professor in Department of Zoology, U. Fla. and former Wetlands Ecologist of Everglades Nat'l Park, (Oct. 28, 1997).

122. See *id.*; see also Robert E. Bennets et al., *The Snail Kite in the Florida Everglades: A Food Specialist in a Changing Environment*, in EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION 507, 517-28 (Steven M. Davis & John C. Ogden eds., 1994).

123. See Interview with Lance Gunderson, *supra* note 121.

124. See *id.* Social and political flexibility refers to the acceptance that alternatives in management exist—a willingness to look beyond imbedded beliefs. This may be accomplished by a "long term set of actions that integrate policy and learning (e.g. a percolation of understanding derived from an assessment), or it may occur when an unforeseen policy crisis allows for reformation or restructuring of power relationships." Lance M. Gunderson, *Flexibility, Resilience, and Adaptive Environmental Assessment and Management*, Abstract, in AMERICAN FISHERIES SOCIETY: ADAPTIVE MANAGEMENT: AN ASSESSMENT OF THE PRINCIPLES AND THE PRACTICES, August 1997 (on file with author).

on this question, even in the case of the ENR project and the ongoing STA project.

III. IS THERE FLEXIBILITY IN OUR LEGAL SYSTEM FOR ADAPTIVE MANAGEMENT TO FOSTER RESTORATION?

The ENR project and future STAs presented a unique situation for the SFWMD—an opportunity to take an adaptive approach to restoration. However, as discussed above, all has not gone smoothly in terms of obtaining the operational permits for the ENR project. This has not discouraged the SFWMD from moving forward with the STA project. However, the SFWMD has been forced to invest substantial time into the structuring of permit requests for the STAs so as not to run into similar problems.¹²⁵ Yet there is no assurance that permitting problems will not arise again.¹²⁶

Gary Goforth, Chief Consulting Engineer with the Everglades Construction Project, believes that section 404 permitting by the Army Corps of Engineers (ACE) for construction of the ENR allowed for a fair amount of flexibility in implementing adaptive management. This flexibility was a result of the ACE's recognition of a degree of uncertainty associated with the construction of the world's largest man-made wetland.¹²⁷ He added that the general consensus in the effort to restore the Everglades tilts decisions toward taking action rather than inaction, and that perhaps this was a factor in the ACE section 404 permitting decision.¹²⁸ However, permitting under section 402 of the CWA poses greater problems. Goforth pointed to the monitoring of water quality data as a major impediment, because compliance with the CWA frequently requires short cycle monitoring on weekly or monthly schedules.¹²⁹ Still, these monitoring and reporting cycles, which are used to ensure compliance with section 402 numerical standards, do not take into account the natural cycles and fluctuations of the Everglades hydrologic system.¹³⁰ Therefore, compliance with section 402 may only be possible if permitting agencies recognize and allow for more flexible monitoring and reporting. It is even more suspect that the ENR required an NPDES permit because it is not a source of added pollution.¹³¹ In fact, the ENR is a structure

125. See Interview with Gary Goforth, *supra* note 102.

126. See *id.*

127. See *id.*

128. See *id.*

129. See *id.*; see also 40 CFR § 122.41 (1997).

130. See Interview with Gary Goforth, *supra* note 102.

131. Although the ENR may actually be creating "pollution" under § 502(19) of the Clean Water Act because it is a "man-made or man-induced alteration" of the chemical, physical & biological integrity of the water, it does not "discharge" pollutants because it does not create an "addition" as defined by §

designed to reduce phosphorus from agricultural stormwater runoff and improve water quality to the Loxahatchee National Wildlife Refuge. Herein lies the paradox of treating restoration projects as development projects and the potential for stifling adaptive management efforts.

A. Legal Flexibility

Keith Rizzardi, counsel for the SFWMD, agrees that reconciling adaptive management and environmental law is a task fraught with difficulties.¹³² His concerns, like that of any agency seeking permits, center on the flexibility available in statutory standards, satisfying due process, and the problem with using permit modifications to “adaptively” manage a project.¹³³

Permitting under Florida’s water laws requires that the permittee provide “reasonable assurances” that “state water quality standard[s] . . . will not be violated and reasonable assurance that such activity . . . is not contrary to the public interest.”¹³⁴ The breadth of “reasonable assurances” in Florida has yet to be fully tested by adaptive management. However, “reasonable assurances” has been tested within the context of construction projects.¹³⁵ The Florida District Court of Appeals required “substantial likelihood that the project [including measures that sustain or improve water quality] will be successfully implemented.”¹³⁶ The problem for adaptive management projects is that “reasonable assurance” is required before the project is started. Unless proponents of an adaptive management project can make such assurances, a permit will be denied. In many cases, an adaptive management project should be able to be analyzed to a degree that will provide this level of confidence prior to construction or operation (such as the ENR); however more radical projects that are experimenting beyond the bounds of conventional analysis

502(12). Perhaps the requirement for the NPDES permit was to ensure that water leaving the ENR would not contain an increase in other water quality parameters irrespective of the planned reduction in phosphorus.

132. See Interview with Keith Rizzardi, *supra* note 102.

133. See *id.*

134. FLA. STAT. ch. 373.414(1) (1997).

135. See, e.g., *Metropolitan Dade County v. Coscan Fla., Inc.*, 609 So. 2d 644 (Fla. Dist. Ct. App. 1992) (involving expansion of a marina and experimental technology to improve water quality parameters); *Berry v. DER*, 530 So. 2d 1019 (Fla. Dist. Ct. App. 1988) (involving evidence presented in favor of dredge and fill permit); *Friends of the Everglades, Inc. v. DER*, 496 So. 2d 181 (Fla. Dist. Ct. App. 1986) (involving alteration of a marina basin).

136. *Metropolitan Dade County*, 609 So. 2d at 648.

may not.¹³⁷ Unlike most projects involving state waters, the STA project will not be subjected to this standard.¹³⁸

The Everglades Forever Act governs the permitting process for the STA projects.¹³⁹ The Act created a streamlined permitting system administered by the Florida Department of Environmental Protection (DEP) to meet the "immediate need to initiate cleanup and restoration of the Everglades . . . through the Everglades Construction Project (ECP)," also known as the STAs.¹⁴⁰ The DEP is authorized to issue the STA permits provided that the SFWMD makes "reasonable assurances . . . that the final design of the ECP shall minimize wetland impacts, to the maximum extent practicable . . ." ¹⁴¹ Given the intent of the Everglades Forever Act to foster restoration efforts and STA construction, the language seems to suggest that a degree of uncertainty regarding the construction and operation of the STAs will be acceptable. This has not yet been challenged in an administrative hearing. Nevertheless, relying on the absence or presence of flexibility in statutory language which does not expressly adopt or recognize adaptive management certainly will not foster the development and use of adaptive management projects.¹⁴²

Another problem with utilizing the current regulatory framework is the difficulty in modifying an approved permit when an adjustment is needed in an adaptive management project.¹⁴³ Permit modification will be needed for most project adjustments of any significance because adjustments are made to test a new adaptive strategy.¹⁴⁴ Each permit modification is vulnerable to a third party challenge as well as disapproval by the permitting agency, thus making adaptive management via permit modification a drawn out and possibly futile process. It has been suggested that an interim period of significant duration for project adjustment be allowed for adaptive

137. See *id.* at 648 n.6 (explaining that even new technologies must be analyzed before permitting). In some cases, adaptive management projects may be the equivalent of an experiment for a new technology or management strategy that cannot be analyzed before permitting. According to the Florida District Court of Appeals, it appears that such projects or strategies would fail to secure permits. See *id.* at 648.

138. FLA. STAT. ch. 373.4592(9) (1994)

139. See *id.*

140. *Id.*

141. FLA. STAT. ch. 373.4592(9)(c)(3) (1994).

142. This is in sharp contrast to the Pacific Northwest Forest Plan that expressly adopts adaptive management as a core approach and has created specific forest areas (Adaptive Management Areas) of up to 400,000 acres for adaptive strategies to be tested for possible implementation on a larger scale.

143. See Interview with Keith Rizzardi, *supra* note 102.

144. See Karen M. Wardzinski et al., *National Pollutant Discharge Elimination System Permit Application and Issuance Procedures*, in CLEAN WATER HANDBOOK 93 (Parthenia Evans ed., 1994) ("minor modifications are nonsubstantive in nature or require imposition of more stringent permit condition. . . . Virtually all modifications that result in less stringent permit conditions are treated as major modifications requiring public notice and comment and compliance with the administrative procedures identified in 40 C.F.R. § 124.5"). *Id.* at 93.

management projects, during which time modifications would not be subject to third party challenges.¹⁴⁵ While this might allow for more timely adjustments and prevent the original permitted conditions from being frozen, it does not satisfy the due process concerns of potentially affected third parties. Solutions to this dilemma might lie in negotiating terms with third parties prior to the issuance of the original permit. Such negotiated terms could include provisions for project evaluation and possible termination similar to those contained in Florida's sunset laws.¹⁴⁶

B. Institutional, Social, and Judicial Flexibility

For now, the best that can be hoped is that agencies utilizing adaptive management projects for restoration efforts will be allowed to have projects permitted with the recognition that uncertainty exists in attempting to restore ecosystem functions, and that restoration projects seek to improve environmental quality. Despite the fact that the experimental nature of adaptive management projects may at times call for strategies that, in the short term, appear contrary to conventional practices (such as experimenting with an ESA-listed species or temporarily releasing sediment from behind a water control structure), the projects pursue long term improvement and learning. Acceptance of this proposition requires either substantial political and social momentum, as in the case of the restoration of the Everglades, or significant cultural and institutional change within governmental agencies to effectively reshape their view of resource management. For adaptive management to succeed, agencies must view management as a long term learning experience that embraces uncertainty.

From a broader perspective, the flexibility needed to implement adaptive management may already exist. Professor Profeta believes that "[a]s long as an adaptive management [project] is approved pursuant to the Administrative Procedure Act, then each individual manipulation in the management plan should not violate due process."¹⁴⁷ This would allow third parties to bring a claim that an adaptive management adjustment was "arbitrary and capricious," yet not place the agency action in extreme danger of violating due process.¹⁴⁸ The Pacific Northwest Forest Plan, which will be the testing

145. See Interview with Keith Rizzardi, *supra* note 102.

146. See Telephone Interview with Lance Gunderson, *supra* note 121. Sunset provisions in legislation set a date for termination of the legislation unless it is renewed, usually after a review of the legislation's effectiveness over the past course of time. A similar review could be conducted with respect to adaptive management projects to give third parties some assurance that periodic review and perhaps termination are options.

147. See Profeta, *supra* note 3, at 96.

148. See *id.*

ground for this approach, hopefully will provide insight in the near future as to its potential.¹⁴⁹

The bulk of the legal support for the implementation of adaptive management projects lies in the presence of flexibility in statutory language and due process—avenues that do not hold great promise. In some instances, the commitment to utilize the techniques in particular resource management situations has come from either executive order or broad social and agency agreement such as in the Pacific Northwest Forest Plan, the manipulation of the Glen Canyon Dam on the Colorado River, and in the Columbia River basin.¹⁵⁰ In order for agencies to be free to use adaptive management as a resource management and restoration tool, the legal framework for decision-making and permitting must explicitly recognize the flexibility needed to manage adaptively, yet still provide a degree of finality to those parties affected by resource management decisions. Solving this puzzle will require broader change rather than piecemeal legislation or legal maneuvering within the existing legal framework.

Professor Tarlock has long advocated that environmental law must change to reflect the new "nonequilibrium paradigm," which accepts the ecological premise that ecosystems are dynamic systems that require management in the face of uncertainty.¹⁵¹ He suggests that "[the] new found respect [of natural processes of ecosystems] can support laws that recognize the value of new resource functions enacted in advance of conclusive scientific evidence."¹⁵² However, in addition to legal change, he adds that "[t]he major institutional change necessitated by the non-equilibrium paradigm is the need to apply adaptive management . . ."¹⁵³ Change of this

149. See Peter List, *Public Judgements About Adaptive Management in the Central Oregon Cascades*, Abstract, in AMERICAN FISHERIES SOCIETY SYMPOSIUM: ADAPTIVE MANAGEMENT: AN ASSESSMENT OF THE PRINCIPLES AND THE PRACTICE, August 1997 ("President Clinton's Northwest Forest Plan calls for ecosystem-based practices in the management of Federal forests in the Pacific Northwest, with greater cooperation between federal and local agencies, private forest landowners, and the general public. Emphasis is to be placed on community-oriented forestry that takes into account the social and economic interests of forests proximate communities. The plan embraces . . . the concepts of . . . adaptive management, and designates ten adaptive management areas in the Pacific Northwest and Northern California").

150. See Profeta, *supra* note 3, at 93; see also Tarlock, *supra* note 1, at 1143; Volkman & McConaha, *supra* note 11, at 1249; Long's Peak Working Group on National Water Policy, 24 ENVTL. L. 125, 130 (1994) (stating that the report of the Long's Peak Working Group, a group of thirty national experts in water policy, presented President Clinton with a major report and recommendations on national water policy which emphasized restoration based upon the principle of adaptive management); Bernard T. Bormann, *Ecosystem Sustainability Through Adaptive Management and Research* (visited Oct. 8, 1997) <<http://www.fs.fed.us/eco/s27pre.htm>>.

151. Tarlock, *supra* note 1, at 1134-37.

152. *Id.*

153. *Id.* at 1139.

kind will take place when we recognize that “[a]ll . . . management is an ongoing experiment.”¹⁵⁴ In his view:

[t]o balance the legal system's traditional promotion of individual fairness with the continued protection of the environment, it must now adapt to the new landscape, in part, by concepts that provide for the *continuous integration of science and policy making . . . and pay as much attention to the implementation and monitoring of management policies as we do their formation.*¹⁵⁵

Professor Tarlock's view of what is needed coincides closely with the concepts of adaptive management, specifically the need for institutional learning through implementation and monitoring of management policies.

A similar view is held by John Titre, editor of the recent ACE publication, *Planning and Evaluating Restoration of Aquatic Habitat from an Ecological Perspective*.¹⁵⁶ This publication expressly adopts adaptive management as the process to manage restoration projects because of the inherent uncertainty present in restoring ecological functions of a system.¹⁵⁷ However, even Titre agrees that the ACE permitting obligations under the CWA are difficult to reconcile with the goals of adaptive management.¹⁵⁸ He, like most others, believes that a large cultural and institutional change must take place to recognize what many of those in the scientific community have accepted—“management requires flexible goals and design and a long-term commitment to detailed monitoring and fine tuning after initial implementation. The potential benefits of adaptive management are great and widely recognized within the governmental community, so *institutional impediments to its use should not persist.*”¹⁵⁹

IV. CONCLUSION

After generations of attempting to control the natural fluctuations in ecosystems in order to secure the benefits of natural resources for human use, there is a growing realization that we have eroded the ability of our natural systems to cope with events of natural and human surprise. These events have

154. *Id.*

155. *Id.* at 1144 (emphasis added) (This is a central feature of implementation of adaptive management).

156. See U.S. ARMY CORPS OF ENGINEERS, *supra* note 87. See also Interview with John Titre, Editor, *Planning and Evaluating Restoration of Aquatic Habitats from an Ecological Perspective* for the U.S. Army Corps of Engineers, Alexandria, Va., (Nov. 6, 1997).

157. See U.S. ARMY CORPS OF ENGINEERS, *supra* note 87, at 1-5.

158. See Interview with John Titre, *supra* note 156.

159. *Id.*; see also U.S. ARMY CORPS OF ENGINEERS, *supra* note 87, at 1-5 (emphasis added).

often come at the expense of further damaging the natural systems and destroying the social systems that have come to rely upon their continued control. Attention is shifting toward the restoration of system functions as a means of preventing this recurring cycle because we have recognized the benefits of natural ecosystem services to human beings. Given this change, the question then becomes how to refocus our legal, social, and institutional systems in order to manage the uncertainty that accompanies the restoration of ecosystems that we now admit we know very little about.

Adaptive management has been recognized in interdisciplinary circles and put forth as the best approach for tackling this job, but it faces impediments because of broad cultural and social resistance to change, as well as inflexible environmental laws and legal processes. While there are some existing avenues through which adaptive management may be implemented into our current legal system, its full potential will not be realized until our legal system explicitly recognizes the new ecological paradigm of "non-equilibrium" and the corresponding management approach of adaptive management. The legal system is often out of step with cultural or scientific change, constantly lagging behind in evolution and acceptance of new approaches. In the case of environmental restoration, we do not have the time to wait for this evolution to take place.

Warren T. Coleman

